



Volume 4

*Report on
Advanced Research*
2016-2017



- Life Science
- Physical Science
- ICT
- Marine Science

- Mathematical Science
- Social Science
- Sustainable Development Goals (SDGs)

Grants for Advanced Research in Education

**Secondary and Higher Education Division
Ministry of Education**



Ministry of Education



Report on Advanced Research 2016 - 2017

Grants for Advanced Research in Education (GARE)

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



PRIME MINISTER
GOVERNMENT OF THE PEOPLE'S REPUBLIC OF
BANGLADESH

Message

It is indeed a great pleasure for me that the Secondary and Higher Secondary Education Division, Ministry of Education published the 'Report on Advanced Research' compiling all the researches carried out during 2016-2017 fiscal year under the program 'Grants for Advanced Research in Higher Education (GARE)'. I congratulate all researchers and inventors for their dauntless efforts, and persons relating to this publication.

The Greatest Bangalee of all times, the Father of the Nation Bangabandhu Sheikh Mujibur Rahman paid the highest importance to education and research. He had allocated incremental budgets to these fields. On the other hand, he expected positive outcomes of public expenditures. Father of the Nation in his speech on 26 march 1975 uttered 'Educated brothers, your cost of education has been borne by the people's money. It has so happened that you are to work for them, you do serve them in return on top of everything'.

Awami League government has achieved tremendous successes in secondary and higher education in the last twelve years. We have adopted a time befitting education policy with an emphasis on building educated and skilled human capital. We are now laying more importance on innovation for improving the quality of secondary education and research in higher education. Since we are striving to achieve SDGs on time and make it to a developed nation by 2041, our government has been allocating increased resources over the years to ensure greater access to research opportunities. We have also undertaken measures so that institutions concerned can have the state of the art facilities to conduct researches to enhance productivity in all sectors.

I hope that the Ministry of Education will continue to do its best to nourish and assist research endeavors through higher educational institutions and research organizations of the country.

I wish all out successes of this publication.

Joi Bangla, Joi Bangabandhu
May Bangladesh Live Forever.


10 December 2020

Sheikh Hasina



Dr. Dipu Moni M.P.
Minister
Ministry of Education
Government of the People's
Republic of Bangladesh

Message

I am delighted that Ministry of Education is going to publish Volume 4 of the Report on Advanced Research that includes 37 Project Completion Reports (PCR) covering different areas of research under Grants for Advanced Research in Education (GARE) during the period of 2016-2017. This publication represents the efforts, achievements and potential of the eminent academics working in different universities/institutes of our country.

Well planned and scholastic research is vital to the success of national, regional and global endeavors. The systematic, controlled, empirical and critical investigations on social, cultural, industrial and economic propositions contribute effectively to the productive outputs of the country. In many developed countries, university academics and researchers are playing vital role through their innovations in high-tech industries and industrial development.

The Ministry of Education is keen to facilitate creation of intellectual capital that can address today's issues, improve the quality of life, and accelerate momentum for our economic growth by providing funds for research through GARE. We expect to get authentic data from researchers on which we may base our policy decisions and enhance our knowledge of how to address national problems and improve our economy.

GARE hopes to go forward achieving dynamic success in research in higher education and thus contribute to improving the quality of life of all peoples of our country. I hope this report will be a useful source of information, especially for those who are interested in conducting research in future to contribute significantly to our national and industrial development.

Joi Bangla, Joi Bangabandhu
May Bangladesh Live Forever.

10 December 2019

Dr. Dipu Moni, M.P.



Mohibul Hassan Chowdhury M.P.
Deputy Minister
Ministry of Education
Government of the people's
Republic of Bangladesh

Message

The necessity of building competitive higher education system inspired the government to initiate a program of Grants for Advanced Research in Education (GARE). The objective of GARE is to develop a research culture in the country so that we can address our problems, find remedies and hence contribute to the economic and social growth of the country. This edition of the publication – a fourth in the process contains the research findings and results for the benefit of the nation. These may bring about useful application and may also invite more and more researches for fruitful utilization to the benefit of the country.

Bangladesh economy is doing well despite frequent global crises, climate change induced disasters, fast population growth, runaway urbanization and increasing environmental degradation. These phenomena put up fresh challenges to the country which must seek out ways collectively to mitigate the problems and thrust upon the universities and research institutions a historic task of generating knowledge, new ideas and technologies that would contribute towards achieving the nation's development goals. The GARE research should also address issues connected with the government's Delta plan 2100 for the future generation.

We are confident, more and more researchers will come forward with innovative proposals and take research grants for enhancing the quality of higher education and quality of our lives and living.

I take this opportunity to thank the officials involved in organizing and managing this programme and thus, contributing to build a strong higher education system in Bangladesh.

Mohibul Hassan Chowdhury M.P.



Md. Mahbub Hossain
Secretary

Secondary and Higher Education Division
Ministry of Education
Government of the People's
Republic of Bangladesh

Message

I am happy to know that the Secondary and Higher Education Division, Ministry of Education (MoE) is going to publish the fourth volume of the Report on Advanced Research on the research projects completed under the Grants for Advanced Research in Education (GARE) program for the period 2016 – 2017. The fund for the projects has been made available for the academics with excellent background in higher education. The purpose was to carry out research works so that they can build up their capacity to generate new knowledge. We are also glad to learn that research in higher education is generating results which can be replicated and applied for national development and boosting our national economy.

The relationship between research and subsequent scientific development is now well recognized. The need for sharing knowledge between researchers and industries has become increasingly evident in recent years. In this backdrop, Bangladesh needs a big leap in developing its research sector, especially in higher education sub-sector, considering the need and demand of the market and growth of industrial sector as well.

It is quite evident that GARE has been over the years contributing immensely in this sector, apart from meeting the scholastic quest of the researchers themselves. I am rest assured that there are some projects under GARE, the findings of which are worthy of having implications in policy formulation and national projects implementation.

We feel proud that our young researchers are working round the clock finding out the problems they encounter every day and their solutions as well. We hope, the focus of their research works will be more on need based and demand driven and the findings will be of great use for the stakeholders, precisely the taxpayers. We hope, there will be more innovative research under GARE in the coming days. We also believe, to successfully meet the challenges of our journey to development, higher education and research should go hand in hand.

I express my gratitude to all researchers, reviewers, experts and different committee members for their immense contribution and support for GARE program. I am also thankful to the officials of Secondary and Higher Education Division and BANBEIS for their engagements in preparing this report.

Md. Mahbub Hossain



Professor Mesbahuddin Ahmed
Chairman, Editorial committee &
Chairman, Bangladesh Accreditation Council

Preface

It is my pleasure to find that fourth volume of the report on Grants for Advanced Research in Education (GARE) is coming out. This volume contains reports of the projects completed between the period 2016-17. I am also very happy to see that this volume contains some very important research findings which are likely to attract attention of a wider section of people and possibly will find useful applications.

We know that a wide range of skilled individuals is essential for the development of research and hence we, not only support research of teachers of the universities and research organizations, but also put in effort to develop skilled manpower by giving support for M.Phil, Ph.D students with the research projects. The program of GARE is growing from strength to strength as more and more researchers are applying for funds. The government of the People's Republic of Bangladesh has taken the laudable stand of offering support to all applicants considered suitable for funding by the reviewer's committee. This is simply a big achievement for all of us to realize that the country can make progress in social and economic sectors only through utilizing results of research. Therefore, developing a research culture should be our top priority and this GARE project is just doing that.

I wish this volume also will receive due attention of our community.

A handwritten signature in black ink, appearing to read 'M. Ahmed'.

Mesbahuddin Ahmed



Habibur Rahman
Member Secretary
Editorial Committee &
Director General
BANBEIS

Foreword

I am pleased that the fourth report on completed research projects under the Grants for Advanced Research in Education (GARE) of Ministry of Education is going to be published soon. We are aware that Bangladesh Government has continued its strong emphasis on advanced research. There is no alternative to research while the country is pursuing to achieve supremely ambitions and transformational vision of the 2030 Agenda. For facilitating the country in its effort to reach middle income status by 2021 and developed status by 2041, the Ministry of Education has been providing all out support for incoming research in HE. Taking into consideration that research is a key instrument for achieving SDGs, the government has enhanced manifold the budgetary allocation in research, especially in higher research over the years. Increased allocation in research resulted in the increase of the coverage of research area as well as the number of research projects. We hope GARE will keep producing a galaxy of researchers in the upcoming years who will be able to conduct innovative and need based research in guiding us for planning future steps towards achieving the global goals.

I express my indebtedness to all concerned for their important assistance and co-operation in the process of publication of this report during the period 2016-2017. I hope, this report will be a great treasure for the researchers and will help build a resilient nation.

Habibur Rahman

Executive Summary

Introduction

The Ministry of Education is keen to facilitate creation of intellectual capital that can address today's issues, improve the quality of life, and accelerate momentum for economic growth through facilitating research and development across the country. The Ministry took initiatives for the Grants for Advanced Research in Education (GARE) program and laid down policies for funding. Researchers and academics of universities and institutions of higher learning are invited to submit focused project proposals leading to solution of important national and regional problems. The proposals are evaluated by experts in the relevant fields, and befitting funding made available based upon the potential of the proposals and the credential of researchers submitting the proposal.

Aims and objectives

The Ministry of Education is providing funds for research proposals through GARE on competitive basis for conducting research in different public and private Universities, Post-Graduate Colleges of National and Open Universities, Public Medical Colleges and Universities and Engineering Universities in the fields of Mathematical Sciences, Life Sciences, Physical Sciences, Social Sciences, ICT, Marine Sciences and Sustainable Development Goals and Research to Achieve 7th Five Years Plan targets. The aims and objectives of this research program are:

- o Acquisition, generation and dissemination of improved knowledge and technologies;
- o Development of necessary critical manpower;
- o Reducing the total production cost and enhancing GDP through utilization of country's own resources and intelligence;
- o Capacity building to meet the challenges of climate change, create favorable condition for production and mainstream as a part of development actions;
- o Taking active participation in global initiatives;
- o Providing priority to both fundamental and applied research; and
- o Fostering and maintaining research culture in higher education.

Eligibility for research grant

The MoE is very much delighted to welcome more researchers with innovative ideas to submit Project Concept Notes (PCNs) as well as Completed Proposal (CPs) in the designated areas for GARE funds. The eligibility for research grants are:

- o The applicants should have good number of scientific papers published in reputed journals;
- o The research team/individual researcher should possess experiences on presenting papers in International/National Seminar/Symposium/Workshop home and abroad;
- o On-going number of research programs of the researchers and physical facilities and international relationship of receiving institution should be satisfactory;
- o The expected outcomes of the research should reflect the national need, demand and technical suitability of its application in the country; and
- o The researchers who have already considerable achievement in research in his/her field of specialization shall be given priority.

Reports included in this publication

This publication includes total 37 Project Completion Reports (PCR) received from Principal Investigator of the projects and covers different thematic areas of research under the purview of the Grants for Advanced Research in Education. There are 19 PCR from life science, 11 from physical science, 4 from social science and 3 from mathematical science in this publication. The reports are of satisfactory standard and based on original work of the researchers. The learned and reputed Principal Investigators presented their study in brief indicating the outcomes/findings of their research.

Conclusion

Our expectation is that more talented researchers with innovative ideas would become interested and submit Project Concept Notes (PCNs) as well as Complete Proposal (CPs) in the designated areas for GARE funds. The MoE and the GoB are generous to make more funds available for creative and need based research. We are also hopeful that our researchers will publish their research outputs in renowned journals home and abroad to highlight Bangladesh. We trust the technologies developed by our learned researchers using GARE fund would get IPRs and potential outcomes would go for commercial applications and thus industrial development of Bangladesh.

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Funding Year 2016-2017

Butterfly Census and Their Eco-Ethological (Colonization) Studies in Three Forests of Bangladesh

M A Bashar and Humayun Reza Khan

Location: Department of Zoology, University of Dhaka

Duration: Three years (2014 – 2017)

Expenditure of the project: Tk. 3000000.00

Introduction

Insect-plant relationship and host-plants selection strategies are based on insect's plant-recognition abilities and adaptations in an ecological condition bring suitability for both of them (Jermy 1988). Our work programme is the part of nature conservation where the role of inter relationship between two biotic factors (plant-animal) has been envisaged. There is a synchronization of coincidences between the life stages of the butterflies and the phenological stages of their host plants where both the plants and the animals are wild organisms (Bashar 2015). Butterflies are found only in the selected forests when their host plants are found there. This coincidence of synchronization between the butterflies and the plants keep the forest healthy. Butterflies require species assemblage of the related plants in a forest ecosystem. On the other hand, the butterflies play a great role in the plant pollination; and also in the fact of plant gene-flow activities (Bashar 2016). When plant populations are ensured in a forest ecosystem, the successive trophic levels (availability of different kinds of consumer animals) are ensured. Consequently, flora and fauna are ensured to have their well-established habitats (Bashar 2014).

In accordance with the above considerations, the present research proposal has been undertaken to examine “how to estimate butterfly population per unit area under indigenous methods”.

Objectives

The pilot project aimed research objectives as stated below:

- To utilize a model for estimating butterflies in some forests of Bangladesh;
- To use biotic epicentre for identifying interactiveness between-butterfly life-cycles and their host-plant(s); and
- To establish butterfly colonization in an open forest ecosystem.

Methodologies

The present research project deals with butterfly census and butterfly behavioural strategies for evaluating essential points of biodiversity conservation as a whole. Almost all butterflies require their respective host plant (species) to maintain life style and larval development. The plant species richness contributes not only in the butterfly species richness but also in the richness of other animals in the same ecosystem (Akand *et al.* 2015). This biotic mechanism (plant-butterfly interaction) establishes a tremendous spectacular situation in the forest ecosystems. Butterfly colonization and “biotic indicators” assessment in the forest ecosystems need to conduct some proper experiments and their applications. This is necessary for piloting a developed monitoring system for biodiversity conservation in the forest ecosystem.

Followers Method- 1: *EBBL model for assessment of biodiversity status*

The Environmental Biology & Biodiversity Laboratory (EBBL), D. U. has started to do work on butterflies since 1998 as a team work. During the course of the working tenure, the research team (of the EBBL) had delivered endless efforts and immense contributions to study of the status of butterflies in forest the ecosystems of Bangladesh. Focusing on the study, the team constructed a framework to assess the status of butterflies in Bangladesh designated as “EBBL Model”. This was based on the results obtained from their field data. Additionally, the research team of the laboratory prepared a model by using ‘indigenous’ procedure. The indigenous procedure model-exercise has been processed in the present investigation (Table 1).

Six categories have been suggested by the EBBL in the context of categorizing ‘vulnerability status’ to prepare the ‘assessment process’ by using all collected and identified species of the experimental stations (forest areas). The model-exercise is stated below. In the exercise, 32 experimental stations (forest areas) have been selected as the model’s experimental units. Total experimental butterfly species were 16. Butterfly individuals of the 16 species were recorded in the selected 32 stations (forest areas). The records were made on the individuals butterfly numbers per species per stations as adopted by the procedures Latin squares design (Fig. 1).

Table 1. The EBBL-modulated formula for category determination of ‘vulnerability status’.

Conservation Status	Number of forest station (s)	Number of butterfly (s) per station
Available	>5	>5
Rare	≤5	≥5
Near Threatened	>5	≤5
Threatened	≤5	≤2
Critically Threatened	<5	1
Endangered	1	≤3

Note: >5 = more than ‘5’; ≤5 = equal or, less than ‘5’; ≥5 = equal or, more than ‘5’;
≤2 = equal or, less than ‘2’; <5 = less than ‘5’; ≤3 = equal or, less than ‘3’

LSD is very helpful and applicable method for assessing biodiversity monitoring and biodiversity sampling application. This design produces data accumulation for the numerous small-sized organisms like butterflies in the wild state. This design has got some advantage in taking measures to analyze data statistically. Data recording has been made by group wise pattern (Fig. a-1, a-2, a-3 and a-4). There are 4 groups. All the four groups started recording butterflies from 8.30 hours and ended by 11.30 hours. They completed recording as per schedule time period (8.30-11.30 hours) simultaneously (Fig. 1). The groups followed their recording operation in a cyclic order by using the blocks in A-B-C-D chronology. Block means the unit area for butterfly recording in a region of the forests (North, South, East or West).

Working-
Name of Forest:

Working Group: Gp-1
Date:

Block (Regions)	Hours				Total butterflies
	8:30	9:30	10:30	11:30	
A					
B					
C					
D					
Total butterflies					

a-1

Working-
Name of Forest:

Working Group: Gp-2
Date:

Block (Regions)	Hours				Total butterflies
	8:30	9:30	10:30	11:30	
A					
B					
C					
D					
Total butterflies					

a-2

Working-
Name of Forest:

Working Group: Gp-3
Date:

Block (Regions)	Hours				Total butterflies
	8:30	9:30	10:30	11:30	
A					
B					
C					
D					
Total butterflies					

a-3

Working-
Name of Forest:

Working Group: Gp-4
Date:

Block (Regions)	Hours				Total butterflies
	8:30	9:30	10:30	11:30	
A					
B					
C					
D					
Total butterflies					

a-4

Fig. 1. Modulation of ‘Latin squares design of sampling’. a-1. exercise of Gp-1; a-2. exercise of Gp-2; a-3. exercise of Gp-3; and a-4. exercise of Gp-4.

Method- 2 : Practice of Butterfly-Plant assessment model

The ‘butterfly-plant assessment model’ has dealt with the practice to record butterflies; and in addition to record the number of plant species in each experimental square area. Sampling procedure on the butterfly-plant assessment practice in the field was exercised in the way as it is show in below (Fig. 2).

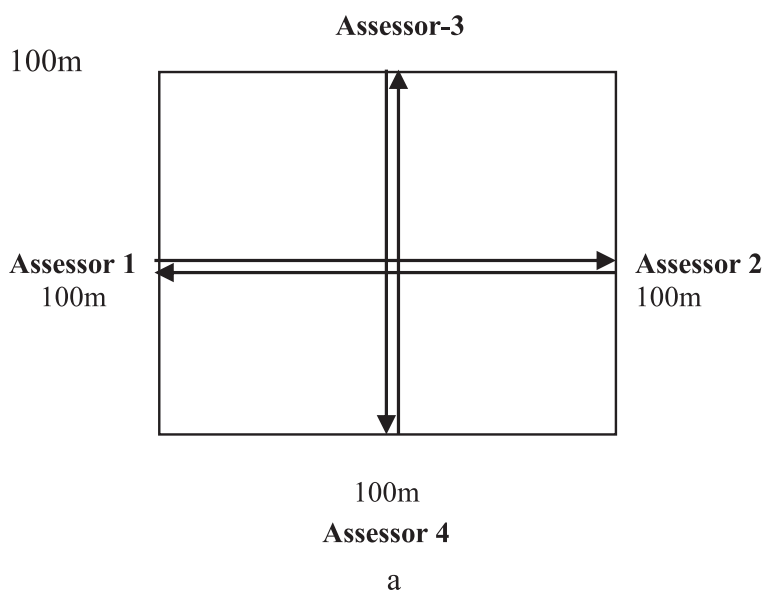


Fig. 2. Practice of Butterfly-Plant assessment model. a. four assessors-modeling.

In this practice, four assessors were assigned in the field (100 m² area) as shown on working pattern (Fig. 2). In this procedure assessor-1 will count the butterfly and as well as the number of plants species in the target area; and will continue from his standing point to the standing point of the assessor-2. Similarly the assessor-3 will do the same job to the assessor-4. The total number of the plants and butterflies of the assessors of the assessment will have been shown in the models 1, 2 and 3.

Results

Results are presented under two heading like Assessment of ‘Vulnerability status’ and Population census.

Assessment of ‘Vulnerability status’

In studying ‘Vulnerability status’ of butterflies, it is found that some of the experimental species were presented them in the field with a big size of population, some of them with moderate population size; and others were found with very small population size. In the present investigation, six categories have been exercised as EBBL model of vulnerability study of the butterfly population on Bangladesh context. These ‘Vulnerability categories’ practiced in the present method are processed as follow:

***Available (Av)** - A species is designated as ‘Available’ in Bangladesh at that case when it was recorded in more than 16% of total (5) forest stations and as well as the recorded butterfly-individuals belonging to the species per station were more than 16% of total (5) in number.

***Rare (Rr)** - When a species was found in not more than 16% of total (five or, less than in five) stations; but on the other hand, the butterfly-individuals of the species per station were recorded not less than 16% of total (five or, more than five) in number; then it is termed as 'Rare'.

***Near Threatened (Nt)** - The status 'Near Threatened' is applied in case of those species which might be found available in more than 16% of total (five) forest stations but the butterfly-individuals per species per station had not been exceeded more than 16% of total (five) in number.

***Threatened (Tr)** - A species is said to be held the status 'Threatened' when the number of butterfly-recorded forest stations had not been exceeded more than 16% of total (five). And the butterfly-individuals belonging to that species per station also had not been exceeded more than two 6% of total (two) in number.

***Critically Threatened (Ct)** - When only a single butterfly-individual of a species was recorded per station in less than 16% of total (five) forest stations but in more than one station, then it is designated as 'Critically Threatened' species.

*****Endangered (En)** - When less than 11% of total (three or, less than three) butterfly-individual(s) of a species was recorded only in 3% of total (one) experimental station; then the species is designated as 'Endangered' species in Bangladesh perspectives. The species is supposed to be no longer existed in Bangladesh if immediately measure(s) for its conservation is not to be taken.

Population census

In the present investigation total seven major families were examined in the field experiments. In total 202 butterfly species were studied in the experimental stations (forests). The families are Hesperidae, Papilionidae, Nymphalidae, Pieridae, Danaidae, Lycaenidae and Satyridae. The 'vulnerability status' are 'Available (Av)', 'Rare (Rr)', 'Near Threatened (Nt)', 'Threatened (Tr)', 'Critically Threatened (Ct)' and 'Endangered (En)'. Analytical description on the application of 'Red List preparation model' has been made as follows:

Among the total 202 examined butterfly species from the seven mentioned families the family Lycaenidae was occupied top position in the volume of species number. In the relative frequency (fr) analysis, it is revealed that the family Lycaenidae contained 22.27% species of the total species recorded (Table 2). Minimum number of species was found in family Danaidae. It was only 5.94% of the total species record. The examined butterfly species of the family *Hesperidae*, *Papilionidae*, *Nymphalidae*, *Pieridae* and *Satyridae* were 18.81%, 9.41%, 16.83%, 11.39% and 15.35%, respectively. Among the examined butterflies 48.51% species hold the 'Available' status. 22.28% butterfly species were recorded in the 'Rare' status whereas 4.46%, 6.44% and 5.94% species were in the 'Near Threatened', 'Threatened' and 'Critically Threatened' status, respectively. Only 2.97% butterfly species were recorded in the 'Endangered' status in Bangladesh context.

Table 2. ‘Vulnerability status’ of the experimental butterflies in Bangladesh context. Percentage of the examined butterflies (relative frequency) (as per method no. 4: Latin squares design).

Butterfly family	Total species examined (N)	Vulnerability status					
		Available (Av)	Rare (Rr)	Near Threatened (Nt)	Threatened (Tr)	Critically Threatened (Ct)	Endangered (En)
Hesperiidae	38 (18.81%)	21(55.26%)	12(31.16%)	--	4(10.53%)	--	1(2.63%)
Papilionidae	19 (9.41%)	7(37%)	6(31%)	3(26%)	--	2(10.5%)	1(5.3%)
Nymphalidae	34 (16.83%)	20(58.82%)	10(29.4%)	--	--	2(5.88%)	2(5.88%)
Pieridae	23 (11.39%)	13(56.52%)	8(34.8%)	1(4.34%)	--	1(4.34%)	--
Danaidae	12 (5.94%)	7(58.33%)	4(33.33%)	--	--	--	1 (8.33%)
Lycaenidae	45 (22.27%)	15(33.33%)	12(26.66%)	3(6.66%)	9(2%)	6(13.33%)	--
Satyridae	31 (15.35%)	15(48.4%)	13(41.93%)	2(6.45%)	--	1 (3.22%)	1 (3.22%)
Total	202 (100%)	98(48.51%)	45(22.28%)	9(4.46%)	13(6.44%)	12 (5.94%)	6 (2.97%)

In the family Hesperiidae, 55.26% species were recorded as available species whereas 31.16%, 10.53% and 2.63% species were recorded as rare, threatened and endangered species, respectively. No species of the family was recorded in the status ‘Near Threatened’ and ‘Critically Threatened’. 37% species of the family Papilionidae hold the status ‘Available’. Recorded butterfly species of the Papilionidae were 31%, 26%, 10.5% and 5.3% in the status ‘Rare’, ‘Near Threatened’, ‘Critically Threatened’ and ‘Endangered’, respectively. No species of the family was recorded as ‘Threatened’ species. In case of family Nymphalidae, 58.82% butterfly species were recorded as ‘Available’. 29.4% species of the family hold the status of ‘Rare’. On the other hand 5.88% species was recorded both in the ‘Critically Threatened’ and in the ‘Endangered’ status. No butterfly species belonging to the family was found in the status ‘Near Threatened’ and ‘Threatened’. In the family Pieridae 56.52% species were recorded as ‘Available’ species whereas 34.8% species were rare status. Only 4.34% of species were both in ‘Near Threatened’ and ‘Critically Threatened’ status. No species of the family was recorded as ‘Threatened’ and also as ‘Endangered’. 58.33% species of the family Danaidae were recorded as available species whereas 33.33% species were in the ‘Rare’ status. 8.33% species were recorded as the status ‘Endangered’ under the family. In this family, no species was found in ‘Near Threatened’, ‘Threatened’ and in ‘Critically Threatened’ status. In case of family Lycaenidae, 33.33% and 26.66% species was hold the status ‘Available’ and ‘Rare’, respectively. Species was recorded 6.66%, 2% and 13.33% as ‘Near Threatened’, ‘Threatened’ and ‘Critically Threatened’, respectively. No butterfly was found as ‘Endangered’ belonging to the family Lycaenidae. In the family Satyridae 48.4% species were examined in ‘Available’ status whereas 41.93% and 6.45% species were in the ‘Rare’ and ‘Near Threatened’, respectively. 3.22% species of the family hold the status of both as ‘Critically Threatened’ and ‘Endangered’. No butterfly species of the family Satyridae was found as ‘Threatened’ species.

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Investigating the Potential of Clustered Regularly Interspersed Short Palindromic Repeats (CRISPR) Pathway to Limit the Spread of Antibiotic Resistance Genes Among Pathogenic Bacterial Species

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Location: Department of Biochemistry and Molecular Biology, University of Dhaka

Duration: Three years (2014 – 2017)

Expenditure of the project: Tk. 2580000.00

Introduction

Similar to the eukaryotic RNA interference-like pathway, bacteria and archaea contains clustered, regularly interspaced, short palindromic repeat (CRISPR) loci that confer resistance against exogenous genetic elements such as phages and plasmids. CRISPR limits horizontal gene transfer (HGT) in bacteria and archaea through phage transduction, transformation, or conjugation, and the latter is particularly important for the spread of antibiotic resistance [Luciano A. Marraffini, *et al.* 2008]. CRISPRs, first recognized in *Escherichia coli* in 1987, are found within the genomes of about 40% of bacteria and 90% of archaea tested so far. Our previous studies have shown that CRISPR in enterobacteria such as *V. cholerae* may provide immunity against bacteriophages [Sajib Chakraborty *et al.* 2009]. CRISPR loci typically consist of several repeated noncontiguous, partially palindromic DNA sequences (DRs) which are separated by stretches of non-repetitive spacer sequences. CRISPR repeats vary between 21 and 48 bp, while spacers range from 26 to 72 bp. Repeat spacer units can reach nearly 300, but loci tend to contain fewer than 50 units. They are usually located on the chromosome, although CRISPRs occasionally appear on plasmids. CRISPR spacer sequences show homology to phages and plasmids [Rodolphe Barrangou and Philippe Horvath, 2009].

Objectives

- Identification of CRISPR locus in published *Salmonella* spp. genomes by Bioinformatics approach;
- Isolation and identification of *Salmonella* spp. from environmental sample (Sewage water); and
- Biochemical and molecular characterization of the isolated strains using 16S rRNA gene sequencing.

Methodologies

Water samples collected in a sterile tube from hospital drainage and Buriganga river were grown in selective Salmonella-Shigella-agar (SS agar) media. 20 bacterial colonies were selected for further characterization using biochemical tests (Motility Test, Catalase Test, Gelatin Hydrolysis Test, Indole Test, Urease Test, Triple Sugar Iron Agar Test). All the tests were performed according to the protocol of ASM Microbe Library (<http://www.microbelibrary.org>). 16S rRNA gene specific primers were used for identification of the isolated bacteria (after sequencing the PCR product). The Kirby-Bauer disc diffusion test was carried out with the isolated bacteria to determine the sensitivity towards various commonly used antibiotics (n = 11). Clustering of bacterial strains based on the antibiotic susceptibility pattern was performed by using K-means clustering algorithm.

Basic Local Alignment Search Tool (BLAST) (<https://blast.ncbi.nlm.nih.gov/Blast.cgi>) was used to identify the bacterial isolates. Publicly accessible CRISPRs database and software (<http://crispr.i2bc.paris-saclay.fr/>) was used for easy detection of CRISPRs in locally-produced data and consultation of CRISPRs present in the database. Molecular Evolutionary Genetics Analysis (MEGA) was used for the comparative analysis of molecular sequence data for reconstructing the evolutionary histories of species and inferring the nature and extent of selective forces shaping the evolution of genes and species.

Results

Characterization of Bacterial Isolates

Antibiogram of the isolated bacteria (Fig.1). indicated that multi-drug resistance bacteria were more prevalent in hospital drainage system (Group B) as compared to Buriganga river (Group A except strain 13 and 14).

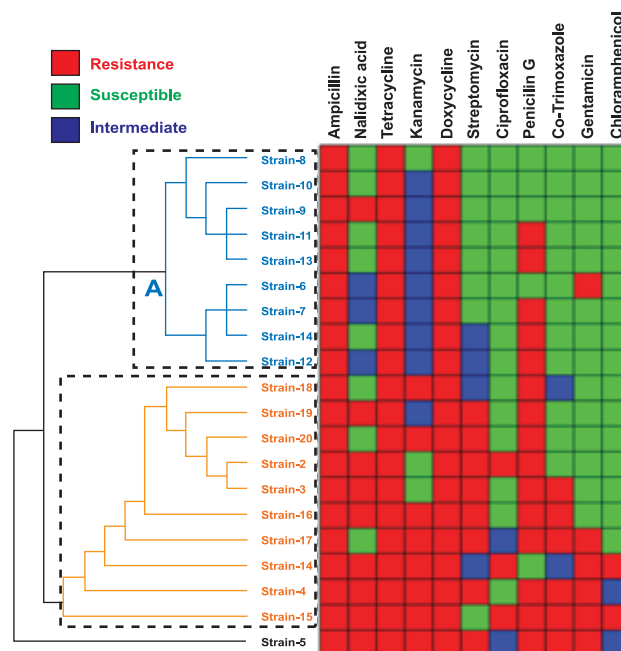


Fig. 1. Antibiotic susceptibility is shown here by Heat map.

35% of the bacterial strains were resistant to four different antibiotics (Fig. 2)

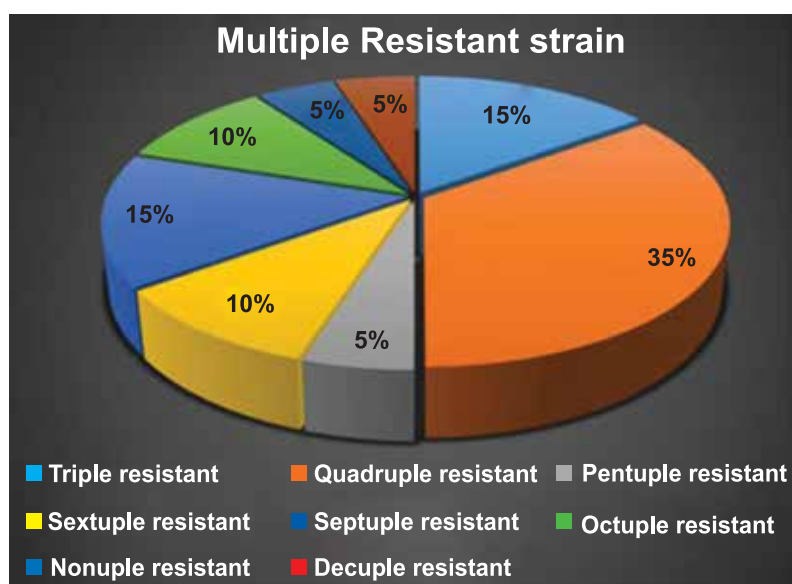


Fig. 2. The Pie chart shows the percentage of resistance against multiple antibiotics among the isolated bacterial strains.

16S rRNA Gene Sequence Based Identification of Isolated Bacterial Strains

The sequences of 16S rRNA gene were blasted using online BLAST tool. Molecular identification reveals the isolated bacteria belong to *Proteus* & *Citrobacter* bacterial strain (Fig. 3).

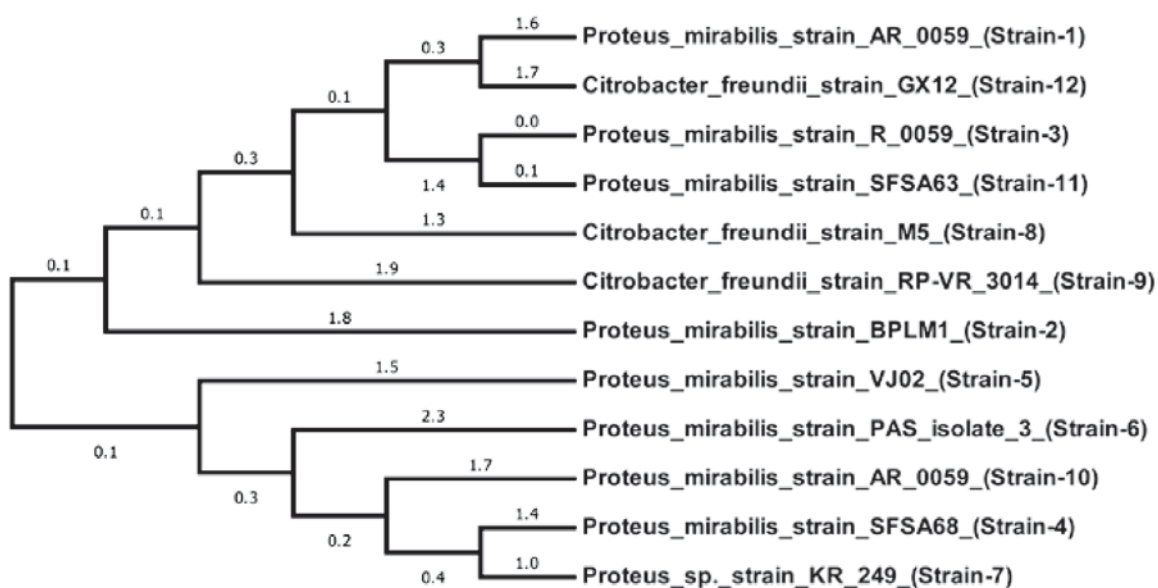


Fig. 3. Phylogenetic neighbour joining tree of 16S rRNA gene sequences of 12 bacterial isolates.

Identification of CRISPR Locus in Bacterial Isolates

To identify CRISPR locus in the bacterial isolates, PCR was performed using two CRISPR locus primers CRISPR-1, and CRISPR-2. Results confirmed that there was no CRISPR locus present in the isolated bacterial strains (Fig. 4).



Fig. 4. Gel image of PCR product obtained by using CRISPR primer. No band found for 2.1 kb. That indicate the bacterial isolates have no CRISPR locus in their genome.

CRISPR analysis in Salmonella using in silico tools

All the analyzed *S. Typhi* and *Paratyphi* strains harbor at least one confirmed CRISPR locus. Interestingly, all CRISPR elements were found to reside within the chromosome. Multiple Spacers sequences span these CRISPR elements (3 to 10). Most of the *Salmonella* species possesses DR repeat that are 29bp in length. More interestingly, this CGGTTTATCCCCGCTGGCGCGGGGAACAC (29bp) DR repeat is conserved in many *Salmonella* and other bacterial genome suggesting a common ancestor (Fig. 5).

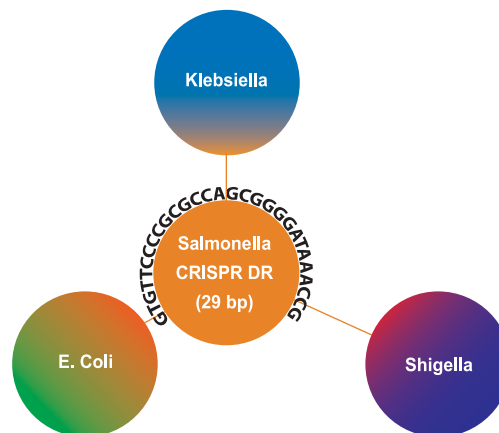


Fig. 5. Conservancy of *Salmonella* specific repeat sequences in other bacterial species. The 29 bp DR sequence from the *Salmonella* species shows high degree of conservancy among different *E. coli*, *Klebsiella* and *Shigella* strains.

Conclusion

Exposure to antibiotics may exert such selective pressure on the bacterial strains that may shift the balance toward the efficient acquisition of foreign genes required for antibiotic resistance, by losing the CRISPR-cas locus. This shift of balance may be prominent in pathogenic bacteria compared to non-pathogenic ones. The acquisition of antibiotic resistance genes not only confers the survival advantages but also enables bacteria to colonize new habitats, including the hospital in which antibiotics are frequently used to treat patients.

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Selective Catalytic Degradation of Waste Plastics to Gasoline and Diesel Fuel

Mohammed Mahmudur Rahman and Zinia Nasreen

Location: Department of Chemistry, Jagannath University

Duration: Three years (2014 – 2017)

Expenditure of the project: Tk. 800000.00

Introduction

Plastic wastes have become a major environmental concern in the world. Plastics do not degrade and stay for decades in soil due to their non-biodegradability. Waste plastics are also responsible for clogging drains and other animal health problems. More importantly, plastic waste is more voluminous than the organic waste and thus takes up a huge amount of landfill space. It is an urgent need for us to find an efficient and cheap way to dispose plastic wastes and save our environment. Catalytic degradation of waste plastics can offer high value product like gasoline (Al-Salem, *et al.*, 2017). In degradation process, a catalyst is added which enhances fuel quality and conversion. Catalytic degradation of plastics offers several advantages. Catalytic degradation occurs at low temperatures and short time. Gasoline selectivity is also high and thus eliminates the necessity of further processing. The gasoline that is produced contains less olefin, more branched hydrocarbon and has high octane value. Over the years numerous catalysts have been developed for obtaining better selectivity and conversion of waste plastics to liquid fuel (Aguado, *et al.*, 2008; Yan, *et al.*, 2015). Catalysts developed so far for degradation of polyolefins are mostly based on conventional zeolite (HZSM-5, Y-Zeolite), ultrastable Y zeolite (US-Y), nanocrystalline zeolite, silica-alumina, mesoporous aluminosilicate (MCM-41), clays, fresh and spent FCC catalysts, superacid solids (ZrO_2/SO_4^{2-}) basic catalysts such as $MgCO_3$ and $BaCO_3$, basic oxide (BaO , K_2O) and metal complexes of the type MCl_n-AlCl_3 or $M(AlCl_4)_n$ ($M = Li, Na, K, Mg, Ca, Ba; n = 1-2$) (Chandrasekaran, *et al.*, 2015; Serrano, *et al.*, 2012) . However, high conversion and selectivity have not been achieved yet.

Objectives

Go develop efficient catalysts for *selective* degradation of waste plastics to light value liquid *gasoline* and diesel fuel.

Methodologies

Experimental method will be employed in this project to convert waste plastics into liquid fuel. Three different catalysts will be prepared namely silica-alumina ($\text{SiO}_2\text{-Al}_2\text{O}_3$), acid treated kaolin and acid treated bentonite catalysts. Silica-alumina catalyst will be prepared by reacting tetraethyl orthosilicate and aluminum isopropoxide. Acid treated kaolin clay and acid treated bentonite catalyst will be prepared by reacting kaolin and bentonite clay with different concentration of sulphuric acid. Catalysts will be characterized by Fourier Transformed Infrared Spectroscopy (FTIR), Brunauer–Emmett–Teller (BET), Scanning Electron Microscope (SEM), X-ray fluorescence spectroscopy (XRF), and XRD. The produced liquid oil will be characterized by FTIR and GCMS.

Results

The amorphous silica-alumina catalyst has been prepared by reacting tetraethyl orthosilicate and aluminum isopropoxide. The N_2 adsorption/desorption experiment (Fig. 1). shows that the surface area of silica-alumina catalyst is $141.51\text{m}^2\text{g}^{-1}$ and mean pore diameter is 12.865 nm. This shows that the synthesized silica-alumina is mesoporous and it exhibits type IV isotherm. The hysteresis loop is similar to type H3; typical of agglomerates of plate like particles containing slit-shaped pores.

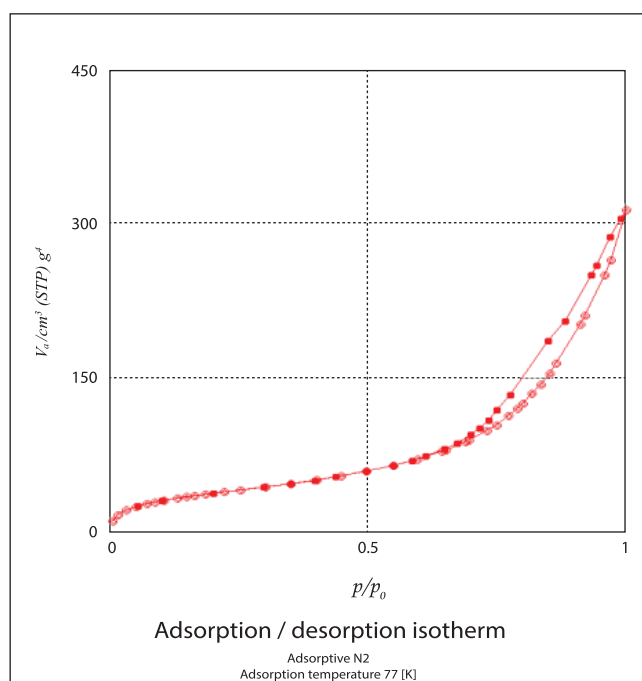


Fig. 1. N_2 adsorption/desorption isotherm of silica-alumina

The SEM image of silica-alumina (Fig. 2). shows disaggregation of the particles. The particle size is few nanometer and they are almost same in size.

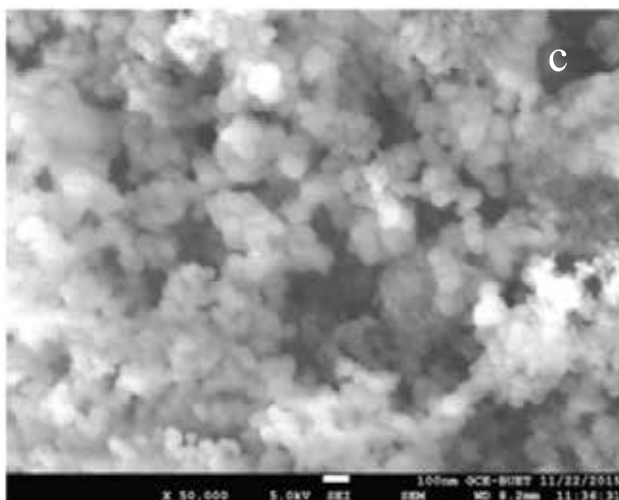


Fig. 2. SEM image of silica-alumina catalyst

The catalytic degradation of both high- and low-density polyethylene has been carried out in a stainless steel batch reactor using silica-alumina catalyst at plastic to catalyst ratio= 25 at 400°C under inert atmosphere. About 40% oil is produced from HDPE. Of this oil, 41% is gasoline, 28 % kerosene, and 5% diesel.

In order to develop a cheap and cost effective catalyst, kaolin clay and 5 M sulfuric acid have been reacted to develop acid treated kaolin clay catalyst.

The reaction between kaolin and sulphuric acid is as follows:



The Electron-dispersive spectroscopy (EDS) experiment shows that the Si/Al ratio has increased from 1.3 to 3.55 after sulfuric acid treatment. BET experiment shows that the surface area of acid treated clay increased to 17.92 m²/g compared with the untreated clay of having surface area 6.85 m²/g. The acid treated kaolin clay exhibits a wide distribution of pore size ranging from 1.2 to 100 nm having maxima around 11 nm. After acid treatment, it becomes mesoporous. When 53 g waste plastics are reacted with 5.3 g acid treated kaolin catalyst at 350-420 °C under inert atmosphere, 34 ml (27 g) oil is produced. Density of the oil is 0.7953 g/ml. The yield is 50.94%. The FTIR (Fig. 3). and GC/MS of oil shows that the produced oil contains both linear and branched alkanes and alkenes from C₅-C₂₀.

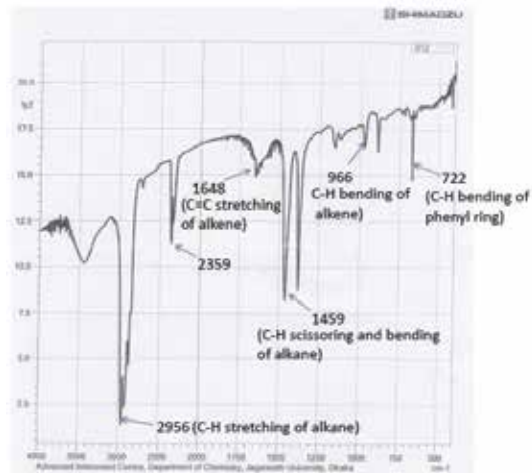


Fig. 3. FTIR of oil

Bentonite clay based catalyst has also been explored for waste plastics degradation. Bentonite catalyst is prepared by reacting bentonite with 3M H_2SO_4 . The degradation of 50 g waste plastics with 5g acid treated bentonite catalyst under nitrogen atmosphere at 350-420°C produces 56 ml oil (44.5g). The yield of 89%.



Fig. 4. Converting waste plastics into oil by bentonite catalyst under inert atmosphere

In absence of any catalyst, 50g waste plastics produce 30 ml wax which solidifies within few minutes. This means that catalyst plays important role in converting waste plastics into oil.

Conclusion

Three catalysts namely silica-alumina, acid treated kaolin catalyst, and acid treated bentonite catalyst have been developed for degradation of waste plastics into liquid oil. The N_2 adsorption/desorption experiment shows that all these catalysts are mesoporous. Among these catalysts, acid treated bentonite catalyst is found very effective in waste plastics degradation. About 89% yield of oil is achieved by using bentonite catalyst. The FTIR and GC/MS of oil shows that the produced oil contains both linear and branched alkanes and alkenes from C_5 - C_{20} . The linear and branched alkenes need to be hydrogenated to be used as fuel for car.

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Identification of Policy Options for Universal Access to Food, Education, Health and Housing

Mohammad Osman Gani, A F M Mainul Hossain and Shamil Mardi Al-Islam

Location: Independent University Bangladesh (IUB), Dhaka

Duration: Three years (2014 – 2017)

Expenditure of the project: Tk. 1000000.00

Introduction

The basic economic problem is to assure that the people have access to sufficient food, education, healthcare, and shelter. Prevailing economics is inherently unable to see how to solve this basic problem properly. This is because it starts with the axiom that there is an inviolable resource constraint and that there is zero profit in equilibrium. It fails to see the presence of socially instituted rules of conduct governing exchange between strangers (who do not co-own the resources traded between them) and the general existence of profitable exchange. This failure disables the discovery of the true options available to society to solve the basic problem.

There is a new alternative analytical device to uncover the universals of a market economy. This new analytical device is consistency analysis. It recognizes the primacy of the trading relation that allows people to defeat optimization and reach the super-optimal outcome. The key revelation from this is that credit is the most potent instrument to simultaneously create and sustain both new demand and new supply. The policy imperative is to manage the obligations of the borrowers and to enforce the claims of the lenders. With a properly functioning financial management system, society can ensure universal access to food, healthcare, education, and shelter.

Objectives

The original objective of the project was to carry out an empirical analysis of the realities of life in a Bangladeshi rural union to identify the options to create a sustained universal access to food, healthcare, education, and shelter. However, the severely limited budget (less than 30% of the proposed) compelled the scope of the research to be drastically reduced. Ultimately, access to food and education alone could be considered.

Methodologies

The original intent was to carry out a two stage analysis, both quantitative and qualitative. The first stage would gather benchmark data and the second stage would check the changes brought about by the interventions of the crucial variables as well as gather stakeholder opinions on their perceptions, intentions and expectations about alternative policy regimes. The basic data were gathered for 4328 families of Suhilpur Union, in Brahmanbaria. It roughly covers 12 of the 16 villages and about 82% of the entire union population. The sample was chosen purposively in order to facilitate easier logistic support for fieldwork.

The study of policy options ideally would compare the outcomes of different policies aimed at the same goal. This would be a time series study. This ambition was frustrated owing the drastically reduced scope of research. Ultimately, an analysis of the first stage census data on 4328 families was limited to comparing the cross section of the families.

The vast data set itself is a product of this research effort, available to help future studies that can utilize the benchmark and carry out a time series analysis. The present report was prepared on the cross section analysis of differential impact of income and credit on the access to food and education. Detailed econometric and statistical analysis of the data was carried out.

Data Analysis

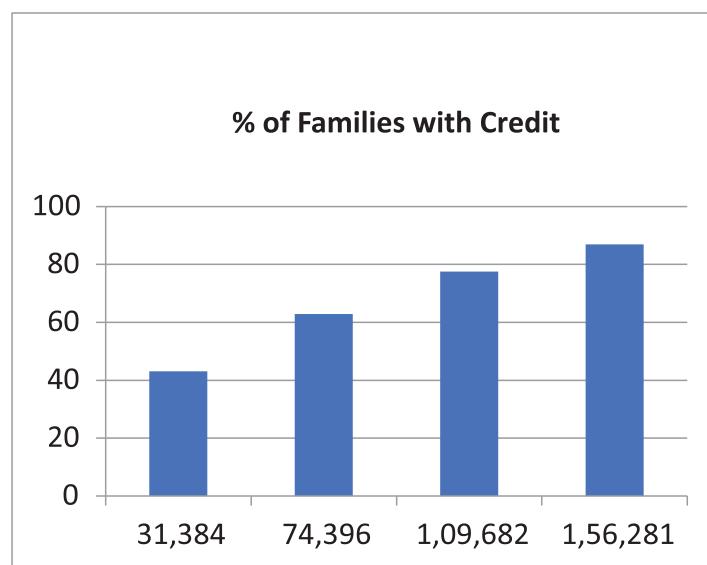
Strong Correlation between Credit and Income Level

The data reveal a clear positive correlation between availability of formal credit and the level of income. Higher income families as a rule have greater access to credit from the formal sector, as both a greater percentage of the families have access to credit and they also tend to have larger quantum of credit for longer duration.

Table 1. Per Capita Income and Credit Availability

Per person Income (BDT/Year) Range	Per person Income (BDT/Year) Mean	No. of families	No. of families getting Credit	% of Families getting Credit
0-40,000	31,384	1088	469	43.11
40,001-80,000	74,396	2003	1260	62.91
80,001- 120,000	1,09,682	893	692	77.49
120,000 +	1,56,281	344	299	86.92
Total	77,372	4328	2720	62.85

The graph below shows the positive relation between income (mean income per person per year) and credit availability (% of families getting formal credit).



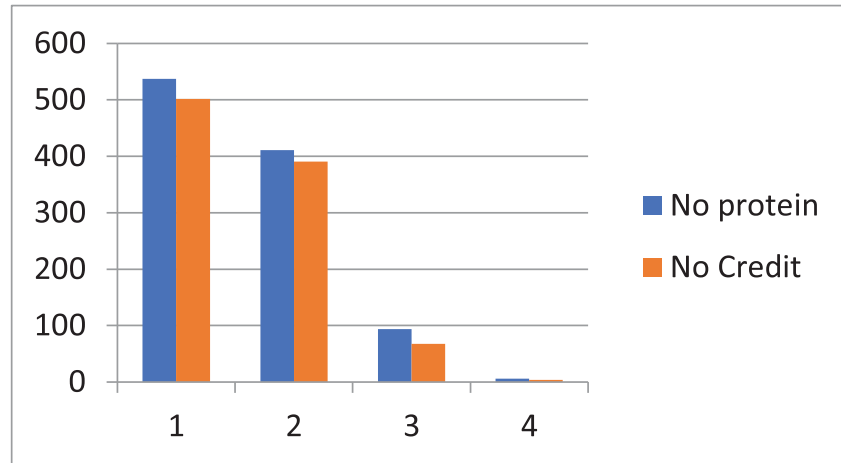
Food Security

As 91% of the families reported taking 3 meals a day, with little evidence of carbohydrate shortage, we focused on measuring protein deficiency (amount of fish, meat, egg, and milk). First, poorer families have higher frequency of protein inadequacy. Secondly, most families with protein deficiency have no access to formal credit, despite the presence of several microcredit agencies and formal banks in the area.

Overall, about a quarter of the families have protein inadequacy. Tellingly, 92% of them are without access to formal credit.

Table 2. Lack of Credit and Lack of Protein Adequacy

Per capita Income Range (BDT/Year)	No. and (%) of Families	No. and (%) of Families without Adequate Protein	No. and (%) of families Without credit
Up to 40000	1088 (25.14)	537 (54.35)	502 (93.48)
40001 -80000	2003 (46.28)	411 (19.54)	391 (95.13)
80001 -120000	893 (20.63)	94 (11.84)	68 (72.34)
120000 +	344 (07.95)	6 (01.35)	4 (66.67)
Total	4328 (100.00%)	1048 (24.21)	965 (92.08)



It clearly shows that lack of credit goes with lack of protein adequacy in food.

Educational Attainment (Elementary Level)

Elementary education is mostly provided by publicly funded schools (and madrasas). The school enrolment is high, but many enrolled students were staying to of school. We were concerned with the elementary school age children (up to age 14) staying out of school.

Table 3. School age children and staying out of school

	School age children (age 6-14)		
	Boys	Girls	Total
Total No. of children	4231	3642	7873
No. of Stay out Children	1370	602	1972
% stay out	32.38	16.53	25.05

About 25% of the children aged 6 to 14 are staying out of school, although most are shown registered in the schools. Nearly a third of the boys stay out of school, especially as the boys are subject to economic pressure to engage in earning. Again, truancy is a cultural phenomenon for the early teenagers. Some teenage girls stay home for fear of sexual harassment on the road.

The situation with girls is encouraging: about 16.52% of the girls are staying out of school. The girls like school as they seem to gain greater freedom than at home, and are encouraged by a strong signal from female teachers who constitute the majority of the elementary teachers. However, fear of sexual harassment on the road between home and school is a major concern of young teenage girls.

Table 4. Children Staying Out of School by Income Level

Per person income (BDT/Year) Range	No. of School age children	No. of Children staying out of school			% of children staying out of school		
		boys	girls	Total	Total	boys	girls
	Total						
0-40,000	1865	487	161	648	34.75	26.11	8.63
40,001 – 80,000	3774	564	308	872	23.11	14.94	8.16
80,001 – 120,000	1567	268	91	359	22.91	17.10	5.81
120,001 +	667	51	42	93	13.94	7.65	6.30
Total	7873	1370	602	1972	25.05	17.40	7.65

The relation between staying out of school and credit availability via level of income is inverse, but somewhat weak. Relatively upper income families show a large stay out percentage among boys. One explanation is that the absence of a father at home (often working abroad) is responsible for truancy of teenage boys coming from richer families. This requires serious sociological and psychological analysis.

Conclusion

The policy conclusion derived from this study concerns access to food and education. With respect to food, the status quo is that there is sufficient access to staple cereals, indicating food security in carbohydrates. But the poorer segments get an unbalanced diet with protein deficiency. The policy option in respect of food subsidy is to enhance the subsidy to create access to protein beyond the staple cereals. The overall option is to enhance credit to the poor to enable them to get access to protein-rich fish, meat, milk, and egg, as well as to increase their earning capacity.

With respect to education, a serious concern is to prevent the high dropout rate among the boys of elementary school age. The poorer families need income subsidies to be able to keep the boys in school rather than send them to earn cash. A program of cash grants to the very poor may be tried with a pilot project to discover how such a program may improve educational attainment, improve earning skills and prevent drop-outs.

Access to elementary education has made a dramatic positive impact on gender equality. A long term policy option is to develop pathways to post-secondary education for girls such that they may compete for jobs with good wages. Stress on vocational training suitable for women will assure a long term productivity growth as an impact of educational policy.

There is a crying need to assess and rectify the problems of poor service delivery by the school system, creating untenable pressure on the parents to send their children, even as early as in the first grade to paid tutors or coaches. In addition to ensuring proper training of teachers, there is a need to develop work manuals and build a system of recording and monitoring the compliance with the manual. The ministry of education may want to develop a high-level expert committee to prepare web-based multi-media teaching plans. Digitally enriched schools may be better able to provide educational service delivery to the children.

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Chemical and Biological Investigations of *Corypha taliera* Roxb., the Only Living Species, and Its Propagation and Plantation

Md Abdur Rashid and Md Khalid Hossain

Location: Department of Pharmaceutical Chemistry, University of Dhaka.

Duration: Three years (2014 – 2017)

Expenditure of the project: Tk. 2925000.00

Introduction

Bangladesh has nearly 5000 floral species, including 546 higher plants with significant medicinal values (Yusuf *et al.*, 1994). However, 12.75 % of vascular species of these plants are facing a greater risk of extinction because of threatened biodiversity (Irfanullah, 2011). Bangladesh National Herbarium (BNH) has recorded over 100 endangered angiosperm species in Bangladesh (Khan, 1991).

Corypha taliera Roxb., locally known as “Tali palm”, is a critically endangered plant species belonging to the Arecaceae family. It gives flowers once in nearly hundred years and the last flowering plant specimen was found in the campus of University of Dhaka (Khondker *et al.*, 2010; Shoeb *et al.*, 2013; Khan *et al.*, 2017). Until 2011, it was the only living species of wild “Tali palm” in the world in its natural habitat. When the plant started to give flowers, serious concern was created among different communities as it was thought that the plant will extinct from the world. Thus, initiatives have been taken for germination of seeds and plantation of the saplings as well as to study different extracts for isolation and characterization of chemical constituents and determine the bioactivities of the extractives in a number of assay methods.

Objectives

The use of plant preparations in the treatment of various diseases is an age-old practice. In the present days, the World Health Organization (WHO) is also giving emphasis on concomitant use of traditional formulations, which are largely based on plant materials to ensure the total health coverage. The major objectives of the study program included-

- Phytochemical and pharmacological (total phenolic content, antioxidant, membrane stabilization, thrombolytic, antimicrobial and cytotoxicity) investigations of the selected plant;
- Isolation and characterization of the active principle(s) from the plant species;
- Computational and docking studies of the isolated compounds;
- Plantation of *C. taliera* in several districts, including some major locations of Dhaka; and
- Assists the local drug-manufacturing units to attain knowledge on herbal drugs and develop new drug from natural resources.

Methodologies

The sun dried and powdered unripe fruits (500g) of *C. taliera* was extracted with 1.5 L methanol for 10 days at room temperature. The extract was concentrated with a rotary evaporator at reduced temperature and pressure. A portion (5g) of the concentrated methanol extract was fractionated by the modified Kupchan partitioning method (Van wagenen *et al.*, 1993) to provide n-hexane (1.25g), carbon tetrachloride (0.55g), dichloromethane (0.60g) and aqueous soluble (2.00 g) materials. Similarly, extraction of the air-dried flowers (250g) with methanol yielded 7.5g of crude mass. The crude extractives were tested for membrane stabilizing (Shinde *et al.*, 1999), thrombolytic (Miah *et al.*, 2018), antimicrobial (Bauer *et al.*, 1996), antioxidant (Brand-Williams *et al.*, 1998) and cytotoxic (Meyer *et al.*, 1982) activities.

Repeated chromatographic separation and purification of various Kupchan fractions of fruits of *C. taliera* by gel permeation chromatography (GPC) over Sephadex LH-20 followed by vacuum liquid chromatography (VLC, silica 60H) and preparative thin layer chromatography (PTLC, silica gel F254) provided 8 (eight) compounds. The structures (Figure 1) of the isolated compounds were solved by spectroscopic studies and co-TLC with authentic samples, whenever possible. The pharmacokinetic and toxicological properties of some of the isolated compounds from *C. taliera* were calculated on online server Pre ADMET. Furthermore, molecular docking study of the purified compounds of the plant was conducted on AutoDock vina in PyRx 0.8.

For conservation of the plant, 500 mature seeds were sown in Medicinal Plant Garden of Faculty of Pharmacy, University of Dhaka and Azimpur Government Officers' Quarter premises. After 40 days, the root was first seen to grow in its habitat and 85 days later, the shoot developed up to 2.5 cm in height. The mature saplings have been planted in important locations of different districts of Bangladesh, including the capital city, Dhaka.

Results

Successive chromatographic separation and purification methanol extract of the unripe fruits of *C. taliera* as well as its n-hexane soluble fraction afforded 8 compounds, which were identified as stigmasterol (1), β -sitosterol (2), β -amyirin (3), lupeol (4) and betulinic acid (5), daucosterol (6), 3-hydroxybenzoic acid (7) and 2-hydroxy-3,4-dimethoxybenzoic acid (8). On the other hand, the methanol extract of flowers of *C. taliera* provided β -sitosterol (2), β -amyirin (3) and betulinic acid (5) (Fig. 1).

The methanolic crude extract of *C. taliera* fruits exhibited the highest antioxidant activity ($IC_{50} = 19.33 \mu\text{g/ml}$) as compared to $9.5 \mu\text{g/ml}$ for the standard agent, butylated hydroxytoluene (BHT). The crude extract and its carbon tetrachloride, dichloromethane and aqueous soluble fractions showed mild to moderate inhibition of microbial growth against gram-positive and gram-negative bacteria. All the extractives exhibited strong cytotoxic properties, among which the methanol extract revealed the strongest cytotoxicity ($LC_{50} = 0.43 \mu\text{g/ml}$). The crude methanol extract of flowers of *C. taliera* and its aqueous and organic soluble partitionates revealed the presence of significant phenolic compounds.

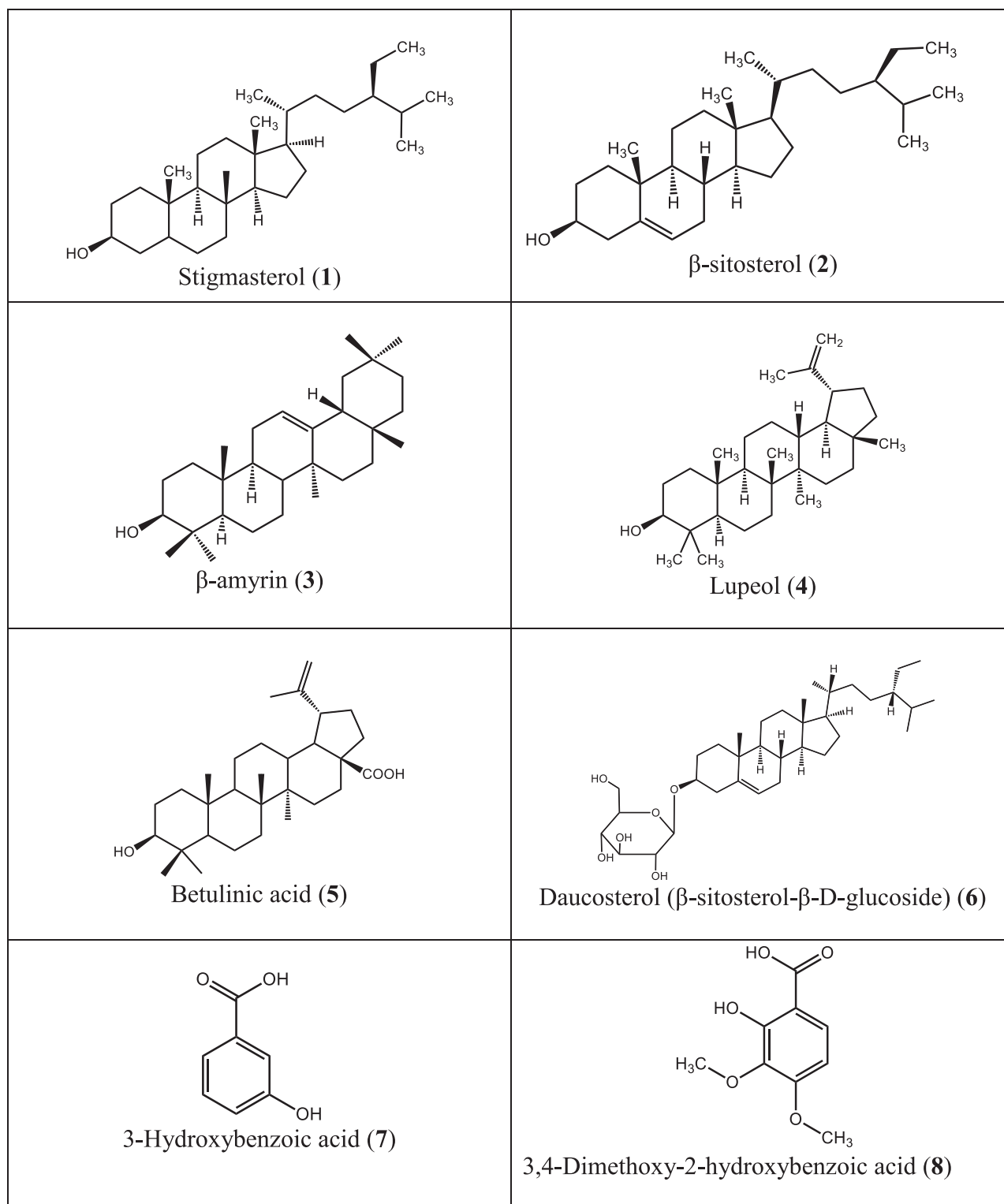


Fig. 1. Compounds from *C. tailera*

The methanol extract demonstrated considerable membrane stabilizing and thrombolytic potentials as compared to its aqueous and organic soluble partitionates.

The chemical potential of betulinic acid (BA), an isolated compound of the plant, has been characterized through computational study. From the results of polarizability and softness, it was clear that BA is less stable and hence, kinetically more reactive in water. BA demonstrated good human intestinal absorption (HIA) and moderate cellular permeability. Further, BA also exhibited positive CNS activity due to high permeability through blood brain barrier. The toxicological study revealed that BA was a mutagenic compound but non-carcinogenic in mice model.

The rate of germination of the seeds of *C. taliera* was found to be 89-93%. The matured saplings have been planted in different important locations of several district of Bangladesh for conservation of the plant and protection of biodiversity by *ex situ* arrangement.

Conclusion

The project has led to the isolation and characterization of 8 compounds. It is clearly evident that *C. taliera*, which was thought to be extinct, now exists in reasonably growing stage in many locations of Bangladesh (Fig. 2). It is also established that careful and timely efforts by the scientists have made conservation of *C. taliera* successful and there is no more risk of loss of biodiversity due to its extinction.



Fig. 2. *Corypha taliera* in different stages (a) flowering, (b) seed germination, (c) sapling, and (d) growing condition.

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Improving Crop Productivity and Livelihoods in the South-West Coastal Areas of Bangladesh Through Modern Production Technologies and Soil Management Practices

Md Anamul Hoque and Mahmud Hossain Sumon

Location: Department of Soil Science, Bangladesh Agricultural University

Duration: Three years (2014 – 2017)

Expenditure of the project: Tk. 3000000.00

Introduction

Salinity is a major concern to agriculture worldwide. Salinity imposes both ionic toxicity and osmotic stress to plants, leading to nutrition disorder and oxidative stress (Zhu, 2003). About 1.06 Mha lands are affected by soil salinity in Bangladesh (SRDI, 2010). Rice is mainly grown in the saline areas but yield is low due to lack of salt-tolerant high yielding variety and inappropriate management practices. Appropriate management strategies with suitable genotypes having higher yield potential contribute to the improvement of crop production in the saline areas. Both organic and inorganic amendments are found to be effective in the amelioration of saline soils. Soil amendments with organic manures reduce the toxic effects of salinity in plants (Raafat and Thawrat, 2011; Dhar *et al.*, 2015). Salt tolerance is directly associated with K contents because of its involvement in osmotic regulation and competition with Na. Rice production could be improved in saline areas through application of higher doses of potassium fertilizers (Kibria *et al.*, 2015). To elucidate the responses and adaptation of crops to salt stress, physiological and biochemical studies are necessary. Similarly, improvement of crop production in saline areas could be achieved by integrated plant nutrition management with high yielding crop varieties.

Objectives

The main objective of the project was to increase crop production and farmers' livelihood in coastal areas by integrated plant nutrient management using high yielding crop varieties. Therefore, the research work was undertaken with the following objectives:

- To assess the impacts of climate changes on crop-diversity and crop productivity in saline areas;
- To screen and identify salt-tolerant crop cultivars by physiological and biochemical characterization;
- To minimize the adverse effects of soil salinity on crops through organic and inorganic amendments;
- To evaluate the available indigenous practices for crop production under changing climate; and
- To disseminate improved crop production technologies in the coastal areas.

Methodologies

The project work was carried out at the Department of Soil Science, BAU, Mymensingh. One upazilla from each of coastal areas of Khulna (Batiaghata upazilla) and Satkhira (Kaliganj upazilla) districts was selected as study areas. Pot experiments were carried out at the net-house of the Department of Soil Science, BAU. Seeds or seedlings of different crops including salt-tolerant rice cultivars viz. BRRI dhan47, Binadhan-8 and Binadhan-10 were sown or transplanted in the pots. Plants were exposed to different levels of salinity at 15 days after sowing/transplanting. The crops were harvested at 45 days after sowing/transplanting. Growth of the crops, chlorophyll and intracellular proline contents, activity of antioxidant enzymes and K^+/Na^+ ratio were recorded. On the basis of existing cropping patterns as well as physiological and biochemical assays, major crop species from the study areas were selected. Salt-tolerant crop cultivars were also used in this study. The field experiments were carried out at the SMRC, SRDI, Botiaghata, Khulna and farmer's fields of saline areas (Kaliganj, Satkhira). Improvement of crop production in saline areas could be achieved by integrated plant nutrient management. Different treatment combinations with manures and chemical fertilizers were designed to minimize the adverse effects of salinity.

Results

Livelihood status

Farmer's livelihood status was low in saline areas due to low crop production. Almost 80% farmers followed the T. aman-til-fallow and T. aman-mungbean-fallow. Cereal crops mainly rice was not grown in dry season because salinity problem was higher in this period.

Growth performances of crops at pot experiments

Significant reductions of growth parameters were observed in all crops in response to salt stress. All the growth parameters showed significant decreases in both salt-sensitive and salt-tolerant rice cultivars but the reduction was much higher in salt-sensitive cultivar than the salt-tolerant cultivars (Tables 1-4). With the increase in salinity levels, shoot fresh and dry weight decreased in all rice genotypes. The highest shoot fresh and dry weight was obtained in Binadhan-10.

Biochemical characteristics

Biochemical assays revealed that BR23, BR10 and BRRI dhan49, BARI Gom-25, and BARI til-4 and T-6 showed higher proline accumulation and antioxidant defense systems in response to salt stress. Salt stress decreased total chlorophyll content in all the rice varieties but the decrease was not significant in Binadhan-10. Among the salt-tolerant rice genotypes, Binadhan-10 accumulated 2.2 folds proline. Higher proline content in Binadhan-10 might be the one of the reason for higher salt tolerance. Antioxidant enzymes showed differential responses to salt stress (Figure 1). Catalase and ascorbate peroxidase activities were significantly increased in all salt-tolerant rice genotypes (Figure 2). Contrary, peroxidase activity was decreased in all rice genotypes with the increasing salinity level. Binadhan-10 maintained the lowest reduction percent in root and shoot K^+/Na^+ ratio among the rice cultivars.

Mitigation strategies of salinity on crop production

Application of organic manures with fertilizers improved the growth, yield contributing characters and yields of all crops under saline conditions. Additionally, combined application of manures and fertilizers increased nutrient uptake and K^+/Na^+ ratio as well as improved fertility status of saline soils.

Table 1. Effect of salinity on the growth of salt-sensitive (BRRI dhan28) rice under salt stress

Treatments	Shoot fresh weight (g)	Root fresh weight (g)	Shoot dry weight (g)	Root dry weight (g)	Plant height (cm)	Root length (cm)	No. of tillers /hill
Control	43.12a	19.58a	10.71a	7.49a	62.5a	27.5a	13a
20 mMNaCl	29.84b	16.63b	7.07b	4.46b	60.0b	17.5b	12a
40 mMNaCl	23.72c	11.76c	5.72c	2.61c	58.0b	14.5c	10b
60 mMNaCl	6.32d	4.45d	1.43d	1.73d	47.0c	12.5d	6c
SE (\pm)	0.634	0.361	0.329	0.113	0.613	0.448	0.338

Table 2. Effect of salinity on the growth of salt-tolerant (BRRI dhan47) rice under salt stress

Treatments	Shoot fresh weight (g)	Root fresh weight (g)	Shoot dry weight (g)	Root dry weight (g)	Plant height (cm)	Root length (cm)	No. of tillers /hill
Control	32.56a	19.05a	7.57a	5.64a	66.5a	25.5a	13a
20 mMNaCl	26.57b	17.58b	6.73b	5.08b	63.0b	21.5b	12b
40 mMNaCl	18.20c	13.57c	4.53c	2.59c	60.0c	15.5c	9c
60 mMNaCl	14.22d	6.29d	2.86d	1.54d	58.5c	14.0c	8d
SE (\pm)	0.637	0.288	0.154	0.106	0.454	0.500	0.270

Table 3. Effect of salinity on the growth of salt-tolerant (Binadhan-8) rice under salt stress

Treatments	Shoot fresh weight (g)	Root fresh weight (g)	Shoot dry weight (g)	Root dry weight (g)	Plant height (cm)	Root length (cm)	No. of tillers /hill
Control	35.29a	20.32a	7.43a	9.39a	65.5a	26.5a	15a
20 mMNaCl	16.78b	8.46b	4.83b	2.62b	61.0b	18.5b	14a
40 mMNaCl	13.76c	6.46c	3.79c	2.47b	55.5c	16.5c	10c
60 mMNaCl	12.43d	4.82d	2.51d	1.71c	52.0d	13.0d	8d
SE (\pm)	0.165	0.412	0.165	0.107	0.496	0.541	0.336

Table 4. Effect of salinity on the growth of salt-tolerant (Binadhan-10) rice under salt stress

Treatments	Shoot fresh weight (g)	Root fresh weight (g)	Shoot dry weight (g)	Root dry weight (g)	Plant height (cm)	Root length (cm)	No. of tillers /hill
Control	24.78a	17.09a	5.67a	4.92a	64.5a	27.0a	16a
20 mMNaCl	24.42a	17.40a	5.53a	4.88a	63.5a	22.5b	15b
40 mMNaCl	23.36b	10.21b	4.20b	3.22b	54.0b	18.0c	12c
60 mMNaCl	15.45c	7.28c	2.96c	1.91c	49.0c	16.0c	11d
SE (\pm)	0.219	0.290	0.132	0.136	0.361	0.617	0.264

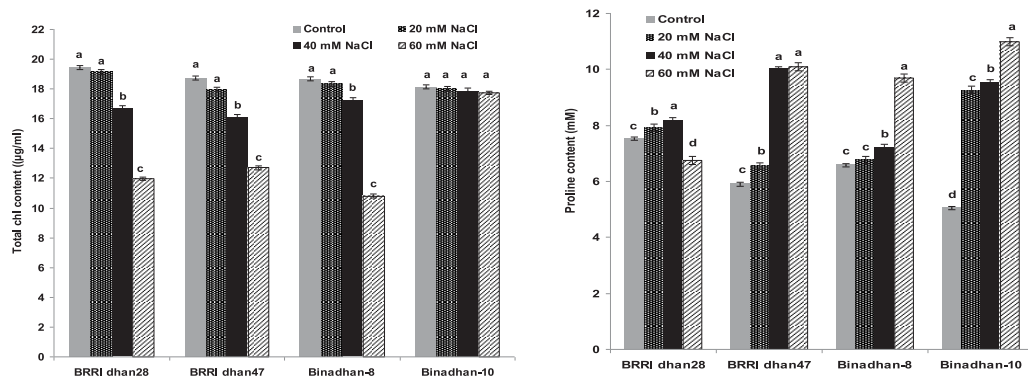


Fig. 1. Effect of salinity on total chlorophyll and proline contents in different rice cultivars

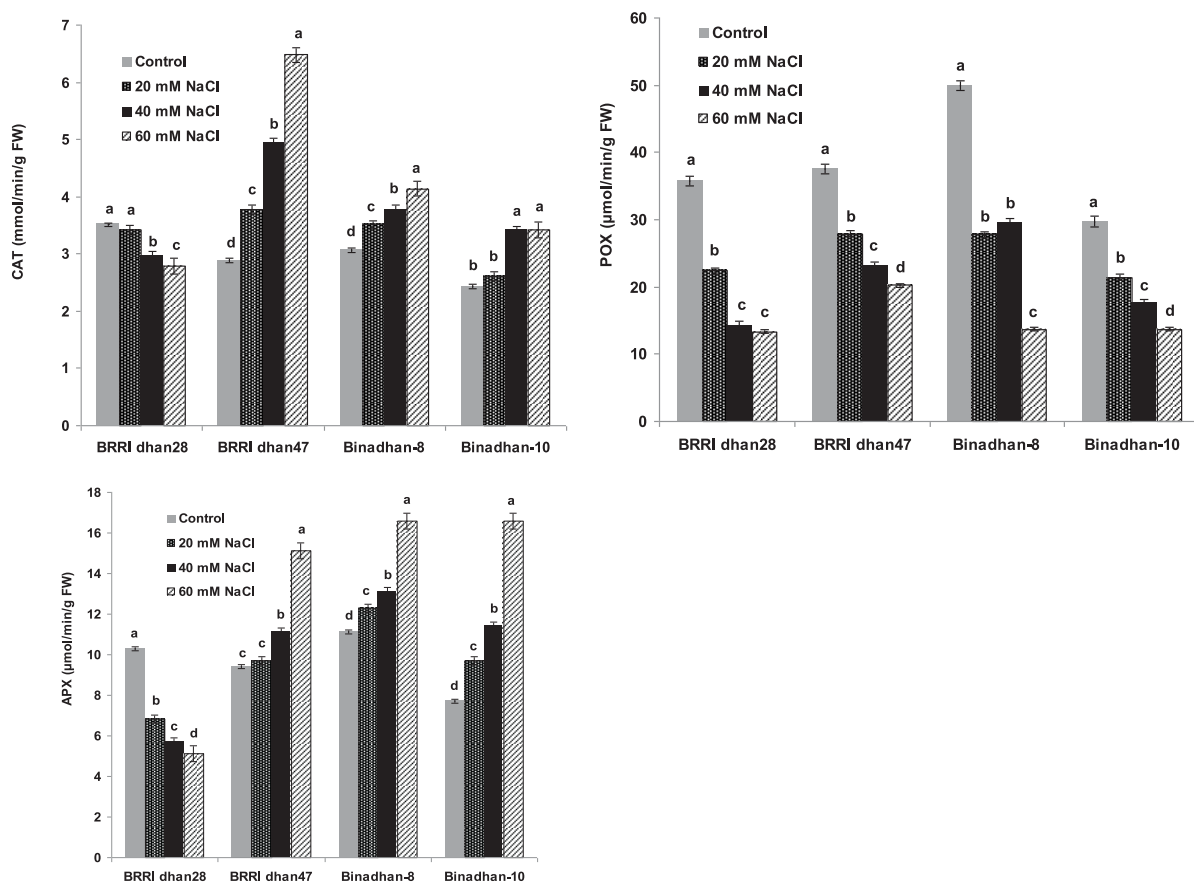


Fig. 2. Effect of salinity on antioxidant enzyme activities in different rice cultivars

Conclusion

Results of the pot experiments demonstrated that salinity caused significant reductions in growth of all crops including rice. Different crop cultivars showed wide ranges of physiological and biochemical mechanisms under salt stress conditions. There were considerable differences between salt-sensitive and salt-tolerant rice varieties in response to salt stress.

Antioxidant enzyme activities increased in salt-tolerant cultivars but decreased in salt-sensitive cultivars with the increasing salt stress. The present study suggests that salt-tolerant rice variety (Binadhan-10) might have better protection against salinity-induced oxidative damage by increasing the activity of antioxidant enzymes. Moreover, BR23, BR10 and BRR1 dhan49, BARI Gom-25, and BARI til-4 and T-6 showed better performances against salinity. Salt-tolerant crop cultivars were also used in the field experiments. Salinity caused significant reductions in growth, yield contributing characters and yields of crops in all the cropping patterns. Application of organic manures with fertilizers improved the growth, yield contributing characters and yields of all crops under saline conditions. Additionally, combined application of manures and fertilizers increased nutrient uptake and K^+/Na^+ ratio as well as improved fertility status of saline soils. It can be concluded that organic amendments confer tolerance to salinity in crops due to increasing nutrient uptake and maintaining higher K^+/Na^+ ratio. However, crop cultivation in saline areas might be profitable with organic amendment of soils. Extensive field research work is needed in this area since organic manures are more available and less expensive.

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Development of Integrated Mosquito Management Strategy for Mymensingh District

Mohammad Mahir Uddin and Naznin Nahar

Location: Department of Entomology, Bangladesh Agricultural University, Mymensingh

Duration: Three years (2014 – 2017)

Expenditure of the project: Tk. 1200000.00

Introduction

Mosquitoes are serious concern from the standpoint of human welfare because the females are blood sucking, and they serve as vectors in the transmission of several important human diseases such as malaria, dengue, yellow fever and encephalitis (Reinert, 2001). Most disease causing mosquitoes spend their entire lives within 300 feet of their breeding site. Most of mosquitoes of Bangladesh belong to genera, *Culex*, *Anopheles* and *Aedes*. Bangladesh is at war with mosquitoes, and the mosquitoes are winning in most cases. Since 2000, public health officials in Bangladesh estimated nearly 160,000 people have contracted malaria and dengue fever carried by the mosquito. The mosquito problem is particularly acute in the densely populated capital city of Dhaka (Hossain *et al.*, 2000). Recently there are some reports also found in Mymensingh. Mosquitoes are mainly controlled by using different insecticides in Bangladesh (Hossain *et al.*, 2006). But due to indiscriminate and non-judicious use of insecticides is causing insecticidal residue, toxicity to human, animals and water, insect resistance and death of the beneficial insects and other animals. Moreover, residual effect of insecticides causes the imbalance of the field and aquatic ecosystem. Integrated management practices play a crucial role to reduce the infestation and make the environment safe and healthy for future generation.

Objectives

The present study has been done with the following objectives:

- To gain the information on the density of mosquitoes in different habitats;
- To assess the efficacy of biological agents (predatory fish) to control mosquito larvae;
- To determine the potentiality of botanicals and chemical insecticide against mosquito; and
- To manage the mosquito population at BAU campus and some selected areas of Mymensingh Municipality through IPM packages.

Methodologies

Survey of the study areas

A survey of mosquito breeding grounds was done in Bangladesh Agricultural University Campus and some of the Wards of the Mymensingh Municipality. All the mosquito breeding grounds and the larval habitats were classified broadly into two groups: drains and other water bodies. The drains were further grouped as stagnant and flowing. A significant number samples were taken. Another monthly survey of the temporary breeding grounds in some areas of Mymensingh Municipality was conducted during first year of project; five different types of temporary habitats were encountered.

Effect of different botanicals and chemical insecticide on the control of mosquito larvae

An experiment was conducted in the laboratory using four botanicals viz. Neem oil (2ml/Litre of water), Mahogany oil (2ml/Litre of water) and Karanja oil (2ml/litre of water) and a chemical insecticide, Decis 2.5EC (1ml/Litre of water). A control treatment was also maintained. The experiment was done in the laboratory at Department of Entomology, BAU, Mymensingh. Twenty mosquito larvae were released in a large sized petridish and directly sprayed with different treatments and then 20ml water was provided in each petridish. In case of control treatment only water was provided with twenty mosquito larvae. All the treatments were replicated three times. After twenty four hours of treatment application the mortality of mosquito larvae was noted. The experiment was continued up to 72 hours. Then the average mortality percentage in every 24 hours was calculated.

Predation performance of Tilapia, *Oreochromis mossambicus* (L.) and Catfish, *Clarias batrachus* (L.)

Predation performance study was done in laboratory of the Department of Entomology, BAU, Mymensingh. The third instar larvae of *Culex* spp. were put in a 10 Litre volume plastic bucket containing five litres of water. The bucket size was 30cmX25cm. In each bucket five predator fishes tilapia and catfish was introduced against five hundred mosquito larvae. The time of introduction of the predator and prey for each experiment and that of each replicate was recorded, and the mosquito larvae, alive and/or dead, remained after consumption by the tilapia and catfish were counted after 24 hours. The consumption rate of each type of fish per day was, thus calculated accordingly from each of the replicate i.e. the total number of mosquito larvae introduced at the beginning of experiment minus total number of alive were found after 24 hours, and were calculated as the number of mosquito larvae consumed per day per predator fish. The experiment was replicated thrice.

Results

Prevalence of mosquito larvae at four different wards of Mymensingh Municipality

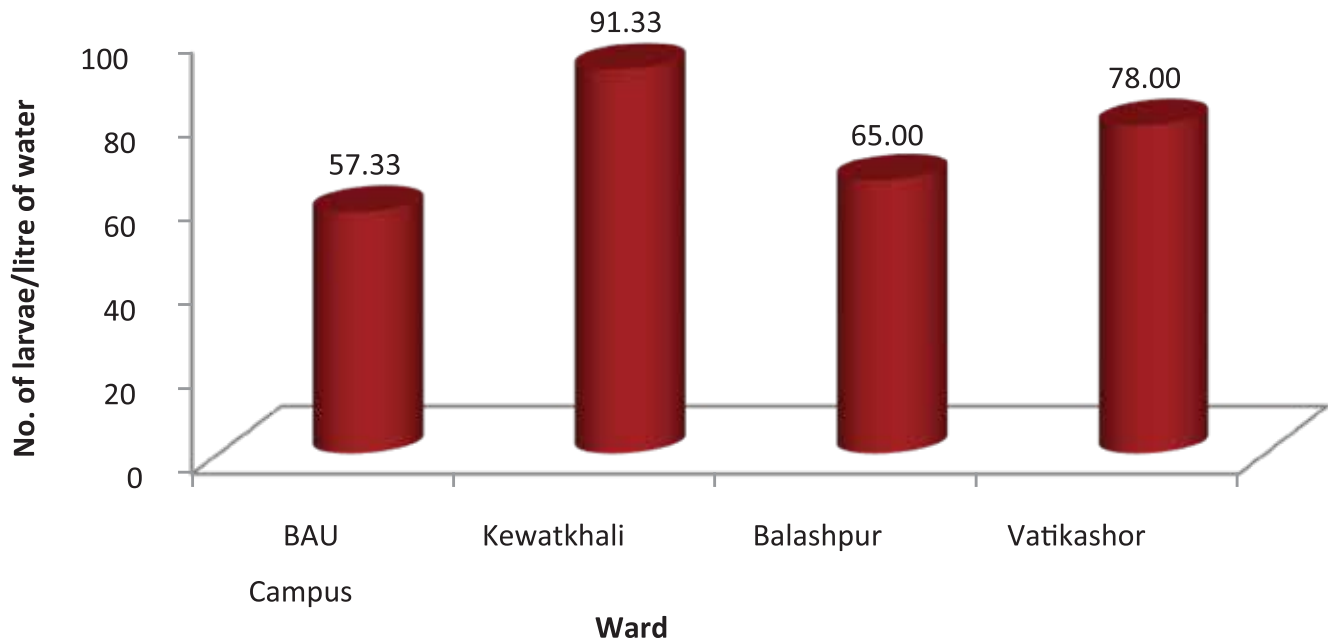


Fig 1. Number of mosquito larvae per litre of water at four different wards of Mymensingh Municipality

A total of 1539 mosquito larvae were collected from different places of BAU Campus, Kewatkhali, Balashpur and Vatikashor areas during December 2014 to June, 2015. Among the collected larvae of mosquito three genera were identified. All the collected larvae were found to be of the family Culicidae. The identified three genera were *Anopheles*, *Culex* and *Aedes*. At different locations the number of different mosquito larvae varied significantly. Among four major locations of four Wards of Mymensingh Municipality, the highest number of larvae /litre of water was found Kewatkhali and the lowest number was at BAU Campus (Fig. 1). This result was found due the high density of human population. The other reasons were polluted water, foul smell of water and waste product in the water. Similar results were reported by Anosike et al. (2007) and Hopkins (1952). They stated that the occurrence of mosquito larvae depended on the polluted water and sites which had foul smell. Similarly Ahmed (2014) reported that the highest prevalence of mosquito larvae was in the polluted drains which differed from the present study. Khan and Ahmed (1986) stated that the area has many polluted drains and runoffs which could have provided conducive environment for the prolific breeding of *Culex* species.

Monthly prevalence of mosquito larvae per litre of water at BAU campus

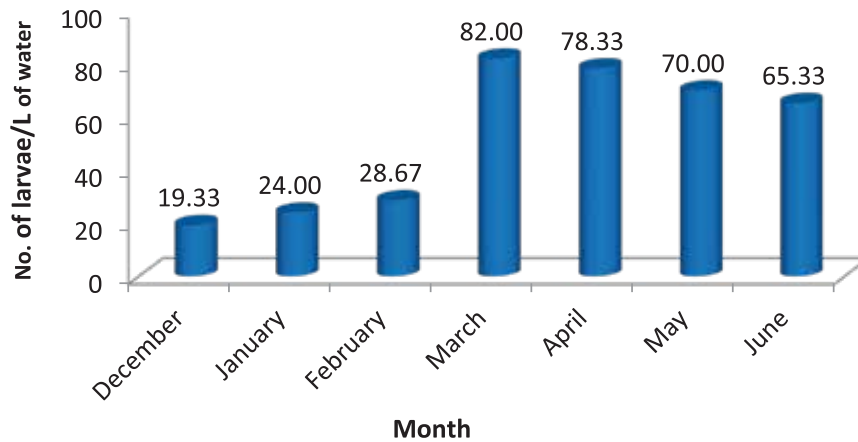


Fig. 2. Monthly prevalence of mosquito larvae per litre of water at BAU Campus

In case of monthly prevalence of mosquito larvae at BAU Campus varied significantly. The highest average number of larvae was found in March followed by April. On the other hand the lowest number of larvae was observed in December followed by January (Fig. 2). This variation of larvae might be due to different environmental factors mainly temperature and rainfall. Similar result was found by Ahmed (2014) in an experiment conducted at BAU Campus and its surroundings. He stated that the lowest prevalence of mosquito larvae (11.7%) was found in January- February as because the environmental temperature was very low considering the other month of the year. The highest prevalence of mosquito larvae were found in March to April (46.9%) followed by May-June (41.4%). Lower density of mosquito larvae in May-June than the March-April might be associated with floods, which might wash the eggs and larvae. Other reports also indicated that heavy rains with flooding eliminate *Anopheles* habitats (Dejenie *et al.* 2011).

Effect of different botanicals and an insecticide on the mortality of mosquito larvae

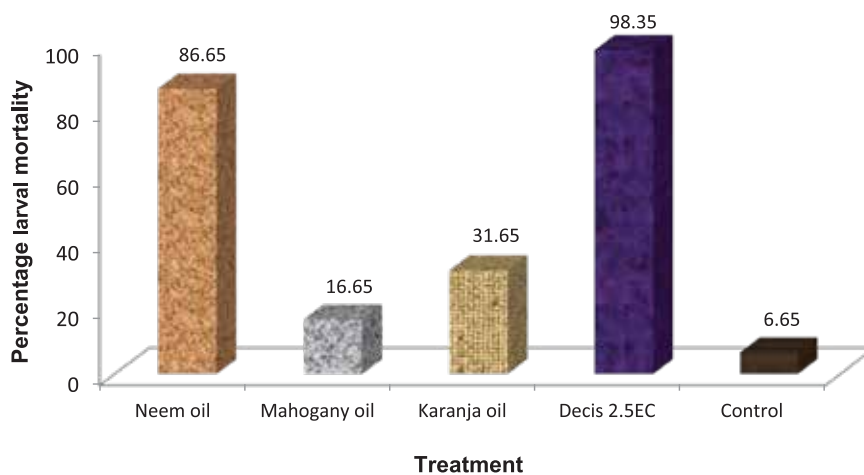


Fig. 3. Effect of different botanicals and an insecticide on the mortality of mosquito larvae

The effect of different botanicals and a chemical insecticide varied significantly (Fig.3). The highest percentage mortality (98.35%) of mosquito larvae was observed in case of Decis 2.5EC application in comparison to control treatment. Similar mortality percentage (86.65%) was found in the application of Neem oil. Decis and Neem oil did not vary significantly in their effect on the larval mortality. On the other hand the lowest mortality percentage was found in the control treatment. Pugazhvendan and Elumali (2013) evaluated three essential oils of plant species (Camphor oil) *Cinamomum camphora*, (Clove oil) *Myrtus caryophyllus* and (Eucalyptus oil) *Eucalyptus globulus* for their larvicidal activity against three vector mosquito larvae *Aedes aegypti* (L.), *Anopheles stephensi* (Liston) and *Culex quinquefasciatus* (Say). Three essential oils were tested at 1000 ppm concentrations at 24 h. Of these, the essential oils of Camphor oil, Clove oil and Eucalyptus oil exhibited relatively high larvicidal effect. These findings partially support this present finding where among three botanicals Neem oil showed very good effect on the control of larvae. Among the treatments the lowest larval mortality percentage was found in case of mahogany oil (16.65%) application followed by Karanja oil (31.65%) application. Among the botanicals Neem oil showed highly significant effect on the percentage larval mortality. But Mahogany oil and Karanja oil did not significantly differ in their effect on the larval mortality.

Predation potentiality of Tilapia and Catfish

The predation performance of two predatory fishes viz. Tilapia, *Oreochromis mossambicus* (L.) and catfish, *Clarias batrachus* (L.) was tested in the laboratory and their performance was found significantly effective (Table 1). The predatory fish consumed on an average 30.04 and 50.02 mosquito larvae per day per fish of tilapia, *Oreochromis mossambicus* (L.) and cat fish, *Clarias batrachus* (L.), respectively. Elias *et al.*, (1995) studied the predation potentiality of a biological control agent, the guppy fish, *Poecilia reticulata* (= *Lebistes reticulatus*), over the mosquito larvae under laboratory conditions. The third instar larvae of *Culex quinquefasciatus* mosquito were used as prey. The average consumption rate was 41.0 per day per fish. This result is very much similar with the findings of the present research.

Table 1. Predation performance of two predatory fishes

Type of predatory fish	No. of days observed	Total number of larvae released	Total no. of larvae consumed	Average no. of larvae consumed per fish per day
Tilapia	5	2500	1255	50.02
Catfish	5	2500	751	30.04

Efficacy of different IPM packages on the mortality of mosquito larvae

In case of different IPM packages L. Fos + Sumithion and Decis + L. Fos showed the best results on larval mortality both after 24 and 48 hrs after spraying (Table 1). Whereas, Mahogany oil + Karanja oil was also similarly effective. Among the six treatments the lowest percentage of larval mortality was noticed when the larvae was treated with Neem oil + Mahogany oil combination (Fig. 4).

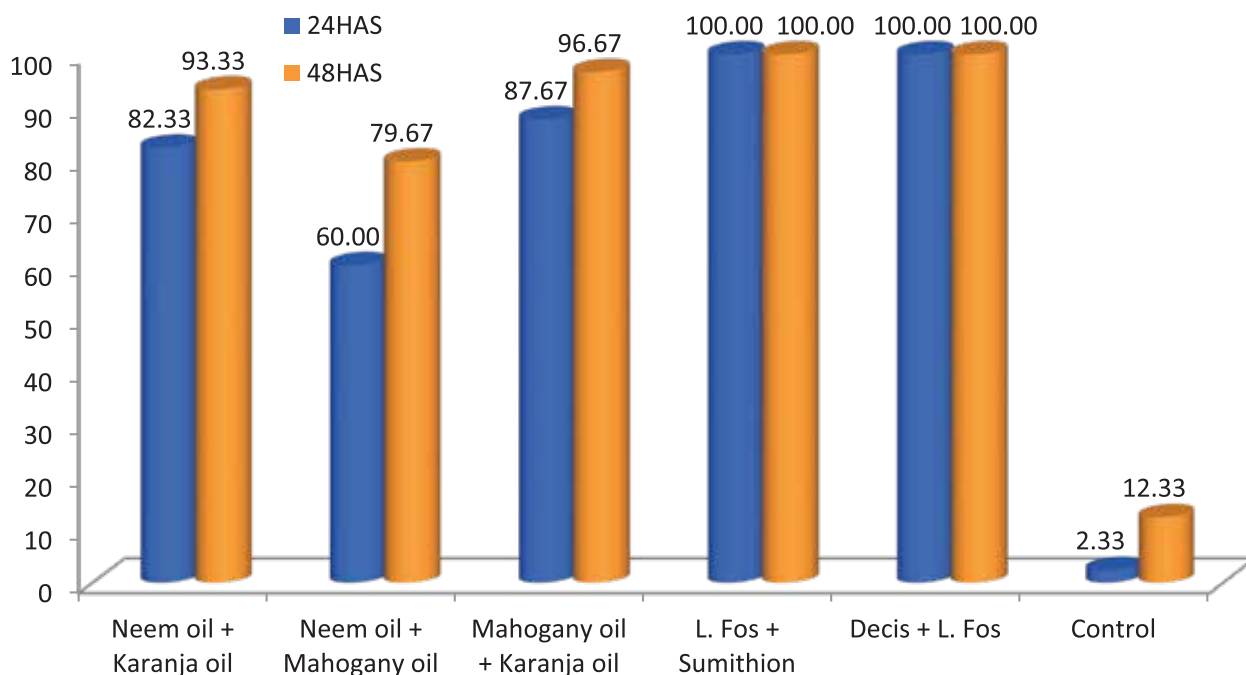


Fig. 4. Percentage larval mortality under different IPM packages

Conclusion

Neem oil and Mahogany oil might be incorporated in the IPM package for the management of mosquito. Among the used three doses 0.50% would be increased in case of field experiment. Both the two predatory fishes might be used in the management of mosquito larvae as alternatives of chemical insecticides and eco-friendly management tactics. Considering the efficacy of different IPM packages, L. Fos + Sumithion and Decis + L. Fos combination showed the best results on larval mortality at 0.25% concentration both after 24 and 48 HAS, Whereas, Mahogany oil + Karanja oil performed very effectively. Among the six treatments the lowest percentage of larval mortality was noticed when the larvae was treated with the package developed from Neem oil + Mahogany oil.

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Process Development for the Production of Encapsulated Fruits and Vegetable Powders for Primary and Secondary Food Formulation

Md Azizur Rahman and Mohammad Gulzarul Aziz

Location: Department of Horticulture, Bangladesh Agricultural University

Duration: Three years (2014 – 2017)

Expenditure of the project: Tk. 2300000.00

Introduction

A variety of fruits and vegetables is produced in Bangladesh because of favorable soils and agro ecological conditions. Fruit and vegetables are seasonal and highly susceptible to spoilage, which results in huge post-harvest loss of nearly 24-42% (FAO, 2011). It has been evident that processing part of them into value added products could contribute substantially to reduce post-harvest losses, ensure availability of them year-round and encourage producers for continuous production. Drying is considered one of the vital techniques of processing and preservation of fruits and vegetables. However, drying techniques mainly use in primary processing of agricultural crops in Bangladesh. Deshi fruits and vegetables in the form of powder like “Tank” are hardly observed. Besides consumption as drinks, fruits and vegetables powders have bright prospect as secondary ingredients for using in weaning foods, soups, noodles, fruit bar, herbal medicine, vitamin-C tablet etc. However, technological barrier in producing powders are low yield, low quality and hygroscopicity of the powder. These post drying complexities could be eliminated by the techniques of encapsulation. Encapsulation is a useful technique widely applied to food, pharmaceutical and chemical industries for carrying active compounds and stabilizing heat sensitive compounds in solid form and removing hygroscopicity of hygroscopic compounds. This background motivated to propose the project of converting local fruits and vegetables into powders for using direct consumption or secondary food ingredients.

Objectives

- To optimize encapsulated agents and drying conditions for the process of fruits and vegetable powder production;
- To assess material, thermal and rehydration/dissolution properties of encapsulated powders; and
- To assess the diversified use in terms of product quality, sensory and storability of encapsulated powders.

Methodologies

Methods adopted according to the proposed activities. In case of screening fruits and vegetables for drying, different fruits and vegetables were analyzed for moisture, TSS, fiber and pulp and low moisture and high solid content produces were selected for powder production. Fruits like jackfruit, banana, bael, papaya, mango, olive etc and vegetables like tomato, carrot, red amaranth etc were finalized for encapsulated drying. After grading and cleaning, they were grinded into pulp and mixed with encapsulating agents. Low cost polysaccharide like starch or gum, proteins and lipids were used as encapsulating agents. The encapsulating agents were hydrated for 8 hours before adding into pulp. The pulp with encapsulating agents were heated to form complex and then dried. Drying was carried out in a laboratory scale cabinet drier as well as in wind-assisted solar dryer fabricated locally. The ratio of pulp and agents, drying temperature and time were optimized for producing quality powders. The dried mass was grinded into powder and characterized for material, thermal and solubility properties. The bioactive properties like total antioxidant, radical scavenging activities and IC50 were also assessed. The powder was finally assessed for its applicability as formulated drinks powder as well as secondary food ingredients.

Results

A screening study in relation to the content of moisture, fiber, pulp and juiciness was conducted primarily for tomato, mango, pineapple, bael, papaya, green chilli, Hog-plum, guava, mint leaves etc. A significant variation was observed in moisture, fiber, pulp and juiciness of fruits as influenced by variety and ripening stages. Pulpy fruits with respect to maturity and ripening stages were selected for encapsulation and powder production.

The pulp with encapsulating agents was dried in a solar cum mechanical dryer. This dryer was modified by attaching an exhaustor to the outlet of the dryer. The existing solar cum mechanical dryer is shown in Figure 1.



Fig. 1. Wind existed solar cum mechanical dryer. Wind operated exhaustor has been placed at the top of the dryer

The drying of coated fruit slices were carried out in the dryer and the drying kinetics were predicted as shown in Figure 2.

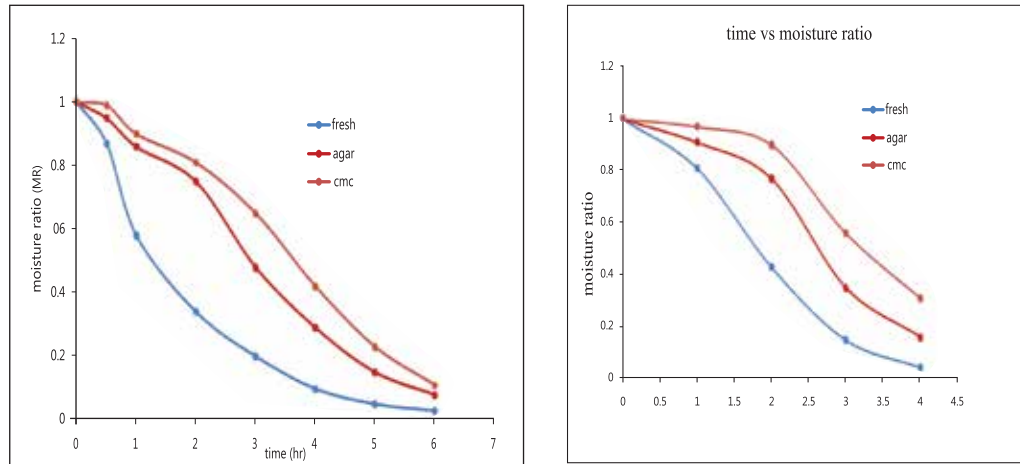


Fig. 2. Variation of moisture ratio with drying time for the carrot slices influenced by coating at 50°C (left) and at 60°C (right)

The colour of the encapsulated carrot was superior to non-coated slices as shown in Figure below.

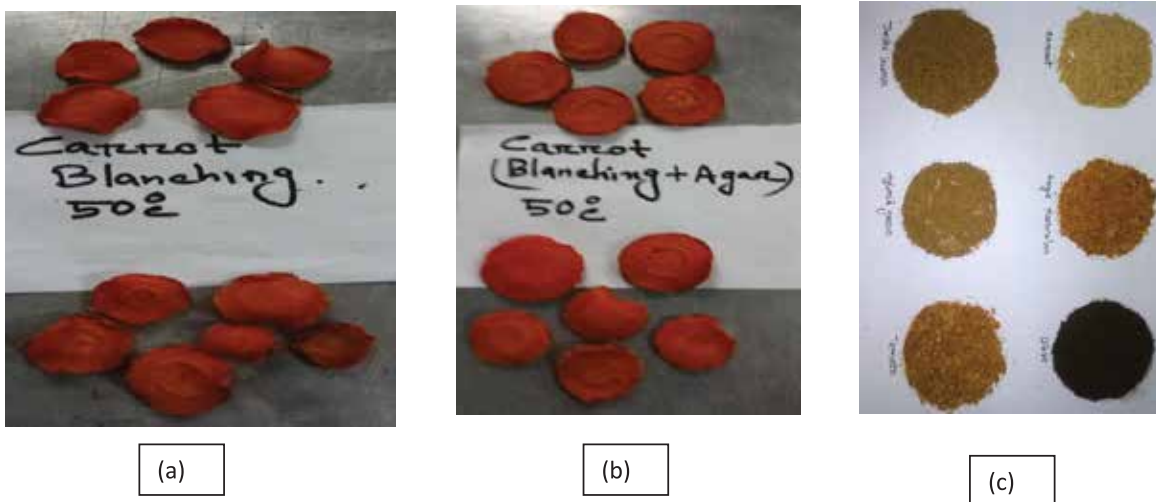


Fig. 3. Carrot slices (a) without coating (a) with coating (c) powder of different fruits

More than six seasonal fruits were experimentally dried using different parameters and reduced the dried samples into powders. The pictorial views of the powders are presented in Figure 3.

These powders are used to prepare convenient food formulation like tablets. Tableting was carried out in the Process Engineering Laboratory in the Department of Process and Food Engineering, Universiti Putra Malaysia. Powder in the form of tablet will easily be used as a substitute of sugary candy.

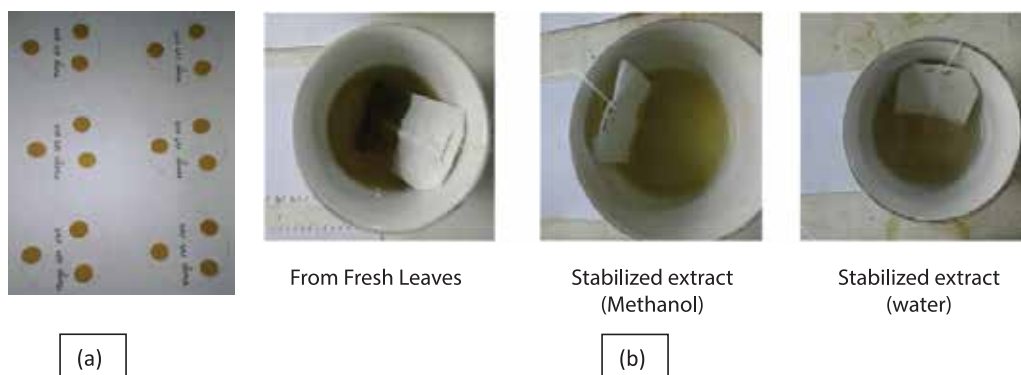


Fig. 4. Product formulation (a) tablet (b) mint tea

Ment leaves of both fresh and encapsulated were dried and herbal blends were formulated to prepare refreshing drinks.

Conclusion

The overall objective of the project was to establish a noble process for the production of food powder from ripe and high sugar fruits and different colored vegetables by encapsulation via drying. To achieve the overall objective several activities were proposed and implemented in connection to the proposed specific objectives. Duration of the project was three years and year one was mostly concerned to the activities related to ensure physical facilities like staff recruitment and procurement of equipment, accessories and chemicals. Four important equipment namely chroma meter, control desiccators, shaking incubator and solarimeter were purchased under this project and extensively used for the research purposes. Processes for the production of different fruit powder and tablets from beal, mango, papaya, banana, carrot were developed. Drinks tablet and mint tea formulation were standardized and optimized. Six (6) MS students finished their post-graduate researches with financial assistance from this project under this activity. One publication entitled “Profiling of Physical and Chemical Properties of Mango at Different Ripening Stages” in the Journal of Environmental Science and Natural Resources have been published.

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Enhancing Livelihood of Farming Community through Adoption of Conservation Agriculture: A Socioeconomic Study

Md Taj Uddin and Md Hammadur Rahman

Location: Department of Agricultural Economics, Bangladesh Agricultural University

Duration: Three years (2014 – 2017)

Expenditure of the project: Tk. 2000000.00

Introduction

Agriculture is the heart of Bangladesh economy where more than 80% farmers are smallholder having land less than 1.0 hectare. Due to monoculture of cereal crops, soil fertility and crop productivity are reducing day-by-day. Introduction of resource conserving agriculture (like conservation agriculture or organic farming) plays a vital role in increasing organic matter content in the soil. It is a modern agricultural practice which is gaining popularity in many parts of the world. FAO (2007) determined three key principles of conservation agriculture, which are: i) continuous minimum mechanical soil disturbance; ii) permanent organic soil cover; and iii) diversified crop rotations.

The research identified the nature of conservation agriculture practices adopted by the farmers in the selected areas of Bangladesh, and analyzed financial and other conditions that spur farmers to adopt the practice. Further, the study determined the extent of adopting of conservation agriculture by the farmers. It identified the economic and environmental benefits of conservation agriculture in relation to conventional agriculture. The study also identified the determinants of adopting conservation agriculture by the farmers under different socioeconomic conditions. Finally, it addressed the nature and extent of livelihood enhancement of the farming community through adoption of conservation agriculture practices.

Objectives

The overall goal of the research was to determine pertinent aspects of livelihood enhancement of farming community through adoption of conservation agriculture. The specific objectives were as follows:

- To identify the nature of conservation agriculture practiced by the farmers in different areas of Bangladesh;
- To determine the extent of adoption of conservation agriculture by the farmers;
- To assess the economic and environmental benefits of conservation agriculture in relation to traditional agriculture;
- To identify the determinants of adopting conservation agriculture by the farmers under different socioeconomic conditions; and
- To address the nature and extent of livelihood enhancement of the farming community through adoption of conservation agricultural practices.

Methodologies

The research had been conducted in five districts of Bangladesh which were: Mymensingh (major crop: potato), Bogra (major crop: bean and brinjal), Tangail (major crop: pineapple and banana), Sherpur (major crop: rice) and Jamalpur (major crop: wheat). Three categories of farmers were targeted for investigation which were: focal farmers (farmers receiving technical and logistic support), proximal farmers (neighboring farmers of focal farmers, receiving indirect support) and control farmers (farmers receiving no technical support). A total of 500 farmers (i.e., 50 focal, 200 proximal and 250 control) were interviewed with structured questionnaire to collect the primary data. Different books, publications, published and unpublished documents were also considered as the sources of secondary data and information.

A limited amount of input support (i.e., seeds/planting materials, manures and organic fertilizers, organic pesticides, care and management, etc.) were provided to the focal farmers at free of cost to adopt conservation agriculture.

To analyze the data, a combination of descriptive (i.e., tabular statistics, figures and SWOT analysis), mathematical (profitability analysis, Enyedi's index of crop profitability, percentage perception index, expenditure elasticity, multidimensional poverty index and problem confrontation index) and statistical techniques (probit and logit models with marginal effect analysis, DID analysis and Ravallion test) were used.

Results

Focal farmers had been given knowledge and training on different aspects of conservation agriculture. They were provided with limited input support for 10.0 decimal land (command area) to adopt this farming practice. With this limited support, farmers had experienced a great reduction in their cost of production as well as a remarkable increase in the crop production in that command area.

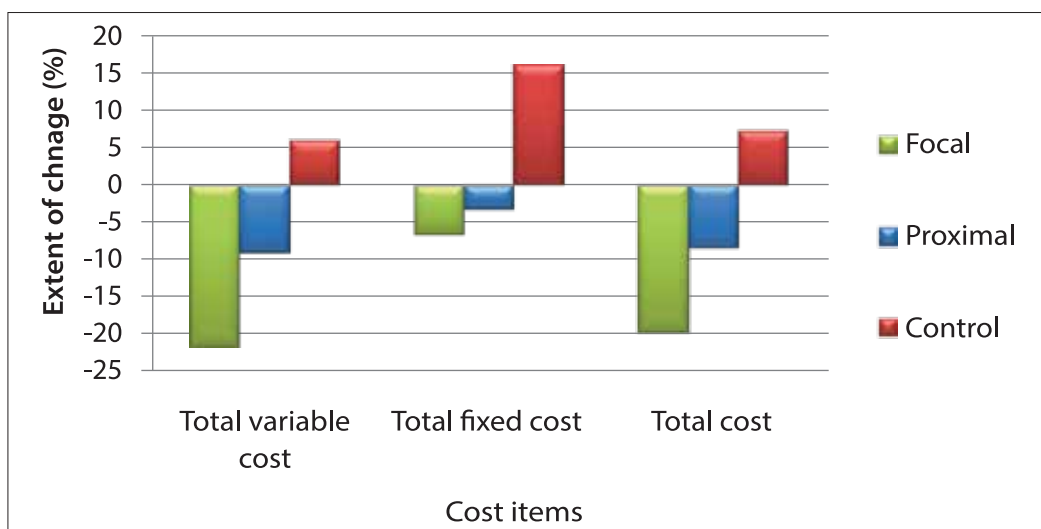


Fig. 1. Change in cost of production after adopting conservation agriculture

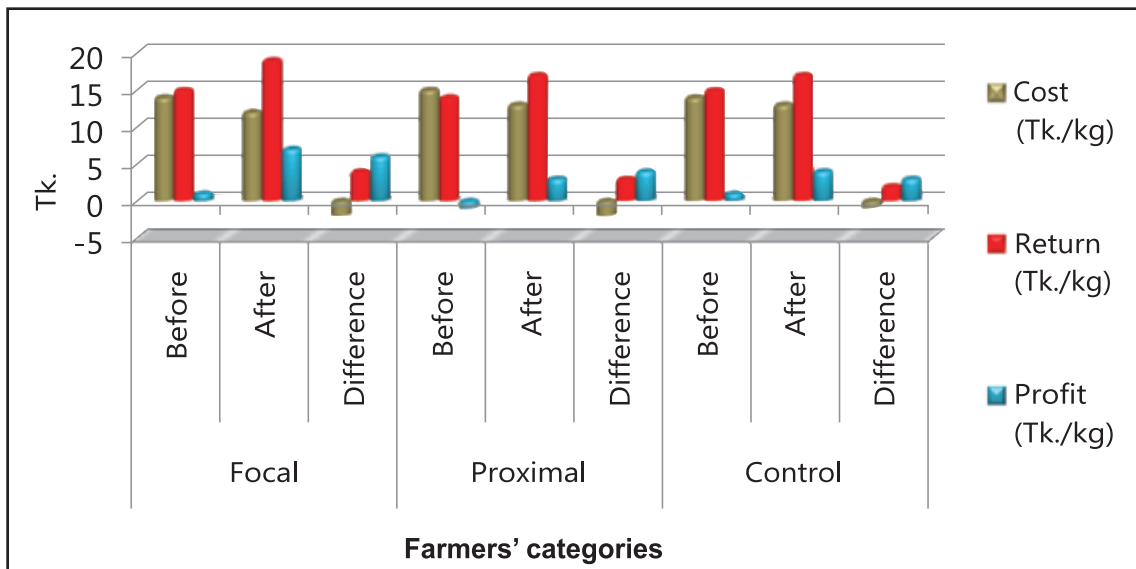


Fig. 2. Profitability per unit final product

It was also evident that if the farmers in the research areas would cultivate crop in their entire cropland according to this farming practice, it would be profitable for them compared to conventional farming practice. Crop productivity of the focal farmers was increased in response to the crop production in the entire region.

Majority of both focal and proximal farmers avowed about enhanced environmental circumstance like increase in soil organic matter content, soil fertility, soil nutrient availability, etc. after adopting conservation agriculture than before, while majority of control farmers stated about constant environmental condition. The estimates of probit model depicted that minimum tillage operation, permanent organic soil cover, and application of compost and vermicompost had significant influence on improving environmental quality due to practicing conservation agriculture.

The logit model revealed that farmers' educational level, farm size, farm income, extension contact and farming experience had significant influence on farmers' adoption of conservation agriculture practice. It was also experienced that farmers' income was increased through conservation agriculture practice. Farmers got higher price for their product free from poisonous medicine and synthetic fertilizers. This practice helped them to minimize their labour and other input costs. The study also indicates that poverty in terms of deprivation of health, education and living standards was decreased; and hence overall livelihood circumstances was improved adopting conservation agriculture practice.

Conclusion

Agriculture plays a crucial role in overall economic development of agro-based developing countries like Bangladesh and its agriculture. FAO has determined three main principles of conservation agriculture and the project has taken all three principles to some extent. The main focus of the project was to practice minimum tillage and keep crop residue. Conservation agriculture as a new resource saving farming practice was appreciated and successfully adopted by the farmers.

A mental change of farmers, technicians, extension agents and researchers away from environment degrading farming operations towards sustainable production system like conservation agriculture which was necessary to bring changes in adoption attitudes of the farmers in the research areas. The most important factors in the adoption of this practice was overcoming the hurdles of lack of knowledge about this farming scheme, difficulties in its maintenance, lack of good quality inputs, lack of extension service, lack of institutional credit, etc. To overcome the problems, policy makers should pay heed to the strengths and opportunities of practicing conservation agriculture keeping different internal and external factors in contrast, and evaluate the suggestions provided by the researchers for developing conservation agriculture in the context of Bangladesh which is presented below in the form of recommendation matrix:

Table 1. Recommendation matrix indicating issues that needed further research, extension and policy recommendation

Facts of consideration	Recommendations		
	Research needed	Extension needed	Policy intervention needed
Knowledge and training provision			
Nourishment of farmers' knowledge		√	
Arrangement of training programs		√	
Regular extension contact		√	√
Input and credit support			
Enhancing direct input support and subsidy programmes			√
Accessibility of the farmers to institutional credit			√
Motivational activities			
Providing farmers' access to modern agricultural equipments and machineries	√	√	
Inspiring the farmers to use organic fertilizers	√	√	
Restricting the use of chemical fertilizers, pesticides and medicine	√		√

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Inventory of the Environmentally Threatened Medicinal Plants of Bangladesh for Their Conservation and Sustainable Management

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Location: Department of Botany, University of Chittagong

Duration: Three years (2014 – 2017)

Expenditure of the project: Tk. 1700000.00

Introduction

The majority of the world's population continues to rely on medicinal plants for health care needs. Current global demand for herbal products is vast and growing. WHO has listed over 21000 plant species as medicinal using around the world (Akshay *et al.* 2014). Chopra (1958) listed about 2000 medicinal species with medicinal properties in the *Materia Medica* of traditional medicine from the Indian subcontinent while Akshay *et al.* (2014) reported 2500 plant species to be using in indigenous system of medicine in India. About 7000 plants are known to be used in the Chinese Traditional Medicine System (Han 1989). Philippine flora possesses about 1100 medicinal species (Anonymous 2016). About 2062 indigenous plant species also have been recorded to be used in traditional medicine in South Africa (Williams *et al.* 2013). About 3000 species of plants have also been reported globally to possess anti-cancerous properties (Hartwell 1982).

Ghani (2003) in his *Medicinal Plants of Bangladesh* listed a total of 550 species of plants while Yusuf *et al.* (2009) in their revised *Medicinal Plants of Bangladesh* listed a total of 747 medicinal species from 40 plant families out of about 200 families. Rahman & Rashid (2009) and Rahman *et al.* (2012) initiated family wise inventory for medicinal species diversity for the first time in Bangladesh and made inventory report of 18 families. Very recently Sultana (2017) identified 220 species of plants of Bangladesh possess anticancer properties based on literature survey. Bangladesh is a small country, with an area of about 147,570 sq km situated in the sub-tropical zone of the Indian sub-continent. Its flora has not yet been completed. Khan (1977) estimated about 5000 species of angiosperms to be represented in Bangladesh. In the recent years, about 3611 species of angiosperms belonging to 199 families have been cited in the *Encyclopedia of Flora and Fauna of Bangladesh* (Ahmed *et al.* 2008, 2008a, 2009, 2009a). It has been estimated that more than 60% of the total species of Bangladesh are medicinal which are impoverished by continuous loss and degradation of the plant diversity from the nature due to various biotic and abiotic interferences. Rahman (2013) in his *Red Data Book of Flowering Plants of Bangladesh* reported about 45.19% species of Bangladesh as threatened and 13.27% species as possibly extinct.

The complete inventory of the medicinal plant diversity in the flora of Bangladesh with their status of occurrence has not yet been made. Even no concrete attempts have been made to save the threatened medicinal components for restoring the environment although it is being a global concern, and Bangladesh has signed the agreement of CBD of Earth Summit (1992). In the recent years a few medicinal plant gardens have been established privately by some research institutions, like Ghonoshastha, Hamdard for cultivation of rare and endangered species. Governmental initiation for medicinal plant conservation strategy in Bangladesh has not yet been implemented.

The present study with 36 plant families has been carried out in order to make family wise inventory of the threatened medicinal species of plants and assessment of their status of occurrence and habitats in the wild following directions laid down by IUCN (IUCN 2004) for planning and implementing National Conservation Strategy (NCS).

Objectives

The main objectives of the project was to make family wise inventory of the threatened medicinal plant species of Bangladesh and assessment of their status of occurrence and habitats in the wild for proper planning and implementing National Conservation Strategy (NCS) for conservation management. In addition, a trained manpower in respective field is to be produced.

Methodologies

The study has been completed on 36 plant families as listed in Table 1. The inventory as well as assessment has been made based on field investigations, examination of herbarium specimens and survey of relevant literature.

Field investigation: Intensive field investigations throughout the flora for more than 3 years have been made by a trained team of taxonomists in order to determine the distribution, abundance, status of occurrence and threat to the species. Fieldworks in most plant rich areas have been made in every season. Collection and identification of specimens have been made following standard taxonomic method.

Herbarium consultation: The plant specimens, collected before and after independence and preserved at DACB, DUSH, BFRIH, BCSIRH, HCU, HJU, HRU, CAL, E, K have been thoroughly surveyed for determining the places of occurrence and assessment of status of occurrence of respective species.

Literature survey: Floristic literature relevant to the flora of Bangladesh have been consulted, such as, Roxb. (1814, 1832), Baker (1876-1879), Kurz (1877), Prain (1903), Heinig (1925), Cowan (1926), Raizada (1941), Sinclair (1956), Huq & Begum (1984), Huq (1988), Khan *et al.* (1994), Rahman & Hassan (1995), Rahman & Uddin (1997), Yusuf *et al.* (1997), Dey *et al.* (1998), Uddin *et al.* (1998), Uddin & Rahman (1999), Rashid *et al.* (2000), Khan & Huq (2001), Rashid & Mia (2001), Uddin *et al.* (2003), Hossain *et al.* (2005), Alam *et al.* (2006), Momen *et al.* (2006), Khatun & Rahman (2006), Ahmed *et al.* (2008, 2008a, 2008b, 2009, 2009a, 2009b), Islam *et al.* (2009), Rahman *et al.* (2010, 2012, 2012a, 2013, 2015), Tutul *et al.* (2010), Uddin & Hassan (2010), Arefin *et al.* (2011), Uddin *et al.* (2013) etc.

Determination of medicinal taxa: Determination of a species as medicinal has been made by consulting concerning medicinal literature/internets, such as, Dymock *et al.* (1890), Kirtikar & Basu (1980), Caius (1986, 1989, 1998), Kapoor (1990), Longman (1993), Rahman (1999), Uddin *et al.* (2001, 2012), Ghani (2003), Prajapati *et al.* (2003), Aderogba *et al.* (2006), Govil *et al.* (2006), Uddin (2006), Jagessar *et al.* (2007), Rahman *et al.* (2007), Yusuf *et al.* (2007, 2009), Céline *et al.* (2009), Rahman & Rashid (2009), Abdollahi (2010), Rahman (2010), Kaur *et al.* (2011), Srinivas *et al.* (2011), Mohiuddin *et al.* (2012), Quattrocchi (2012), Behera (2013), Cunha *et al.* (2013), Umadevi *et al.* (2013) and Ghosh (2014).

Assessment of Red list categories: The assessment of the conservation status of medicinal plant species and their classification into Red List Categories have been made using the *IUCN Red List Categories and Criteria: Version 3.1* (IUCN 2001).

Preparation of Enumeration: Taxonomic enumeration of 397 medicinal species (310 threatened and 88 possibly extinct) is prepared as *Red List of Medicinal Plants of Bangladesh* with base line data stored in *Taxonomic Data Bank* (Rahman 2017: www.biodiversityandenvironment.com). Family wise enumeration is made in alphabetical order. Species in each family are also cited in alphabetical order. Each species is cited with collected data on Bangla name(s), habit, flowering and fruiting time, medicinal properties, plant part(s) used, status of occurrence, habitat, collection/recorded localities, threat to the species, conservation measures proposed and list of preserved herbarium specimens.

Results

In this study, 36 plant families have been inventoried for their medicinal species diversity including assessment of their status of occurrence and habitats in the flora of Bangladesh. The study has resulted (Table 1) the identification of 1673 species in 36 families and 985 (58.88%) medicinal species in 35 families where one family, Ancistrocladaceae, has no medicinal species yet to be known to occur in Bangladesh.

Assessment of status of occurrence has resulted 310 (31.47%) species (Table 1) as threatened in the wild which need immediate and appropriate conservation measures. On the other hand, 88 (8.93%) species are assessed to be possibly extinct since these could not be located in the field and no report of occurrence from elsewhere in Bangladesh was found to be available for more than 50 to 100 years. Among these threatened medicinal taxa, 91 species are found to have been already reported in the *Red Data Books* of Khan *et al.* (2001), Rahman (2013) and Ara *et al.* (2013) as Red List Categories and recommended conservation measures.

Further survey to in-and-around the recorded localities is to be made extensively for making rediscovery of those which could remain *exist yet*. About 431 species are assessed to be common which do not require immediate conservation management while 156 are cultivated. Among these 985 medicinal species, 103 (10.47%) are being identified as anti-cancerous plants based on Kaur *et al.* (2011), Umadevi *et al.* (2013) and Sultana (2017).

The study suggested to take in-situ or ex-situ conservation measures, as appropriate, for ensuring sustainable use of each of the medicinal plant resource as directed.

Table 1. Inventory and assessment data of 36 plant families representing in the flora of Bangladesh

Family	No. of spp as per EFFB	Total species as per present study	Medicinal species					
			Total medic. species	% of medic. species	No. & % of threatened species	No. & % of extinct species	No. of common species	No. of cult. species
1. Acanthaceae	107	130	84	64.62%	40 (47.62%)	7 (8.33%)	24	13
2. Aizoaceae	02	02	02	100.00%	0 (00.00%)	0 (0.00%)	02	00
3. Alangiaceae	03	03	01	33.33%	0 (00.00%)	0 (0.00%)	00	01
4. Anacardiaceae	22	24	14	58.33%	6 (42.86%)	0 (0.00%)	04	04
5. Ancistrocladaceae	01	01	00	00.00%	0 (00.00%)	0 (0.00%)	00	00
6. Annonaceae	42	42	22	52.38%	7 (31.82%)	0 (0.00%)	08	07
7. Apocynaceae	46	46	28	60.87%	3 (10.71%)	1 (3.57%)	17	07
8. Araceae	89	111	54	48.65%	7 (12.96%)	0 (0.00%)	35	12
9. Aristolochiaceae	04	04	02	50.00%	0 (00.00%)	0 (0.00%)	02	00
10. Asclepiadaceae	67	67	17	25.37%	5 (29.41%)	1 (6.67%)	10	01
11. Begoniaceae	08	19	09	47.37%	3 (33.33%)	1 (11.11%)	02	03
12. Bixaceae	01	01	01	100.00%	0 (00.00%)	0 (0.00%)	00	01
13. Boraginaceae	20	20	09	45.00%	2 (22.22%)	0 (0.00%)	07	00
14. Caesalpiniaceae	69	72	64	88.89%	20 (31.25%)	8 (12.50%)	14	22
15. Cucurbitaceae	39	41	33	80.49%	9 (27.27%)	1 (3.13%)	11	12
16. Dioscoreaceae	17	18	09	50.00%	2 (22.22%)	0 (0.00%)	07	00
17. Euphorbiaceae	87	90	71	78.89%	18 (25.35%)	6 (8.57%)	33	14
18. Fabaceae	254	254	169	66.53%	62 (36.69%)	15 (8.88%)	48	44
19. Gentianaceae	06	06	06	100.00%	4 (66.67%)	0 (0.00%)	02	00
20. Lamiaceae	86	86	52	60.47%	18 (34.62%)	3 (5.77%)	30	01
21. Magnoliaceae	11	11	04	36.36%	0 (00.00%)	0 (0.00%)	00	04
22. Marantaceae	05	05	01	20.00%	0 (00.00%)	0 (0.00%)	00	01
23. Menispermaceae	16	17	17	100.00%	8 (47.06%)	0 (0.00%)	09	00
24. Myrsinaceae	22	22	10	45.45%	3 (27.27%)	0 (0.00%)	07	00
25. Orchidaceae	179	188	86	45.74%	57 (66.28%)	21 (24.42%)	08	00
26. Periplocaceae	08	08	02	25.00%	2 (100%)	0 (0.00%)	00	00
27. Ranunculaceae	06	06	06	100.00%	2 (33.33%)	0 (0.00%)	03	01
28. Rhizophoraceae	10	10	09	90.00%	2 (22.22%)	1 (11.11%)	06	00
29. Rubiaceae	170	186	98	52.69%	12 (12.24%)	9 (9.10%)	74	03
30. Salicaceae	01	01	01	100.00%	0 (00.00%)	0 (0.00%)	01	00
31. Santalaceae	02	02	01	50.00%	0 (00.00%)	0 (0.00%)	00	01
32. Stemonaceae	02	02	01	50.00%	0 (00.00%)	0 (0.00%)	01	00
33. Taccaceae	04	04	04	100.00%	2 (50.00%)	1 (33.33%)	01	00
34. Verbenaceae	68	76	48	63.16%	6 (12.50%)	5 (10.42%)	37	00
35. Vitaceae	26	33	23	69.70%	6 (26.09%)	4 (17.39%)	12	01
36. Zingiberaceae	60	65	27	41.54%	5 (18.52%)	4 (14.81%)	15	03
Total:	1560	1673	985	58.88%	308 (31.47%)	88 (8.93%)	431	156

A short taxonomic enumeration with conservation status of 310 threatened and 88 possibly extinct medicinal species is prepared as *Red List of Medicinal Plants of Bangladesh*.

Conclusion

The result of the present project recognized that the flora of Bangladesh is rich with vast wild medicinal species diversity which shows 57.62% of the total species.

Plant species are used in the system of traditional medicines in Unani, Ayurvede and pharmaceutical industries in many countries including Bangladesh.

Many of the traditional medicinal industries, like, Hamdard, Shadana, Modern herbal, Kundeshwary etc. have been importing their plant raw materials mostly from outside the country.

There is no proper data available about the native medicinal plant resources of Bangladesh for which exploration, cultivation and utilization of this resource is still not developed and commercialized like India and other countries.

Moreover, data on the threats to the medicinal species and their conservation status have not yet been made available for planning and implementing NCS of Bangladesh. However, the data obtained from this study could be utilized for both in-situ and ex-situ conservation management of the threatened taxa in order to support traditional medicinal system.

Significant achievement is, therefore, made through this research project which indicates the urgency of conducting complete inventory of the threatened plants of Bangladesh immediately before disappearing those vulnerable species from the flora.

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Treatment of Artificial Wastewater Containing Textile Dyes by Solid Supported Films of ZnO Nanoparticles

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Location: Department of Chemistry, University of Dhaka

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 1800000.00

Introduction

Considerable amount of wastewaters are discharged from dyeing and finishing of fabrics in the textile industries every year. Wastewaters generated from the textile industry contain large amount of azo dyes which owing to their non-biodegradability, toxicity and carcinogenic nature constitute a major threat to the ecosystem [Chung *et al.* 1992, Aragao *et al.* 2005.]. Various methods such as biodegradation, adsorption, chlorination and ozonation are the most commonly used conventional methods for treatment of dyes [Foracs *et al.* 2004, Konstntin *et al.* 2004, Arslan *et al.* 2000, Chaudhuri *et al.* 2000, Stock *et al.* 2000, Dakiky *et al.* 2000.]. Biological method seems to be ineffective for the treatment of reactive dyes and also it is not cost efficient for some organic pollutants. Physical methods such as adsorption, flocculation, reverse osmosis, ion-exchange etc. are not destructive. These methods only transfer the contaminants from one place to the other leaving the problem essentially unresolved. Although chemical methods such as chlorination and ozonation have led to successful results, but discharging of chlorinated compounds during cleaning process causes severe problem for ecosystem than the parent pollutants. On the other hand, ozonation process is not economically feasible.

Nowadays, a much attention has been paid to photodegradation using ZnO and TiO₂ owing to their potentiality of total mineralization of most of the organic pollutants including organic reactive dyes to CO₂, water and mineral acids [Daneshvar *et al.* 2003, Sandhya *et al.* 2005, Golka *et al.* 2004, Kortan *et al.* 1990.]. Due to the exceptional activity of the nanomaterials, researchers are now widely using these materials [Van Dijken *et al.* 2000, Zhang *et al.* 2002.]. On the other hand, in large-scale applications, the use of suspended powder requires the separation and recycling of the ultrafine catalyst from the treated wastewater prior to the discharge, which is a time consuming and expensive process. Although nanoparticles have better removal efficiencies for organics, the separation of these particles intensifies the problem because the used nanoparticles themselves are pollutants.

Objectives

In this project, we have attempted to prepare nanoparticles of ZnO (*n*-ZnO) by sol-gel method. These are then used as photocatalysts for the photodegradation of a typical textile dye, remazol red RR (RRR), from aqueous solution. To overcome the problem of separation of nanoparticles from aqueous solution, *n*-ZnO films will be prepared on glass supports and their dye removal efficiency will be tested from aqueous solution. Adsorption of these pollutants on the oxide surface sometimes enhances their photodegradation. For this reason study of adsorption is a part of this research work.

Methodologies

Remazol red R (RRR, Dyester Germany), zinc acetate dihydrate (Merck, Germany), oxalic acid (Merck, Germany), Commercial zinc oxide (*c*-ZnO, Merck, Germany), absolute ethanol were obtained and used here without further purification. De-ionized water was used throughout the present study. For preparation of ZnO nanoparticles, zinc acetate dihydrate (10.98 g) was treated with ethanol (300 mL) at 60°C. The salt was completely dissolved within 30 min. Oxalic acid dehydrate (12.6 g) was dissolved in ethanol (200 mL) at 50°C. The oxalic acid solution was added slowly under conditions of stirring to the warm ethanolic solution of zinc acetate. A thick white gel formed, which was kept for drying at 80°C for 20 h. The xerogel was calcined in a muffle furnace at different temperatures (400, 500, 600 and 800°C) for 2 h to yield *n*-ZnO particles. [Hariharan *et al.* 2006.]. The weight of the product was found about 3.25 g. This process was repeated several times to prepare sufficient amount of *n*-ZnO particles to carry out the whole research. The prepared materials were then characterized by UV-visible Spectroscopy, FTIR spectroscopy, SEM, EDX and X-ray diffractometry.

For preparation of films, about 1.0 g of prepared *n*-ZnO was taken in a beaker containing 15.0 ml de-ionized water and this aqueous suspension was sonicated for two hours for proper dispersion. The suspension was placed on a previously weighted glass plate with the help of a dropper and the number of drops was counted because different number of droplets of ZnO suspension gives different amount of ZnO film. When the surface of glass plate was covered by suspension, then it was kept in rest for air dry and finally it was dried in electric oven at 100°C for 4 hours. The plate with the film was weighted. The amount of ZnO was then obtained by subtracting the final and initial weight of glass plate at room temperature. To prepare the plates with the same mass of *n*-ZnO, the process was repeated for at least three times. It was found that the prepared mass of *n*-ZnO is almost constant with an uncertainty of ± 0.001 g.

Results

Characterization of the materials: All the results of characterization clearly indicate that the materials obtained are ZnO nano particles. SEM images show that size of particles varies from 35 nm to 200 nm depending on the calcination temperatures (Table 1). Fig. 1. represents three typical SEM images at three different calcination temperatures. Although, data are not shown EDX results confirm that the material was pure ZnO. X-ray data are consistent with that of the crystalline ZnO.

Table 1. Comparison of the material prepared at different temperatures

Catalysts	Calcination temperature (°C)	Average particle size
ZnO	400	40 ± 5 nm
ZnO	500	35 ± 5 nm
ZnO	600	50 ± 5 nm
ZnO	800	90 ± 5 nm (small) 200 ± 5 nm (large)

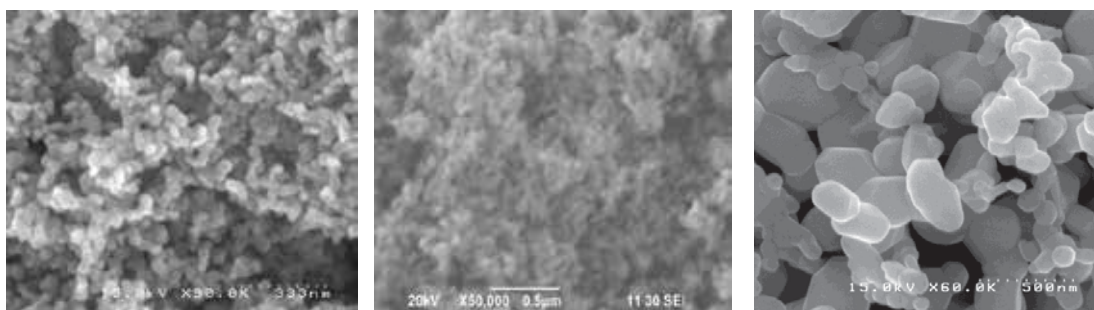


Fig. 1. SEM images of the prepared ZnO calcined at three different temperatures; from left, 400°C, 500°C and 800°C.

Application of the n-ZnO as Photocatalyst: Films of n-ZnO nanoparticles were prepared on glass slide which is used for photodegradation of textile dye, RRR. The experiments were carried out by varying different conditions such as, catalyst dosage, concentration of the dyes, light sources, etc. To determine the effect of the catalyst loading in the glass supported n-ZnO film, a series of experiments were carried out by varying the amount of catalyst from 0.05 to 0.141 g/100 mL, at a dye concentration = 1.0×10^{-4} M, at a solution $p^H = 5.56$. Figure 2 shows the effect of catalyst dosage, which is prepared at 500°C, on the photodegradation. The results clearly indicate that the percent degradation increases with increasing the amount of catalyst and shows a maximum at 0.115 g/100 mL of the solution. It is widely accepted that the photodegradation is caused by the electron-hole pairs produced by the irradiation of the light. With increase in the amount of the catalyst, the surface area increases which increase the photodegradation. However, a higher amount of photocatalyst makes the n-ZnO film less stable and thereby reduces the photodegradation.

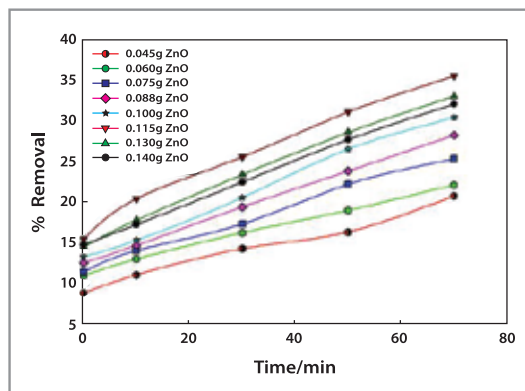


Fig. 2. A plot of percent removal of RRR against (left) time and (right) different amount of n-ZnO at different time intervals. [RRR]₀ = 1.0×10^{-4} M; light: UV light; n-ZnO prepared at 500°C.

The experiments were repeated by applying these films in a artificial drainage system. The glass slides containing the *n*-ZnO films were put in the drain and the flow of the effluent is allowed to pass over the films while irradiating with UV light or sun light. Although, it takes a bit longer time for complete decolourization of the dye, it may be useful for real wastewater treatment.

Conclusion

Zinc oxide nanoparticles, *n*-ZnO have been synthesized successfully via sol-gel process at different calcination temperatures from 300°C to 800°C. The surface morphology and the size of the particles were found to vary depending on the calcination temperature. The prepared samples were characterized by different technique e.g. UV-visible and FT-IR absorption spectroscopy, SEM, EDX, and XRD. The prepared *n*-ZnO was used to prepare a film on a glass support and applied for treatment of artificial wastewater by photodegradation. It was introduced into the aqueous solution of dye to study the removal of RRR by both adsorption and photodegradation. Prepared *n*-ZnO at 500°C was found to be the most effective for removal of RRR compared to other *n*-ZnO. This removal efficiency of *n*-ZnO is compared with that by using commercially available zinc oxide, *c*-ZnO. The removal efficiency was studied by varying several operating factors such as catalyst loading (0.05 to 0.141g per glass slide), initial concentration of RRR (0.5×10^{-4} M to 2.5×10^{-4} M), and light sources. Maximum removal has been found to occur at an optimum amount of catalyst loading of 0.115 g/glass slide in 100 mL aqueous dye solution. Above and below of this amount, percent removal decreases. The removal efficiency of RRR is inversely related to its concentration. As the concentration increases adsorption of RRR in the active site of ZnO increases, which results in the lower formation rate of OH as well as degradation. Sunlight has been found to show better removal efficiency compared to artificial UV and visible light. The removal efficiency under different light sources depends on the mechanism of the photodegradation and intensity of light. Semiconductor mediated photodegradation is one of the promising method for degradation of organic pollutants including dyes and other toxic organic compounds. *n*-ZnO is a suitable semiconducting oxide for this purpose. Immobilization of oxide on the surface of glass plate is an easy and efficient method to increase removal efficiency without the problem of filtration. Finally, it is possible to completely remove the RRR dyes from aqueous solution in the presence of sunlight under optimum conditions. This process does not involve any cost. Recycling of catalyst makes the system more friendly and cost effective. In future, attempt would be made to apply the method for treatment of wastewater directly from the textile industry.

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Commercial Mass-Rearing and On-Farm Validation of Bio-Control Agents and Insect Sex Pheromone Traps for Eco-Friendly Sustainable Production of Brinjal and Cucurbitaceous Vegetables

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Location: Dept. of Entomology, Sher-e-Bangla Agricultural University, Dhaka

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 2200000.00

Introduction

Brinjal and cucurbits, major vegetables in Bangladesh, suffer colossal losses (15 to 50%) due to insect pests every year (Rahman, 2006) as well as farmers are facing problem of safe management practices against these insect pests and do not get good and hygienic yield. Farmers still rely solely on chemical insecticides to control these insect pests, which are seriously hazardous and unacceptable that are impairing ecology, natural enemies and creating health hazards. Hasanuzzoha (2004) reported that within a cropping season the farmers at Jessore applied insecticides on an average 99 times in brinjal fields for controlling brinjal shoot and fruit borer and 12 times in bitter gourd field to suppress cucurbit fruit fly. It was also found that many farmers sprayed insecticides everyday or every alternate day, even twice a day in brinjal at Jessore. Even though, brinjal shoot and fruit borer, and cucurbit fruit fly are very much difficult to control with the currently available insecticides. This is the prime crisis of farmers over the country. The farmers are also far behind the use of safe and environment friendly management practices of crops. The implementation of the current project geared up the hazards free management practices especially mass rearing of *Trichogramma evanescens* egg parasitoid and utilization of insect sex pheromones against brinjal shoot and fruit borer, as well as cucurbit fruit fly for successful and hygienic crop production.

Objectives

- To develop commercial mass rearing techniques of *Trichogramma evanescens* egg parasitoid of brinjal and cucurbitaceous vegetables;
- To validate the results and effects of bio-control agent *Trichogramma* sp. and insect sex pheromones in terms of yield protection and net profit of brinjal and cucurbitaceous vegetables; and
- To introduce and create awareness of the farmers for adoption of *Trichogramma* egg parasitoid and insect sex pheromones for eco-friendly and sustainable crop production for food security.

Methodologies

Procedures: The study on mass-rearing of *Trichogramma* egg parasitoid on eggs of Angoumois grain moth, *Sitotroga cerealella* was conducted in laboratory under the Department of Entomology at Sher-e-Bangla Agricultural University, Dhaka; where grain moths were reared on wheat grains in metallic rearing cage. The adult grain moths were collected from rearing cage and allowed to lay eggs within transparent glass vessel from which the freshly laid eggs of grain moth were collected daily and preserved in the refrigerator at 4°C for future use. The preserved grain moths' eggs were parasitized by the inoculation of adult *T. evanescens* in the glass tubes/plastic vials to maintain stock culture of parasitoid. The *Trichogramma* parasitized rice moth eggs were examined under the stereo microscope. The egg parasitoids from stock culture were then released periodically in the selected brinjal field as required. The performance of *Trichogramma* egg parasitoid with different densities was evaluated through periodic release in brinjal fields along with set up of sex pheromone traps.

Treatments for field performance of Pheromone traps against cucurbit fruit fly

The following treatments were applied against cucurbit fruit fly in the field of bitter gourd during Kharif I season from February to June 2016.

Treatment	Treatment description and dose/density & position
T ₁	Setting up of pheromone trap at the top of canopy considering one (1) trap per 9 m ² plot and replaced at 1 month interval
T ₂	Setting up of pheromone trap at the top of canopy considering two (2) traps per 9 m ² plot and replaced at 1 month interval
T ₃	Setting up of pheromone trap below the canopy level considering one (1) trap per 9 m ² plot and replaced at 1 month interval
T ₄	Setting up of pheromone trap below the canopy level considering two (2) traps per 9 m ² plot and replaced at 1 month interval
T ₅	Setting up of pheromone trap within the canopy level considering one (1) trap per 9 m ² plot and replaced at 1 month interval
T ₆	Setting up of pheromone trap within the canopy level considering two (2) traps per 9 m ² plot and replaced at 1 month interval
T ₇	Untreated control

Treatments for field performance of *Trichogramma* egg parasitoid and pheromone traps against brinjal shoot and fruit borer (BSFB)

The following treatments were applied against brinjal shoot and fruit borer in the field of brinjal.

Treatment	Treatment description and density & position
T1	Release of 500 Trichogramma egg parasitoid per plot (9 m ²) at 7 days interval
T2	Release of 1000 Trichogramma egg parasitoid per plot (9 m ²) at 7 days interval
T3	Setting up of pheromone trap @ one (1) trap per plot (9 m ²) within canopy level of brinjal field and replaced at one month interval
T4	Setting up of pheromone trap @ two (2) traps per plot (9 m ²) within canopy level of brinjal field and replaced at one month interval
T5	T1+T4
T6	T2+T3
T7	T2+T4
T8	Untreated control

Results

Growth and development of *T. evanescens* egg parasitoid

The significant variations ($P < 0.05$) among different months of the study was observed in terms of egg to larval period of *T. evanescens* egg parasitoid, where egg to adult period was ranged between 7.40 and 4.20 days from the month of September, 2015 to January, 2016. The longest egg to adult period was recorded in September and it was decreased gradually, where the shortest egg to adult period was in January.

Table 1. Variations of growth and developmental period of *T. evanescens* egg parasitoid during the month of September 2015 to January 2016

Month	Egg to larval period (days)	Pupal period (days)	Egg to adult (days)	Adult longevity (days)
September, 2015	3.80 a	3.60 a	7.40 a	3.0 a
October, 2015	3.20 b	3.20 ab	6.40 b	3.0 a
November, 2015	2.80 b	2.60 bc	5.40 c	3.0 a
December, 2015	2.80 b	2.40 c	5.20 c	3.0 a
January, 2016	2.20 c	2.00 c	4.20 d	3.0 a

In column, numeric data represent the mean value of 5 replications and means having similar letter(s) are statistically similar at 0.05 level of probability

Performance of *Trichogramma evanescens* in lab condition

The highest percentage (91.40%) of *Sitotroga* eggs by number were parasitized @ 40 *Trichogramma* (Batch-1) released at pupal stage, which was followed by Batch-2 (88.80%) comprised with 35 *Trichogramma* and Batch-3 (84.0%); whereas the lowest percent parasitization rate by number (68.4%) of *Sitotroga* eggs was recorded for Batch-5 comprised with 20 *Trichogramma* released at pupal stage followed by Batch-4 (76.0%). From the above findings, it was revealed that the parasitization rate of *Sitotroga* eggs by *Trichogramma* egg parasitoid increased with the increase of the number of *Trichogramma* released.

Table 2. Parasitization performance of *Trichogramma evanescens* egg parasitoid on *Sitotroga* eggs in ambient condition during September, 2015

Trichogramma density released (No./batch)	Sitotroga eggs tested (No./batch)	Mean parasitized eggs (No./batch)	Parasitization rate (%)
Batch-1: 40 Trichogramma released	100	91.40 a	91.40 a
Batch-2: 35 Trichogramma released	100	88.80 a	88.80 a
Batch-3: 30 Trichogramma released	100	84.00 b	84.00 b
Batch-4: 25 Trichogramma released	100	76.00 c	76.00 c
Batch-5: 20 Trichogramma released	100	68.40 d	68.40 d

In column, numeric data represent the mean value of 5 replications and means having similar letter(s) are statistically similar at 0.05 level of probability

Field performance of pheromone traps against cucurbit fruit fly

Effect on fruit infestation: In case of early, mid and late fruiting stage, more or less similar trends of percent fruit infestation by number in different densities and positions of setting up of pheromone traps used against fruit fly were observed. At late fruiting stage, the lowest fruit infestation by number (13.55%) was recorded in T₆ and reduced the highest percentage (84.64%) over control, which was statistically similar with T₅ (19.52%) but statistically different from all other treatments. On the other hand, the highest fruit infestation (88.23%) was recorded in T₇ which was statistically different from all other treatments. This was followed by T₁ (58.24%) and reduced the lowest percentage (33.99%) of fruit infestation over control, which was statistically similar with T₂ (41.31%) followed by T₃ (31.53%) and T₄ (30.47%).

Table 3. Fruit infestation using various densities and positions of pheromone traps against cucurbit fruit fly in the field of bitter gourd during Kharif I season of 2016

Treatment	% fruit infestation by number			
	Early fruiting stage	Mid fruiting stage	Late fruiting stage	% reduction over control (late fruiting stage)
T ₁	36.43 b	78.07 b	58.24 b	33.99
T ₂	15.98 cd	31.06 d	41.31 c	53.17
T ₃	11.92 cd	22.53 de	31.53 cd	64.26
T ₄	12.14 cd	26.06 de	30.47 cd	65.46
T ₅	7.81 d	14.53 e	19.52 de	77.87
T ₆	6.28 d	12.51 e	13.55 e	84.64
T ₇	97.65 a	91.71 a	88.23 a	0.00

[In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by DMRT]

Effect on yield performance of bitter gourd: The maximum yield (24.03 ton/ha) was recorded in T₆ and increased highest percentage (163.19%) of bigger gourd yield over control, which was statistically similar with T₅ (23.16 ton/ha), but statistically different from all other treatments. On the other hand, minimum yield (9.13 ton/ha) was recorded in T₇ (untreated control) followed by T₁ (13.96 ton/ha), T₂ (17.02 ton/ha), T₃ (20.45 ton/ha) and T₄ (20.50 ton/ha).

Table 4: Yield performance of bitter gourd using various densities and positions of pheromone traps against cucurbit fruit fly

Treatment	Yield (kg/plot)	Yield (ton/ha)	% increased over control
T ₁	5.23 d	13.96 d	52.90
T ₂	6.38 c	17.02 c	86.41
T ₃	7.66 b	20.45 b	123.98
T ₄	7.68 b	20.50 b	124.53
T ₅	8.68 a	23.16 a	153.66
T ₆	9.01 a	24.03 a	163.19
T ₇	3.42 e	9.13 e	0

Field performance of Trichogramma egg parasitoid and pheromone traps

Effect on shoot infestation: In case of vegetative, early and late fruiting stage, more or less similar trends of percent shoot infestation in different densities and positions of Trichogramma and setting up of pheromone traps used against BSFB were observed. In case of mean infestation, the lowest shoot infestation (6.80%) was recorded in T₇ which was the combination of T₂ and T₄. This was followed by T₆ (7.85%) which was the combination of T₂ and T₃. On the other hand, the highest shoot infestation (25.16%) was recorded in T₈ (untreated control) which was statistically different from all other treatments. This was followed by T₁ (18.11%) followed by T₂ (15.61%) and T₃ (15.42%). This was also followed by T₄ (14.21%).

Table 5. Variations of shoot infestation using Trichogramma egg parasitoid and pheromone traps against brinjal shoot and fruit borer in brinjal field

Treatment	Shoot infestation (%) at different growth stage of brinjal plants				
	Vegetative stage	Early fruiting stage	Late fruiting stage	Mean	% reduction over control
T ₁	5.19 b	14.34 b	34.81 b	18.11 b	28.02
T ₂	4.55 c	12.35 c	29.91 c	15.61 c	37.95
T ₃	4.36 c	12.21 c	29.69 c	15.42 c	38.71
T ₄	4.29 c	11.69 d	26.64 d	14.21 d	43.52
T ₅	4.12 c	11.31 d	23.67 e	13.03 e	48.21
T ₆	3.41 d	6.66 e	13.47 f	7.85 f	68.80
T ₇	1.58 e	6.27 e	12.55 f	6.80 g	72.96
T ₈	10.22 a	23.20 a	42.06 a	25.16 a	-

[In column, means containing same letter did not differ significantly under DMRT at 1% level of significance. Values are the means of three replications]

Effect on fruit infestation: Considering the fruit infestation, in case of early, mid and late fruiting stage, more or less similar trends of fruit infestation by number in different densities and positions of *Trichogramma* and setting up of pheromone traps used against BSFB were observed. In case of mean infestation, the lowest fruit infestation by number (13.67%) was recorded in T₇ which was the combination of T₂ and T₄. This was followed by T₆ (16.0%) which was the combination of T₂ and T₃, followed by T₅ (24.74%) which was the combination of T₁ and T₄. On the other hand, the highest fruit infestation (45.41%) was recorded in T₈ (untreated control) which was statistically different from all other treatments. This was followed by T₁ (33.87%), T₂ (27.69%), T₃ (26.49%) and T₄ (25.46%).

Table 6. Fruit infestation by number caused by brinjal shoot and fruit borer on different treatments in the field

Treatment	% fruit infestation by number at different growth stages of plants				
	Early fruiting stage	Mid fruiting stage	Late fruiting stage	Mean	% r eduction over control
T ₁	25.34 b	30.30 bf	45.98 b	33.87 b	24.92
T ₂	23.21 c	26.86 c	33.00 c	27.69 c	38.62
T ₃	21.67 d	25.80 cd	32.00 cd	26.49 d	41.28
T ₄	20.35 e	24.81 de	31.23 de	25.46 e	43.56
T ₅	19.74 e	23.94 e	30.55 e	24.74 e	45.16
T ₆	12.25 f	15.24 f	20.50 f	16.00 f	64.53
T ₇	7.930 g	13.47 g	19.62 f	13.67 g	69.70
T ₈	33.52 a	40.69 a	61.11 a	45.11 a	-

In column, means containing same letter indicate significantly similar under DMRT at 1% level of significance. Values are the means of three replications.

Effect on yield performance of brinjal: The maximum yield (23.95 ton/ha) was recorded in T₇ that was the combination of T₂ & T₄, and increased highest percentage (163.19%) of bigger gourd yield over control. This was followed by T₆ (21.99 ton/ha), T₅ (15.95 ton/ha) and T₄ (15.37 ton/ha). On the other hand, minimum yield (9.66 ton/ha) was recorded in T₈ (untreated control) which was statistically different from all other treatments. This was followed by T₁ (12.65 ton/ha), T₂ (14.26 ton/ha), T₃ (14.70 ton/ha).

Table 7. Yield performance of brinjal using *Trichogramma* egg parasitoid and pheromone traps against brinjal shoot and fruit borer

Treatment	Yield of fruits		
	(kg/plot)	(ton/ha)	% i ncrease over control
T ₁	11.38 e	12.65 e	30.91
T ₂	12.83 d	14.26 d	47.57
T ₃	13.23 d	14.70 d	52.13
T ₄	13.83 cd	15.37 cd	59.06
T ₅	14.36 c	15.95 c	65.06
T ₆	19.80 b	21.99 b	127.57
T ₇	21.55 a	23.95 a	147.85
T ₈	8.70 f	9.66 f	-

In column, means containing same letter indicate significantly similar under DMRT at 1% level of significance. Values are the means of three replications.

Conclusion

Considering the findings of the study, the following conclusions are drawn

- The highest parasitization (91.40%) of *Sitotroga* eggs by *Trichogramma* egg parasitoid were recorded with the release of 40 *Trichogramma* at pupal stage for every 100 *Sitotroga* egg followed by 88.80% parasitization with the release of 35 *Trichogramma* and 84.0% parasitization with the release of 30 *Trichogramma* for every 100 *Sitotroga* egg.
- The lowest fruit infestation of bitter melon by number (13.55%) was recorded in T₆ comprising 'setting up of pheromone trap within the canopy level considering two (2) traps per plot (9 m²) plot area' and reduced the highest infestation (84.64%) over control.
- The maximum yield (24.03 ton/ha) of bitter melon was also recorded in T₆ and highest increase (163.19%) of bitter melon yield over control was also recorded.
- The lowest shoot infestation (6.80%) of brinjal was recorded in T₇ which was the combination of T₂ and T₄, where T₂ comprised with the release of 1000 *Trichogramma* egg parasitoid per plot (9 m²) at 7 days interval along with T₄ comprising setting up of pheromone trap @ two (2) traps per plot (9 m²) within canopy level of brinjal field.
- Similarly, the lowest fruit infestation of brinjal by number (13.67%) was also recorded in T₇. The maximum yield (23.95 ton/ha) of brinjal was also recorded in T₇ and highest increase (163.19%) of brinjal yield over control was also recorded.

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Preparation of Nanocrystalline Cellulose and Functionally Modified Nanocellulose for the Study of Control Drug Delivery

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Location: Bangladesh University of Engineering and Technology (BUET), Dhaka

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 1700000.00

Introduction

Cellulose in microcrystalline form is the most popular excipient in the pharmaceutical industry for drugs formulation. Due to the abundance, renewability, bio-compatibility of cellulose and its modified products, the materials received great interest in controlled drug delivery system. In this study microcrystalline cellulose (MCC), nanocrystalline cellulose (NCC) and the dialdehyde product of NCC (DANC) were used to study the interaction with a model drug to explore the use of cellulose and their modified products as the media for control drug delivery study. The NCC was prepared from MCC by ultrasound assisted acid hydrolysis method and DANC was prepared from NCC by selective oxidation, were the materials shown to have nanoscopic dimensions and exhibit a high degree of crystallinity. These crystallites bound significant quantities of the water-soluble, ionizable ciprofloxacin hydrochloride, a model drug used in the study. DANC binds a relatively larger amount of ciprofloxacin hydrochloride compared to MCC and NCC. The pH-dependent binding and release were studied. At a certain pH DANC release relatively large amount of ciprofloxacin hydrochloride compared to that of NCC and MCC. The study suggests that DANC can be used as a chemical anchor for further modification in the control drug delivery system.

Objectives

The main objective of this work was to

- optimize the condition for the preparation of NCC from MCC;
- derivatization and functionalization of NCC to DANC;
- characterization of the synthesized products; and
- study of the interaction with a model drug, ciprofloxacin with MCC, NCC, and DANC.

Methodologies

The reaction temperature, time and composition for the preparation of NCC from MCC were optimized in this study and the following optimized condition was applied for the preparation of NCC. Temperature-60°C, concentration of H₂SO₄: 63.5 % (w/w), reaction time: 90 min and MCC to acid ratio:1:20. For the preparation of DANC an aqueous mixture of NCC and sodium periodate was stirred for several hours in the absence of light at 48°C temperature.

The MCC, NCC and DANC were characterized in terms of chemical characterization by FTIR and CHEMICAL tests, surface morphology by FESEM, crystallinity by XRD, thermal by TGA. For the study of the interaction of drugs with the synthesized materials ciprofloxacin hydrochloride was taken as model drugs. For the study of binding interaction certain amount of prepared materials were mixed with the aqueous solution of the drugs at a different time, the concentration of drugs and pHs. The amount of drugs binds was determined with the help of a UV-VIS spectroscopy. In a similar way, cellulose-drugs were subjected to study for the release of drugs at different pH and time.

Results

The synthesized NCC and DANC were chemically characterized with the help of chemical test and by FTIR. Both the test supports the introduction of aldehyde in the glucose moiety of cellulose network. Surface characterization by FESEM shows the formation of NCC and DANC were in nano dimension. The crystallinity of the prepared materials was determined from the XRD plot shows the lower crystallinity of DANC as compared to NCC. Thermal characterization supports the higher thermal stability of DANC over NCC. In the study of a drug interaction of the materials with ciprofloxacin hydrochloride, it was found that the amount of binding drug gradually increases with the increase of the amount of Ciprofloxacin Hydrochloride in all cases. In the case of MCC this binding drug is lowest compared to that of NCC and DANC. This is because nanocrystalline cellulose has a lower size and greater surface area than microcrystalline cellulose. As a result, NCC has a greater number of reaction sites to bind and adsorb ciprofloxacin hydrochloride on it. On the other hand, dialdehyde, nanocrystalline cellulose is a oxidized form of nanocrystalline cellulose. It has two aldehyde functional groups. These two aldehyde functional group bind drug ciprofloxacin hydrochloride more easily than hydroxyl groups of MCC and NCC. The results shown in figure-1.

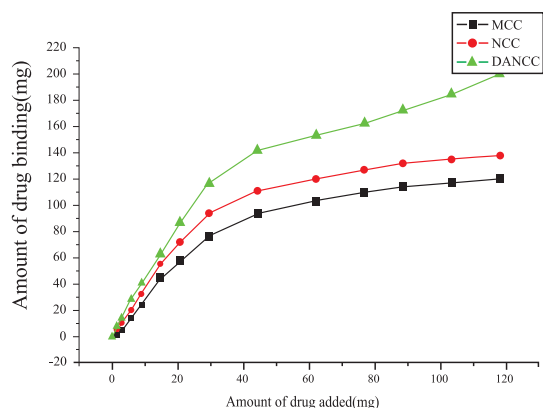


Fig 1. Comparison of Binding of Ciprofloxacin hydrochloride with per g of MCC, NCC and DANC

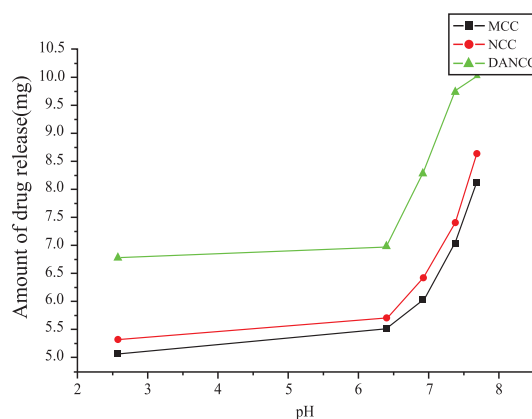


Fig. 2. Comparison of release of Ciprofloxacin hydrochloride with MCC, NCC and DANC

Figure 2 shows the release of ciprofloxacin from MCC, NCC, and DANC. In all the cases, the drug releases rapidly in the first hour. In the range of basic pH, the drug release increased rapidly because the hydroxyl groups of basic solution favor the release of bound drug from the cellulose matrix. At basic pH, the drug release efficiency was higher in case of NCC than DANC and MCC. MCC, NCC, and DANC follow a similar pattern of release. Since DANC bound maximum amount of ciprofloxacin hydrochloride compared to MCC and NCC, so the release of drug from DANC was also greater.

Conclusion

In this study, NCC from MCC and DANC from NCC have been successfully synthesized. FESEM images showed the nano dimension of both NCC and DANC. FTIR and XRD analysis showed their functional groups and crystallinity respectively. From the investigation the interaction of ionizable water-soluble drug Ciprofloxacin Hydrochloride with MCC, NCC, DANC it was demonstrated that the interaction of Ciprofloxacin Hydrochloride was relatively low with MCC. MCC can incorporate a relatively small amount of drug where NCC incorporate a moderate amount of Ciprofloxacin Hydrochloride. The interaction of Ciprofloxacin Hydrochloride was significantly higher in the case of Dialdehyde nanocrystalline cellulose. DANC incorporate a significantly large amount of drug. From the investigation of drug release in different pH it was found that in acidic pH range the amount of drug release increase a small with the increase of pH value. But in basic pH range the release of drug increase drastically with the increase of pH value. Like binding of the drug, a superior quantity of ciprofloxacin hydrochloride was also released from drug bound on DANC. The tendency of binding and release of ciprofloxacin is higher in NCC compared to MCC. DANC and NCC have a greater tendency to bind with the drug than MCC. DANC also release large quantities of the drug over MCC. So the use of DANC and NCC as drug delivery excipients could be highly promising. Overall, these studies have established the potential of DANC as a drug delivery excipient for use alone or in conjunction with other formulations.

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Nutrient Compositional Profile of Selected Key Foods of Bangladesh for the Enrichment of FCTB

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Location: Institute of Nutrition and Food Science, University of Dhaka

Duration: Two years (2015-2017)

Expenditure of the project: TK. 2850000.00

Introduction

Food composition activities (FCA) include data generation in an analytical laboratory, data compilation in a database management system, data dissemination through print and electronic version of Food Composition Table (FCT), and data use by various professional and lay users. Despite the FCA from different data generators of Bangladesh since 1950s, reliable and comprehensive data on the nutrient composition of available foods are insufficient as well as backdated for the development of a national food composition table for Bangladesh (FCTB).

New high yielding varieties (HYV), genetically modified (GM) and non-indigenous foods are constantly being introduced in the food chain of Bangladesh. Chemical analysis of every food item is not possible due to high cost as well as time consuming analytical procedure. Prioritization of foods has been needed for analyzing foods and nutrients, therefore, an investigation to identify the key foods (KF) of the country is essential. The resultant data sets will be the major source for a comprehensive food composition database (FCDB) for Bangladesh.

The currently available FCT in Bangladesh requires updating with newly analyzed nutrient data, particularly with regard to the relatively newer foods like HYV of rice, vegetables, fruits, etc. consumed by the people of Bangladesh. Moreover, food composition data (FCD) also needs revision in the light of newer and more sensitive methods of analysis. Accordingly, the existing FCTB needs to be improved by including newer nutrient values as well as by compiling existing FCD from all over Bangladesh to develop a national FCDB.

Objectives

To support the Government of Bangladesh in improving food and dietary planning by further improving the national FCT.

- To analyze the remaining KFs of the list determined during construction of the FCDB for Bangladesh; and
- Incorporation of generated food compositional data in Archival, Reference and User data base to enrich the existing database (Food Composition Table to capture biodiversity).

Methodologies

KF identification survey

A KFs list was identified according to the method of Haytowitz *et.al*, (1996 and 2002) as outlined in Figure 1.

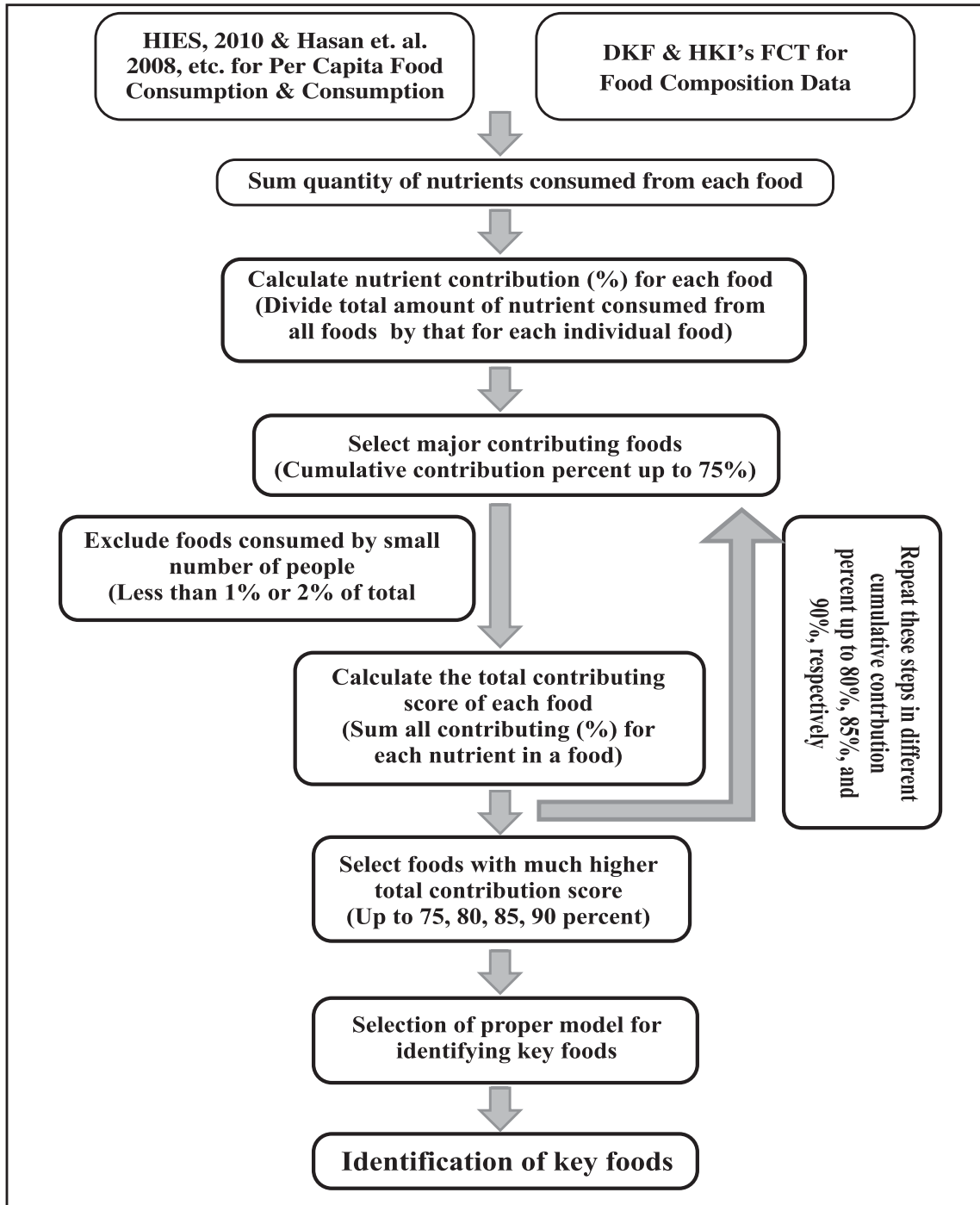


Fig. 1. The Key Food Identification Approach

Laboratory analysis of selected KFs

The analysis of nutrients and other food components preceded by appropriate food sampling process and careful food collection and transportation procedures.

Sample size determination

A total of 73 samples (KFs and non KFs) were selected for laboratory analysis during the whole project period.

Food sampling protocol

Stratified sampling plan based on National Population Census Model was used for food sampling.

Sample collection protocol

The actual collection of the samples was in a random fashion. The samplers randomly chose food samples of dominant variety from preselected sites acting as real consumers.

Logging the laboratory samples:

Laboratory samples logging was done in the same way as the producers/wholesalers/retailers pack, store, and transport their food commodity to the consumers.

Laboratory analysis protocol

Proximate, vitamins and minerals were analyzed by AOAC and other standard methods of food analysis (details in Box1). Duplicate/triplicate analysis of each food item was done to calculate the mean content of each nutrient. Analysis of foodstuffs collected was undertaken at Food analysis and Research Lab of CARS, and Food Analysis Laboratory of INFS.

Box 1. Selection of analytical methods for nutrient analysis

- I. Methods AOAC and other standard methods of food analysis.
- II. Parameters
 - i. Proximate analysis: Protein, Fat, CHO, Water, Ash (by Micro-level digestion-distillation system)
 - ii. Macro-minerals: Na, K, Ca, Mg (by AAS & Flame Photometry)
 - iii. Trace elements: Cu, Zn, Fe
 - iv. Total dietary fiber (TDF) (by Enzymatic-gravimetric method)
 - v. Retinol (by High performance liquid chromatography)
 - vi. β -Carotene
 - vii. Vitamin C, B1, B2,
 - viii. Vitamin B6 (by microbial assay)

III. Quality Assurance Program (QAP)

- i. Method Standardization
- ii. Method Validation: Internal standard (IS), External standard (ES), percentage of recovery
- iii. Data Quality: Precision (CV), Accuracy (In-house reference material – IHRM and well documented food), SEM, Certified Reference Material (CRM)
- iv. Meticulous Documentation

Enrichment of FCTB

Analytical data generated during study have been incorporated in to Archival dataset developed by using FAO data compilation tool 1.2.1 which is structured basically according to Greenfield and Southgate (2003) and separates the database into three different stages: Archival, Reference and User. The primary sources of the data in enriching FCTB included primary analytical value for the analyzed KFs, primary and secondary publications, unpublished reports and analytical reports.

Results

A total number of 58 food samples had been analyzed for proximate composition, includes moisture, protein, fat, available carbohydrate, total dietary fiber (TDF) and ash. The samples collected from different food groups that incorporate both leafy and non-leafy vegetables, fruits, pulses, legumes and their products, fish and meat groups. Moisture and energy content of vegetables and lentils were respectively higher than any other food groups. Protein content as expected was higher in legumes and their products as well as in fish and meat groups. Green gram contains the highest (25.36 g/100 EP) amount of protein among all foods. Fat content of Hilsha fish (13 g/100) was the highest of all foods. Energy content as expected was higher in lentil group due to their higher amount of total carbohydrate content. The data are presented in the Table 1 and Table 2.

A total number of seven minerals were analyzed, among them, four were macro minerals (Ca, Mg, Na, and K) and three trace elements (Fe, Zn, Cu) contents were measured of 32 food samples. The mineral content of the samples is presented in Table 3. Among the different food samples Curry pata contains the highest amount of Calcium (915.69 mg/100g EP) and Magnesium (383.12 mg/100g EP). Surjakannya and Amrulshak contain the highest amount of Iron (5.95 mg/100g EP) and Sodium (522.13 mg/100g EP) respectively. Kohlrabi and Red amaranth contain the lowest amount of Iron (0.1477 mg/100g EP) and Calcium (1.031 mg/100g EP) respectively. Both Beef and Hilsha contain the lowest amount of Sodium (49 mg/100g EP) among all the analyzed foods

Vitamin C content of different variety of fruits and vegetables were measured. Among different fruits and vegetables Vitamin C content of guava (40.30 mgL-AA/100g fresh weight) was higher than any other fruits and vegetables. The data are presented in Table 4.

Table 1. Proximate composition of the key foods (g/100g FW)

Food Groups	Food name in English	Scientific name	Water (g)	Protein (g)	Fat (g)	Ash (g)	TDF (g)	CH(g)	Energy (Kcal)
Non-leafy Vegetables	Cowpea, pods and seeds	<i>Vigna sesquipedalis</i>	87.26	3.38	0.15	0.7	4.85	3.64	39
	Peas	<i>Pisum sativum</i>	66.05	7.81	1.74	1.12	6.34	16.91	91
	Cauliflower	<i>Brassica oleracea var botrytis</i>	92.32	2.25	0.09	0.56	2.93	1.81	27
	Cabbage	<i>Brassica oleracea var capitata</i>	92.83	1.68	0.19	0.49	3.06	1.73	24
	Cucumber (short)	<i>Cucumis anguina</i>	95.45	0.94	0.06	0.33	1.51	1.65	14
	Hybrid Cucumber	<i>Cucumis sativus</i>	96.37	0.6	0.09	0.28	1.28	1.36	8
	Cucumber (desi)	<i>Cucumis sativus</i>	95.35	0.71	0.1	0.35	1.59	1.88	17
	Red amaranth leaves	<i>Amaranthus gangeticus</i>	90.53	3.08	0.18	1.56	2.93	0.69	32
	Plantain	<i>Musa paradisiaca</i>	78.32	1.54	0.3	1.02	2.15	16.65	77
	Gourd, teasle	<i>Momordica cochinchinensis</i>	87.49	1.78	0.2	0.55	1.53	8.42	61
	Papaya, unripe	<i>Carica papaya</i>	93.26	0.96	0.24	0.43	1.7	3.39	30
	Gourd, pointed	<i>Trichosanthes dioica</i>	93.4	2.33	0.05	0.34	1.87	1.99	22
	Ladies finger	<i>Abelmoschus esculentus</i>	88.12	2.92	0.16	0.87	2.95	4.96	39
	Tomato, green	<i>Lycopersicon esculentum</i>	94.11	1.09	0.08	0.44	1.5	2.77	19
	Radish	<i>Raphanus sativus</i>	94.94	0.92	0.02	0.4	1.55	2.15	16
	Gourd, ridge	<i>Luffa acutangula</i>	92.28	1.37	0.05	0.37	2.35	3.56	25
Stolon of Taro	<i>Colocasia spp</i>	91.71	0.71	0.03	0.49	2.5	4.53	26	
Colocasia	<i>Colocasia esculenta</i>	78.49	1.69	0.19	1.37	5.15	13.08	71	
Leafy Vegetables	Spinach	<i>Spinacia oleracea</i>	92.03	3.11	0.15	1.39	2.33	0.94	26
	Bottle gourd leaves	<i>Lagenaria siceraria</i>	90.33	1.32	0.71	1.06	3.96	2.6	26
	Indian spinach, green	<i>Basella alba</i>	92.35	1.99	0.31	0.96	2.5	1.87	25
	Water Spinach	<i>Ipomoea aquatica</i>	89.43	1.31	0.12	1.2	3.21	4.7	43
	Amaranth	<i>Amaranthu slividus</i>	94.38	0.68	0.22	1.16	2.35	1.18	21
	Amaranth, leaves, green	<i>Amaranthu slividus</i>	84.27	1.88	0.37	2.66	5	5.79	25
	Jute leaves	<i>Corchorus capsularies</i>	87.82	3.27	0.16	0.94	5.25	2.55	35
Fruits	Hog plum	<i>Spondias mombin</i>	86.49	1.49	0.04	0.4	1.456	10.1	50
	Pomelo	<i>Citrus maxima</i>	90.2	0.92	0.02	0.4	1.79	6.07	33

Table 2. Proximate composition of the varietal difference foods (g/100g FW)

Food Groups	Food name in English	Scientific name	Water (g)	Protein (g)	Fat (g)	Ash (g)	TDF (g)	CHO (g)	Energy (Kcal)
Pulses, Legumes and their products	Green gram	<i>Vigna radiate</i>	11.36	25.36	1.14	3.35	0.68	58.09	351
	Bengal gram	<i>Cicer arietinum</i>	11.46	21.15	5.8	2.13	2.76	58.26	375
	Anchor flour	<i>Cajanas cajana</i>	9.78	20.56	1.24	2.36	1.5	64.56	355
Non-leafy vegetable	Kohlrabi	<i>Brassica oleracea var gongyloides</i>	93.34	1.35	0.12	0.63	0.36	4.18	24
	Kohlrabi (purple)	<i>Brassica oleracea var gongyloides</i>	92.37	1.64	0.04	0.77	2.66	2.5	22
	Beet root	<i>Beta vulgaris</i>	86.2	1.98	0.11	1.37	3.15	7.18	46
	Turnip	<i>Brassica rapa</i>	89.91	1.77	0.19	0.97	1.06	6.08	35
	Gourd, bitter	<i>Momordica charantia</i>	91.92	2.08	0.17	0.76	1.95	3.1	31
	Gourd, snake	<i>Trichosanthes anguina</i>	95.52	0.72	0.28	0.5	0.79	2.16	24
	Pumpkin	<i>Cucurbita pepo</i>	91.98	1.51	0.1	0.39	0.99	5.03	29
	Pumpkin	<i>Cucurbita pepo</i>	91.35	1.42	0.1	0.1	0.61	6.42	33
	Radish	<i>Raphanus sativus</i>	96.19	1.21	0.02	0.46	0.77	1.35	12
	Radish	<i>Raphanus sativus</i>	96.74	1.31	0.04	0.47	0.7	0.74	10
	Tomato	<i>Solanum lycopersicum</i>	95.68	0.45	0.07	0.81	0.49	2.49	13
	Tomato	<i>Solanum lycopersicum</i>	95.65	1.71	0.12	0.736	0.5	1.28	14
	Brinjal	<i>Solanum melongena</i>	87.94	1.81	0.17	0.63	4.31	5.14	38
	Brinjal	<i>Solanum melongena</i>	91.46	1.73	0.2	0.87	3.56	2.18	25
	Brinjal	<i>Solanum melongena</i>	89.5	1.7	0.15	0.73	3.43	5.49	37
	Brinjal	<i>Solanum melongena</i>	88.84	1.66	0.43	0.73	3.33	5.01	37
	Brinjal	<i>Solanum melongena</i>	86.86	1.66	0.43	0.73	3.33	6.99	45
	Brinjal	<i>Solanum melongena</i>	89.15	1.73	0.32	0.89	1.73	6.18	38
	Bottle gourd	<i>Lagenaria sicerararia</i>	94.74	1.11	0.06	1.65	0.28	2.16	14
	Bottle gourd	<i>Lagenaria sicerararia</i>	96	1.21	0.04	0.82	0.22	1.71	12
Bottle gourd	<i>Lagenaria sicerararia</i>	95.37	1.31	0.04	1	0.28	2	14	
Bottle gourd	<i>Lagenaria sicerararia</i>	95.97	1.34	0.07	0.83	0.23	1.56	13	
Gourd, pointed	<i>Trichosanthes dioica</i>	93.4	2.33	0.05	0.34	1.87	1.99	22	
Meat and fish	Beef	<i>Bos Taurus</i>	73.93	22.86	2.13	1.08	0	0	103
	Goat meat	<i>Capra hircus</i>	74.38	21.58	2.91	1.12	0	0	118
	Hilsha	<i>Tenualosailisha</i>	62.18	23.5	13	1.32	0	0	223
	Shrimp	<i>Machrobrachium lamerrii</i>	74.41	21.1	1.7	2.79	0	0	99
	Catla	<i>Catla catla</i>	76.04	20.37	2.34	1.25	0	0	103
	Gourd, ash	<i>Beninca sahisvida</i>	95.74	0.85	0.02	0.25	1.52	1.59	13

Table 3. Mineral content of some foods (mg/100g of edible portion)

Food Groups	Food name in English	Scientific name	Fe	Ca	Mg	Na	K	Zn	Cu
No-leafy vegetables	Peas	<i>Pisum sativum</i>	1.58	2.28	59.27	256.33	341.66	2.14	0.21
	Cauliflower	<i>Brassica oleracea var botrytis</i>	0.34	5.99	15.51	154.92	133.17	0.39	0.01
	Cabbage	<i>Brassica oleraceavar capitata</i>	0.19	12.33	15.04	109.61	100.43	0.18	0.01
	Cucumber (short)	<i>Cucumisan guina</i>	0.17	3.1	16.82	68.24	73.24	0.21	0.03
	Hybrid cucumber	<i>Cucumissativus</i>	0.17	3.44	11.05	58.89	63.15	0.19	0.02
	Kohlrabi	<i>Brassica oleraceavar gongyloides</i>	0.14	5.91	13.55	135.19	121.14	0.23	0.01
	Red amaranth leaves	<i>Amaranthus gangeticus</i>	1.59	1.03	138.41	234.11	186.18	1.21	0.09
	Spinach	<i>Spinaciao leracea</i>	1.51	19.82	59.58	254.39	125.5	1.05	0.09
	Bottle gourd leaves	<i>Lagenari asiceraria</i>	2.56	30.13	32.73	159.03	196.64	1.78	1.174
Leafy Vegetables	Slender amaranth	<i>Amaranthus viridis</i>	1.75	278.65	272.56	231.98	246.41	1.96	0.2
	Sessile joyweed	<i>Alternanthera sessilis</i>	0.73	295.94	111.25	333.4	239.92	1.88	0.07
	Alligator weed	<i>Alternanthera philoxeroides</i>	1.55	234.74	178.98	322.75	306.14	1.83	0.12
	Spiny amaranth	<i>Amaranthus spinosus</i>	3.15	388.13	195.08	235.25	281.99	0.78	0.13
	Sickle senna	<i>Senna tora</i>	3.94	535.54	345.4	202.96	266.31	1.23	0.11
	Indianpenny worth	<i>Centellaasiatica</i>	0.47	163.56	222.58	253.23	165.67	1.78	0.15
	Bengal dayflower	<i>Commelina benghalensis</i>	0.82	162.35	169.22	172.48	164.75	1.75	0.25
	Drumstick tree	<i>Moringaoleifera</i>	3.12	566.99	58.98	229.88	281.82	1.35	0.25
	Curry leaves	<i>Murraya koenigii</i>	3.45	915.69	383.12	315.08	386.27	3.12	0.39
	Creeping wood -sorrel	<i>Oxalis corniculata</i>	2.07	113.52	87.33	522.13	501.62	1.61	0.32
	Pinkwood sorrel	<i>Oxalis corymbosa</i>	1.64	178.11	189.55	108.22	123.59	0.67	0.13
	Gooseberry	<i>Physalisangulata</i>	1.57	190.26	285.45	197.84	183.4	0.52	0.19
	Javanese long pepper	<i>Piper retrofractum</i>	0.44	278.63	98.98	397.62	427.69	0.92	0.21
	Para cress	<i>Spilanthes calva</i>	5.95	437.21	158.21	176.85	219.43	2.47	0.5
	Indian Ivy - rue	<i>Zantho xylumrhetsa</i>	1.96	693.99	341.74	199.38	252.34	1.72	0.45
Pulse & Legumes	Bengal gram	<i>Cicerarientum</i>	0.68	208	39	102	274	0.82	0.04
	Green gram	<i>Vigna radiate</i>	2.3	17	29	101	377	3.7	0.24
	Anchor flour	<i>Cajanascajana</i>	1.37	9	27	75	355	2.74	0.13
Meat & Fish	Beef	<i>Bos taurus</i>	1.7	906	56	49	103	1.11	0.35
	Goat meat	<i>Capra hyrchusb</i>	1.22	226	52	75	231	0.71	0.11
	Hilsha	<i>Tenualosailisha</i>	3.42	35	79	49	485	2.29	0.53
	Shrimp	<i>Machrobrachiumlamerrii</i>	3.5	52	119	50	509	2.83	0.73
	Catla	<i>Catla catla</i>	5.37	64	161	128	1103	0.82	0.04

Table 4. Vitamin C content of some foods (mg L-AA/100g FW)

Food name in English	Food name in Bengali	Scientific name	L-Ascorbic Acid content (mg L-AA/100 g fresh weight)
Banana	BARI Kola -1	<i>Musa acuminata</i>	3.27
Banana	BARI Kola -2	<i>Musa acuminata</i>	1.03
Banana	BARI Kola -3	<i>Musa acuminata</i>	1.27
Guava	BARI Kazipeara	<i>Psidium guajava</i>	40.3
Guava	BARI Peara -2	<i>Psidium guajava</i>	71.57
Lemon	BARI Lebu -3	<i>Citrus limon</i>	37.61
Mango	BARI Aam -2	<i>Mangifer aindica</i>	2.79
Mango	BARI Aam -3	<i>Mangifer aindica</i>	22.5
Mango	BARI Aam -4	<i>Mangifer aindica</i>	36.12
Pineapple	Anarosh; Justice	<i>Ananus comosus</i>	5.83
Pineapple	Anarosh; Honey Queen	<i>Ananuscomosus</i>	13.53
Pumpkin	BARI Misti Kumra -1	<i>Cucurbita pepo</i>	11.27
Pumpkin	BARI Misti Kumra -2	<i>Cucurbita pepo</i>	9.4
Radish	BARI Mula -2	<i>Raphanus sativus</i>	14.43
Radish	BARI Mula -3	<i>Raphanus sativus</i>	13.87
Tomato	BARI Tomato -14	<i>Solanum lycopersicum</i>	12.71
Tomato	BARI Tomato -15	<i>Solanum lycopersicum</i>	12.87
Brinjal	BARI Begun -Uttara	<i>Solanum melongena</i>	0.93
Brinjal	BARI Begun -10	<i>Solanum melongena</i>	1.87
Brinjal	BARI Begun -8	<i>Solanum melongena</i>	1.77
Brinjal	BARI Begun -4	<i>Solanum melongena</i>	1.07
Brinjal	BARI Begun -3	<i>Solanum melongena</i>	0.33
Brinjal	BARI Begun -5	<i>Solanum melongena</i>	0.77
Brinjal	BARI Begun -6	<i>Solanum melongena</i>	1.4
Bottle gourd	BARI Lau -1	<i>Lagenaria sicerararia</i>	5.17
Bottle gourd	BARI Lau -2	<i>Lagenaria sicerararia</i>	5.77
Bottle gourd	BARI Lau -3	<i>Lagenaria sicerararia</i>	6.37
Bottle gourd	BARI Lau -4	<i>Lagenaria sicerararia</i>	6.13

Conclusion

Bangladesh is experiencing a long-term change in food supply with the emergence of HYV newer foods as well as change in soil composition due to environmental changes, increased use of fertilizers and crop intensity resulting in possible alterations in their nutrient composition. Bearing this in mind, an updated Food Composition Table (FCT) for Bangladesh has been constructed including a total of 604 foods (excluding varieties) which is the first national database and includes data on amino acid profile, fatty acid profile, cholesterol, certain B-vitamins, dietary fiber, heavy metals, total phenol content and antioxidant activity.

Nutrient values of mostly consumed foods e.g. both KFs and non-KFs (high yielding variety), currently are dominant in production and consumption in Bangladesh being analyzed. All the analysis has been done by AOAC and FAO recommended methods and using recommended reference materials. The archival databank for foods composition will be updated, which contained approximately 2500 entries from all kinds of secondary data sources. A food composition database from the archival databank will be developed using INFOOD compilation tool 1.2.1. A comprehensive FCT for Bangladesh with more analytical and least missing nutrient values will be developed.

A multiplicity of professionals will be benefitted by FCT, such as nutritionists, dietitians, food and agricultural scientists, manufacturers, food technologists, home economists, public health scientists, economists, agricultural planners, etc. Data from this updated table would be essential for a variety of purposes in many fields.

FCT will be implicated in i) formulating of national food and nutrition policy, ii) setting goals for agricultural production and designing guidelines for consumption and particular policies, iii) planning of institutional diets in translating recommended nutrient intakes for large sectors of the population (e.g. hospitals, schools, day-care centers, etc) into cost-limited foods and menus, and iv) nutrition intervention programs.

Publications from this Research

Nandi, R., Akhter, K. T., Trfan, N. M., Khan, I. N., Seoty, N. R. and Shaheen, N. 2018. Varietal differences in proximate composition of selected commonly consumed vegetables of Bangladesh. *Bangladesh Journal of Nutrition*, Vol. 28-30, 2018.

Seoty, N. R. 2015. Varietal differences in proximate composition of selected commonly consumed vegetables of Bangladesh. MS Thesis INFS, University of Dhaka.

Seoty, N. R. 2016. Hydrophilic antioxidant activity, vitamin C and total phenol content of selected varieties of commonly consumed fruits and vegetables of Bangladesh (Doctoral dissertation, University of Dhaka).

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Preparation of Biodegradable Packaging Materials with Radiation Induced Natural Polymers

Mubarak Ahmad Khan and S M Wahiduzzaman

Location: Atomic Energy Research Establishment, Bangladesh Atomic Energy Commission, Savar, Dhaka

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 2570000.00

Introduction

Petroleum-based synthetic polymers are used as packaging materials due to their excellent thermo-mechanical properties and for economic reasons. Unfortunately, these materials are not biodegradable and for this, the disposal of this waste plastic has become a serious problem. One of the strategies to solve the difficult questions related to fossil resources and global environment is thorough recycling wasted polymeric materials. The recycling of wasted plastics is limited, whether materials recycling or chemical recycling consumes a considerable amount of thermal energy, and plastics cannot be recycled forever, i.e., wasted plastics are eventually destined to be burnt or buried in landfills. In these concerns, considering sustainability, industrial ecology and eco-efficiency the development of the next generation of materials, products, and processes is essential. The basic core concept of Green Chemistry is the utilization of materials, which would be biologically acceptable to the environment and would have no negative impacts on the surroundings. To fulfill these purposes, the project concerns development of low cost biodegradable packaging materials from locally available renewable resources i.e. cellulosic materials, starch, adhesives etc. The application of a single biopolymer film for packaging is inadequate because of its poor mechanical properties. However, polymer–polymer interactions can be enhanced by the blending of biopolymers with biopolymers or synthetic polymers of different structures and by the introduction of largely charge interactions rather than hydrogen bonding^{1–3}. However, the main drawbacks of these biodegradable films are their strong hydrophilicity and poor mechanical properties, particularly their low elongation (ca. 6%) under ambient conditions.

Objectives

The use of biodegradable polymers for packaging offers an alternative and partial solution to the problem of accumulation of solid waste composed of synthetic inert polymers. However, although some biopolymers are very abundant in Bangladesh, rendering those as useful materials for making biodegradable plastics, they lack the tensile strength, process ability and dimensional stability. To overcome some of these drawbacks, blending, cross linking and grafting technologies were evaluated in this project.

This project involves the following specific objectives to develop such materials to meet the ultimate goals such as preparation of biodegradable thin film to be used as packaging material, characterization of the developed blend films, regarding thermo-mechanical and chemical properties, investigation of the effect of γ -radiation on the improvement of the thermal stability, physico-mechanical and morphological behavior, water uptake and biodegradability of the prepared blend film and encourage private entrepreneurs to use the technology and if possible, the technology will be transferred to private entrepreneurs.

Methodologies

After extensive research and various optimizations the research team of the project has successfully developed a low cost and easy technology to make 100% biodegradable packaging from jute based cellulose. The developed packaging material is not only 100% biodegradable but also it comprises higher strength than polyethylene bags as well as good stability in water. The development process of the biodegradable packaging is briefly given below. Cellulose is extracted from jute fiber by mercerization and acid hydrolysis. Extracted cellulose undergoes surface modification to induce water solubility. The water soluble modified cellulose is blended with biodegradable binder. Then cross-linker and additives are mixed with polymer blend in an autoclave to make viscous solution. The polymer solution is casted in casting tray and allowed to air dry at 40°C and 40% relative humidity. Prepared biodegradable sheets are dislodged from the casting tray and the polybags are made by conventional sealing. Mechanical, thermal, biodegradability, water solubility are studied. Morphological tests are carried out by optical microscope, Scanning Electronic Microscope (SEM), Transmission electron microscopy (TEM).



Mixture machine solution casting machine prepared films



Final products

Flow chart of Jute based polymer films

Results

Mechanical properties of the prepared film is 32 MPa which is 1.6 times higher than that of PE films. Water uptake and water solubility of the films varies on cross-linking densities. Soil burial tests prepared films were done by soil burial method. The degradation style of the films also depends on cross linking density of the files. Generally those films are degraded within 3 to 4 months.

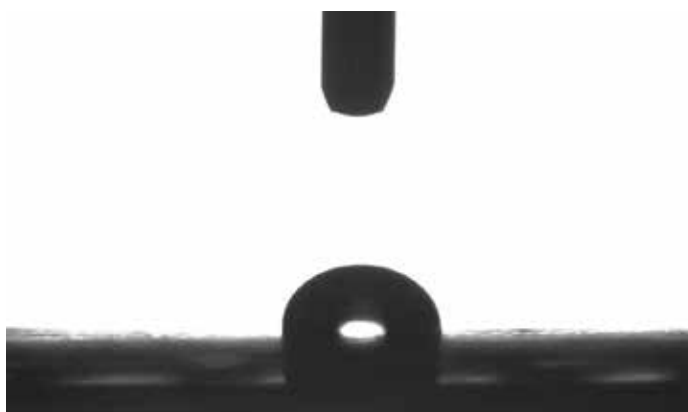


Fig. 1. Water absorption properties studied by contact angle measurement



Day 1

After 30 days

After 90 days

After 120 days

No side effect on plantation

(Complect degradation)

Fig. 2. Soil burial test of degradable films

When prepared films are burned, it produces ash which is not like petroleum based PP/PE films.



Self developed

sample Polyethylene sheet

Fig. 3. Burning style of Cellulose and PE films

Thermal properties of prepared films were studied and it was found that jute based films were more thermally stable than those of PP/PE films.

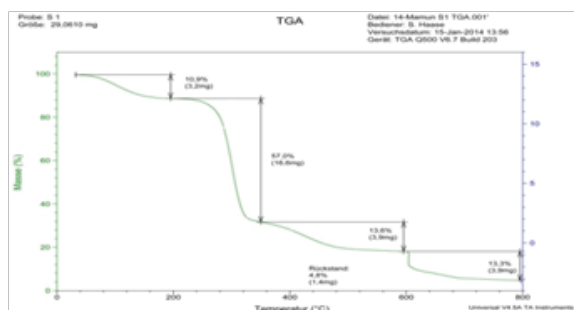


Fig. 4a. TGA curve of resulting films

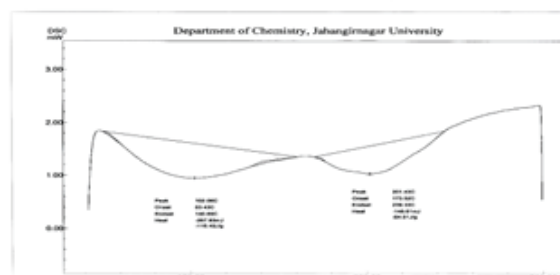


Fig. 4b. DSC of the films

Cross-linking decoration of films were FTIR studied by FTIR and observed new bonds were formed between cellulose and binder.

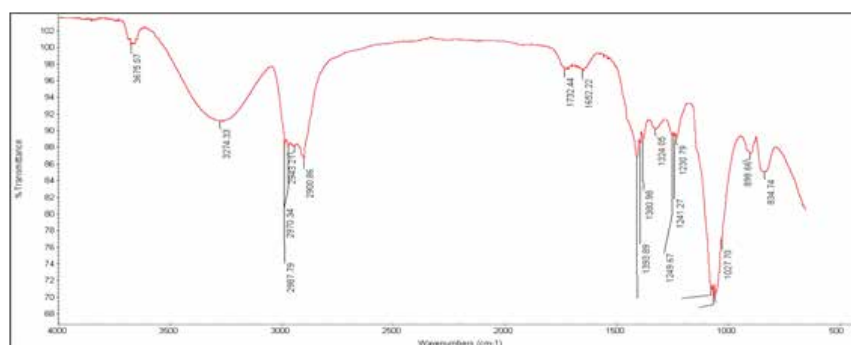


Fig. 5. FTIR spectrum of Cross-linked Cellulose Films

Morphological Characterization

Cellulose nano-fibers are seen under optical microscope in cellulose based films.

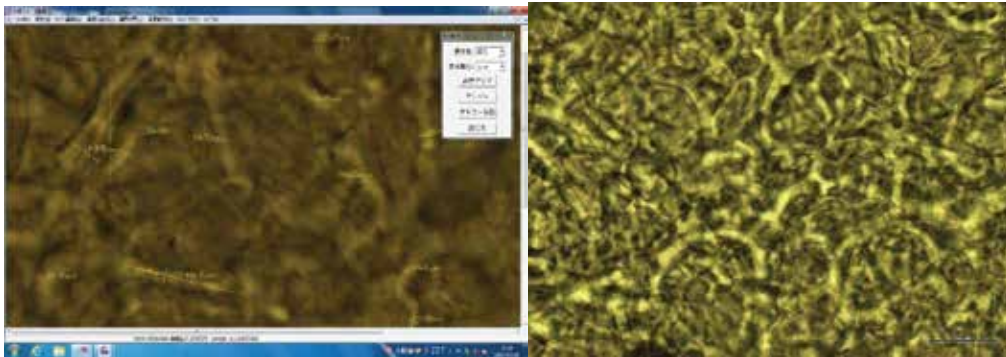


Fig. 6. Optical microscopic image of cellulose based films

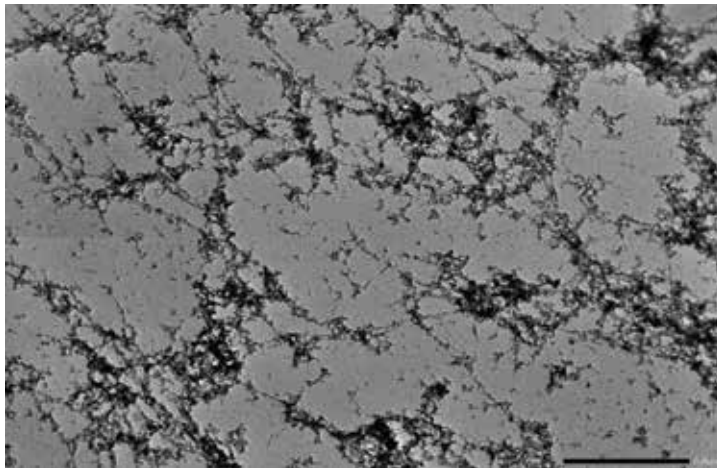


Fig. 7. Transmission of electron microscopy (TEM)

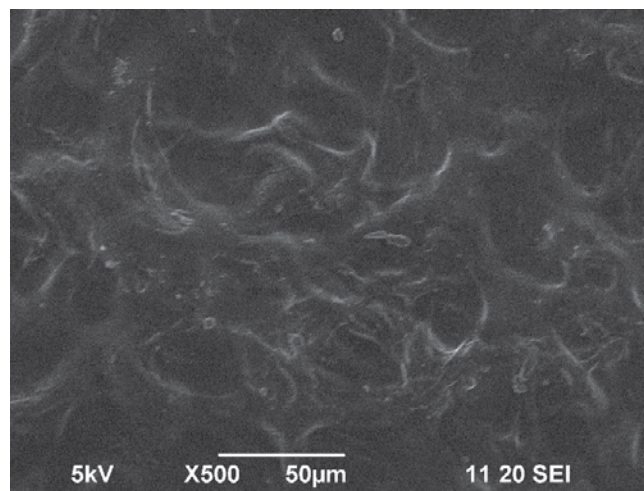


Fig. 8. Scanning Electronic Microscopic (SEM) image of cellulose based films

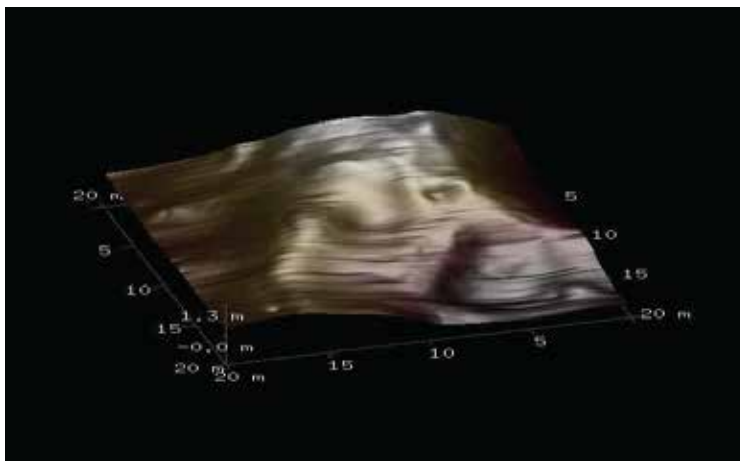


Fig. 9. Atomic force microscopy (AFM) images of films Transparency of virgin polypropylene and cellulose films performed by UV spectroscopy

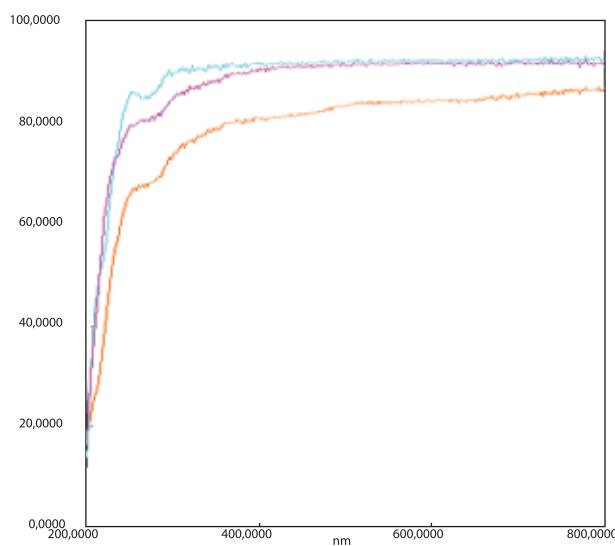


Fig. 10. Transparency of PP films, cellulosed film and color cellulosed film

After successful laboratory scale preparation the Government of Bangladesh has taken initiative for pilot scale production of the jute based polybag under Bangladesh Jute Mills Corporation, Ministry of Jute and Textiles. A jute-polymer unit has already been inaugurated by the Jute and Textile Minister in Latif Bawany Jute Mill, Demra, Dhaka. The team of the initiative is now working to establish a pilot scale production facility to automate the production process of the biodegradable packaging. Sheikh Hasina, the Hon'ble Prime Minister of Bangladesh has named this packaging material as "Sonali Bag" as the principal ingredient is extracted from jute, the golden fiber.

Conclusion

Cellulose is renewable like carbon dioxide, water and sunshine. It is biodegradable, eco- friendly and cheap. It is very easy to modify chemically and physically. The source of raw materials of cellulose is abundant in Bangladesh. So it is unnecessary to rely on petroleum to prepare polymer. People may raise this polymer by planting trees on earth, so the environmental problems will be no longer as severe as today. At present and in near future, Sonali Bag will bring about the golden age in Bangladesh. The physical properties of the Sonali Bag are very much compatible to the traditional poly bags. It is capable of carrying load 1.5 times higher with enhanced thermal properties. It is totally biodegradable (microorganisms can decompose), compostable (could be used as fertilizer for plant growing), time dependable, water soluble (surface can be modified as per requirement. In water, it could be degraded in hours and could be sustained for months). Passively, this material also provides us benefits in two ways- a. by increasing production of jute, b. Reducing the foreign currencies outflow. So, alternatively, it is reducing the emission of CO₂. It is reported that one hectare of jute plants absorbs 15 tons of CO₂ from the atmosphere and adds 11 tons of O₂ during its life span of 120 days. Again, the renewability of jute fiber is much higher than other conventional cellulose sources like wood pulp. For an example, a wood plant takes around 10-15 years to be ready for cellulose collection, whereas jute plant takes only 120 days.

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Preparation of Probiotics for Replacement of Harmful Growth Promoters in Chicken Production to Avoid the Human Health Hazard in Bangladesh

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Location: Dept. of Animal Production and Management, Sher-E-Bangla Agricultural University, Dhaka

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 2000000.00

Introduction

Probiotics are single or mixed cultures of live microorganisms, which when administered in adequate amounts, confer a health benefit on the host. *Lactobacillus*, *Bifidobacterium*, *Leuconostoc*, *Enterococcus*, *Bacillus*, *Lactococcus*, *Saccharomyces*, *Aspergillus* and *Pediococcus* species are most commonly used probiotics in poultry production (Getachew, 2016). Probiotics stimulates the growth of beneficial microorganisms and reduces the number of pathogens thus improving the intestinal microbial balance of the host (Fuller, 1989; Chiang and Pan, 2012). Intake of probiotic lowers the risk of gastro-intestinal diseases by stimulating the growth of beneficial microorganisms (Fuller, 1989; Chiang and Pan, 2012).

Supplementation if probiotics alleviates the problem of lactose intolerance, the enhancement of nutrients bioavailability, and prevention or reduction of allergies in susceptible individuals (Isolauri, 2001; Chiang and Pan, 2012). Probiotics are reported to have also antimutagenic, anticarcinogenic, hypocholesterolemic, antihypertensive, anti-osteoporosis, and immune modulatory effects (Chiang and Pan, 2012). Probiotics in broiler diets improve the growth performance compared with non-supplemented diets, being as effective as antibiotic growth promoters (Kalavathy *et al.*, 2003, Mountzouris *et al.*, 2010, Shim *et al.*, 2010). When supplemented to chicken probiotics improve feed-intake, growth performance, meat quality, egg production, egg quality and have cholesterol lowering potential in poultry products. To avoid the health hazardous growth promoters, we want to introduce newly prepared cost-effective probiotic in the chicken production sector so that farmer can get same benefit instead of antibiotics, steroids etc. Recently, emphasis has been given to the selection, preparation and application of probiotic strains, especially lactic acid bacteria (Wang & Gu, 2010). Natural adaptation of lactic acid bacteria to intestinal environment and the lactic acid produced by them have provided advantages for these organisms over other microorganisms used as probiotic (Guerra *et al.*, 2007). Substitution of conventional and prohibited AGPs with probiotics has received much attention in the recent years. One of the major reason for increased interest in the use of probiotics is because these are natural alternatives to antibiotics for growth promotion in poultry.

Objectives

- Find out the suitable microbes for probiotics;
- Preparation of probiotics for broiler and layer chickens;
- Replacement of antibiotic and steroids growth promoters with probiotics;
- To study the effect of newly developed probiotic feeding on performance (BWG, feed efficiency), meat quality (DP and abdominal fat) of broiler chickens and laying performance in layer;
- To determine the effect of probiotics on microbiological status, blood profiles, immunological parameters and serum in broiler and egg cholesterol in layer; and
- To estimate the cost of probiotics feeding in comparison to other growth promoters.

Methodologies

The research work was conducted in Environmental Biotechnology Laboratory at SAU to prepare probiotic for poultry to avoid health hazard in Bangladesh. The expected organisms were isolated from milk and milk products, whereas yeast (*Saccharomyces cerevese*) was isolated from maize. Total of 144, one-day old Isa Brown layer and 480 unsexed Cobb 500 broiler chicks were subjected to a 50 weeks and 28 days experimental period; respectively.

The chicks (both layer and broiler) were randomly divided separately into four experimental groups with three replicates. The control group-A (T₁) fed a basal diet (un-supplemented-control), whereas the antibiotic and experimental groups fed the same basal diet but supplemented with antibiotic group-B (T₂) containing 14 mg/kg of Flavomycin, probiotic group-C (T₃) provide 100 mg per kg diet and probiotic group-D (T₄) containing 1 g/kg of probiotic. The probiotic group C used in the experiment contained similar proportion of five strains of variable organisms namely *Lactobacillus acidophilus*, *Lactobacillus casei*, *Bifidobacterium bifidum*, *Aspergillus oryzae* and *Streptococcus faecium*. The probiotic group D contained LAB (*Lactobacillus casei/paracasei* LOCK 0920, *L. brevis* LOCK 0944, *L. plantarum* LOCK 0945) and yeast (*Saccharomyces cerevisiae* LOCK 0140). The basal diet fed to the chicks in all groups was the same and were formulated to meet the NRC (1994) recommendations for broiler chickens. The birds in all groups were reared under the optimum environmental conditions and feeds were provided ad-labitum. Chicks in all groups were vaccinated according to local vaccination program. Data were recorded throughout the experimental periods and entered into Microsoft Excel Worksheet and analyzed by using of the ANOVA procedure of Statistical Analysis System (SAS, 2003). Means will be separated by Duncan's multiple range tests. The level of significance will be determined at P<0.05. All data will be expressed throughout as mean ± standard error.

Results

Lactobacillus spp. and *Saccharomyces cerevese* were isolated. We used MRS broth and MRS agar for the isolation and enumeration of *Lactobacillus* spp. *Lactobacilli* appeared as large, round shape, off-white to cream color, shiny colonies embedded in or on MRS Agar or as turbidity in MRS Broth & when Gram stained, found rod shaped, short-medium chain and positive in Gram reaction (violet colour bacilli). Isolation of *Saccharomyces cerevese* was done by PDA agar and round, shining yeast cells were seen 40X zoom.

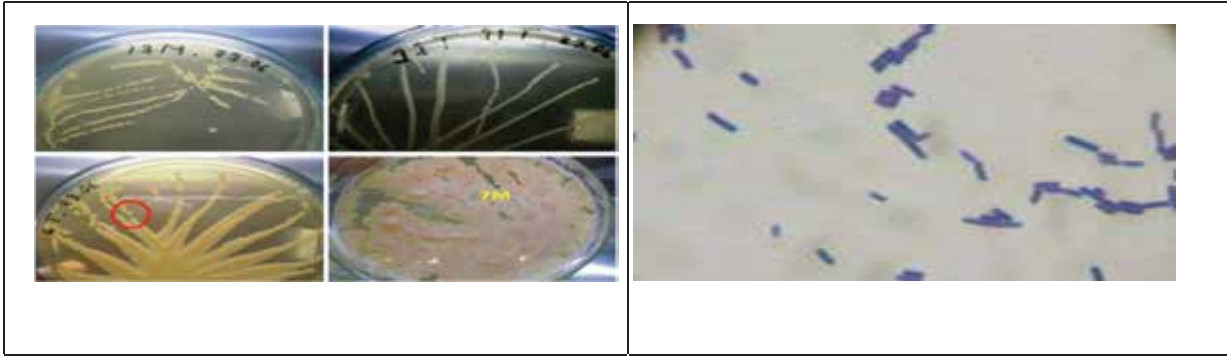


Fig. 1. Colony morphology of *Lactobacillus* spp.

Fig. 2. Microscopic view of isolate when Gram stained

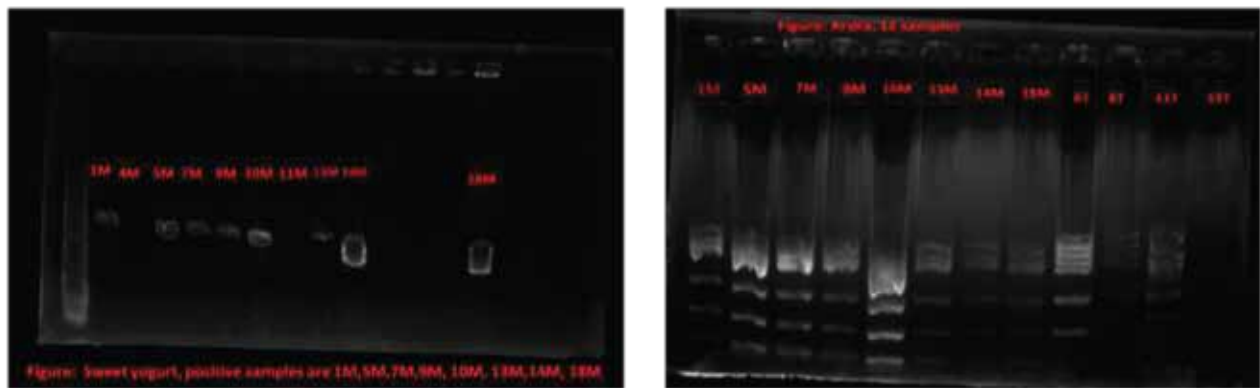


Fig. 3. Yeast on PDA agar



Fig.4. Microscopic view of *Saccharomyces cerevisiae*

From 18 bacterial samples, 12 samples were positive of *Lactobacillus sp.* and from 6 yeast samples, 4 were positive for *Saccharomyces sp.* ARDRA was done to avoid repetition of samples for sequencing. Then five samples with different band size were sent for sequencing.



Positive bands of samples

Bands found after ARDRA

Fig. 5. Positive bands on PCR and ARDRA

A total of five strains were isolated. They were *Lactobacillus gallinarum* JCM 2011(T), *Streptococcus infantarius* subsp. *Coli* HDP90246(T), *Streptococcus salivarius* subsp. *Thermophilus* ATCC 19258(T), *Streptococcus equinus* ATCC 9812 (T), *Saccharomyces cerevisiae*_1.

Effect of probiotics

- **Growth performance and mortality rate in broiler:** Initial weight of chicks on different treatments was similar ($p>0.05$). The average body weight of the birds at the end of the 4th week were higher ($p<0.05$) in all treated groups than control. The mortality was 4.17% in T1 and T4 groups, respectively (Table-11). The data indicated that the mortality percentage was within the normal limit (below 5%).
- **Composition of leg and breastmeat:** Protein% and ash% were increased ($p<0.05$) in probiotic fed chickens together with antibiotic than control, whereas, the fat % of leg and breast meat was lower ($p<0.05$) in probiotic and antibiotic fed chickens. Moisture % was not affected significantly.
- **Production performance in layer:** Egg production (%) and egg mass were significantly affected ($p<0.05$). Compared with the control group, significantly improved egg weight, yolk weight and white weight were found in probiotic group.
- **Haematological parameters:** Bloodparameters such as RBC, WBC, HCT (%), Hb & BGLin both broiler & layer birds did not show significant differences ($p>0.05$) by feeding diets supplemented with probiotics. BCL in both chickens was affected significantly ($p<0.05$).
- **Immunological response:** The levels of NDV titer were significantly higher ($p<0.05$) in all the treated groups as compared with that of control.
- **Microbial load:** The concentration of lactic acid bacteria in intestinal content was significantly increased ($p<0.05$) in the groups fed diets containing antibiotic and probiotics than that of control, whereas the levels of total microbes and *coli* form bacteria were not changed by the dietary antibiotic and probiotics.

Conclusion

Lactobacillus spp., *Streptococcus spp.*, and *Saccharomyces cerevisiae* were very effective strains for probiotic preparation because probiotic from these strains caused better production performance in chicken compared to control and antibiotic treated group. Average live weights of broilers were increased gradually from beginning to 4th week of age by probiotics feeding. Good quality meat was obtained from probiotics group because it caused high percentage of protein and low percentage of fat. Egg production (%) and egg mass were significantly affected by probiotics feeding. Immunological responses were significantly higher in probiotics treated groups. Feeding probiotics resulted in a beneficial modulation of gut microflora as evidenced by the numerous increases in the concentration of lactic acid bacteria. The trial results suggest that probiotic exerted beneficial effects on performance parameters of birds. Moreover, probiotics developed from this study improve immunity and gut health and lower blood cholesterol level of poultry, but no significant effect of feeding probiotics on some other haematological parameters.

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Flow Investigation with Convective Heat Transfer through a Rotating Curved Micro-channel with Strong Curvature

Rabindra Nath Mondal and Bishnu Pada Ghosh

Location: Department of Mathematics, Faculty of Science, Jagannath University, Dhaka

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 1400000.00

Introduction

The study of flows and heat transfer through curved micro-channels has been and continues to be an area of paramount interest of many researchers because of the diversity of their practical applications in many micro-fluidic systems such as in micro-coolers, micro-biochips, micro-reactors and micro-fuel cells. The curved micro-channel is identified as one of the essential elements for improving heat transfer performance, shifting fluid flow direction, enhancing mixed efficiency and increasing fluid path within a miniature area (Schonfeld and Hardt, 2004). In the recent development of microfluidics, the use of secondary flow in curved microchannel with high flow rate is explored for the new science and technology (Ali Asgar *et al.*, 2008; Myung, *et al.*, 2011).

Compared to the classical flow phenomena observed in macroscopic devices, microfluidic systems generally involve laminar flows. Schönfeld and Hardt (2004) investigated pressure-driven microfluidic flow in a curved microchannel and showed that the secondary flows induced in a curved microchannel generate a mixing effect in micro devices. Yamaguchi *et al.* (2005) investigated the interface configuration of two-layered laminar flow in a curved microchannel. Luo *et al.* (2005) investigated the transient electro-osmotic secondary flows which provide evidence of the growth and decay of vortices in the transverse section in a curved microchannel.

To address the effects of curvature, initial conditions and disturbances, a numerical study was made by Wang and Liu (2007) on fully-developed bifurcation structure and stability of the forced convection in a curved microchannel. Recently, the effects of Reynolds number, external wall heat flux and longitudinal rib height on forced fluid convection in a rectangular curved microchannel were investigated numerically by Alireza *et al.* (2014). Chu *et al.* (2010) conducted an experimental investigation of the flow characteristics in curved rectangular microchannels at low Reynolds numbers. In this study, flow structure and heat transfer of fluid flow in a rotating curved microchannel with longitudinal ribs was investigated. Studying the effects of rotation on the unsteady flow characteristics with convective heat transfer, caused by the combined action of the centrifugal, Coriolis and buoyancy forces, is an important objective of the present study.

Objective

The objective of the present study is to establish the precise solution that gives rise to the predicted flows in a rotating curved micro-channel. In this study, a spectral-based numerical result is presented for the fully developed two-dimensional (2D) flow of viscous incompressible fluid. The main concern of the present study is to find out solution structure of steady solutions and to find a close relationship between the bifurcation diagram of steady solutions and the unsteady solutions such as periodic, multi-periodic and chaotic solutions. Dean vortices arising in curved channel single-liquid flows are known as an effective means for heat and mass transfer enhancement, the present study, therefore, focuses on the time-dependent solutions of the non-isothermal flow through a rotating curved micro-channel with various curvatures.

Methodologies

The present study is based on numerical calculations, and in order to obtain the numerical solutions, spectral method is used. The main objective of this method is to use the expansion of the polynomial functions, that is, the variables are expanded in the series of functions consisting of Chebyshev polynomials. In order to obtain steady solutions, the Newton-Rapshon iteration method is used. Then, with a view to investigating linear stability of the solutions, the eigenvalue problem is solved. Finally, Crank-Nicolson and Adams-Bashforth methods together with the function expansion and the collocation methods are applied to obtain unsteady solutions.

Basic Equations

Consider a hydro-dynamically and thermally fully developed 2D flow of viscous incompressible fluid through a rotating curved micro-channel of square cross section. The x , y and z axes are taken to be in the horizontal, vertical, and axial directions respectively. The system rotates at a constant angular velocity around the y' axis. It is assumed that the flow is uniform in the z -direction, which is driven by a constant pressure gradient as shown in Fig. 1. The variables are made non-dimensional. The sectional stream function ψ is introduced as

$$u = \frac{1}{1 + \delta x} \frac{\partial \psi}{\partial y}, \quad v = -\frac{1}{1 + \delta x} \frac{\partial \psi}{\partial x} \quad (1)$$

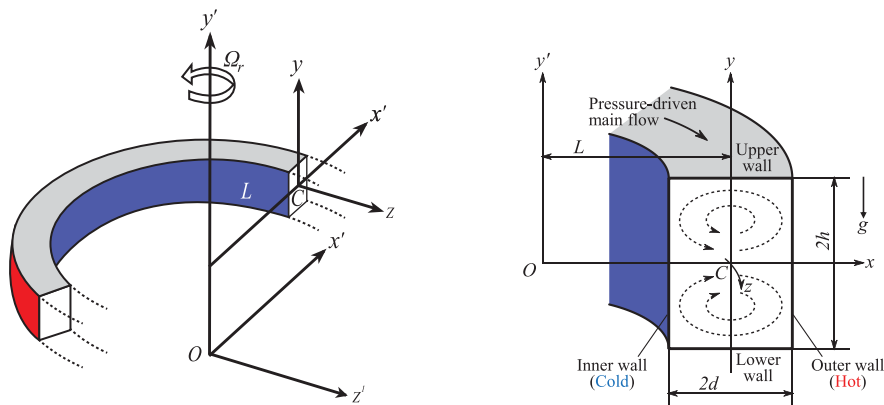


Fig. 1. Coordinate system of the curved duct

Then, the basic equations for the axial velocity (w), stream function (ψ) and temperature (T) are expressed as



$$\boxed{(1 + \delta x) \frac{\partial w}{\partial t} = Dn - \frac{\partial(w, \psi)}{\partial(x, y)} - \frac{\delta^2 w}{1 + \delta x} + (1 + \delta x) \Delta_2 w - \frac{\delta}{1 + \delta x} \frac{\partial \psi}{\partial y} w + \delta \frac{\partial w}{\partial x}}, \quad (2)$$

$$\begin{aligned} \left(\Delta_2 - \frac{\delta}{1 + \delta x} \frac{\partial}{\partial x} \right) \frac{\partial \psi}{\partial t} = & - \frac{1}{(1 + \delta x)} \frac{\partial(\Delta_2 \psi, \psi)}{\partial(x, y)} + \frac{\delta}{(1 + \delta x)^2} \left[\frac{\partial \psi}{\partial y} \left(2\Delta_2 \psi - \frac{3\delta}{1 + \delta x} \frac{\partial \psi}{\partial x} + \frac{\partial^2 \psi}{\partial x^2} \right. \right. \\ & \left. \left. + \frac{\partial^2 \psi}{\partial x^2} \right) - \frac{\partial \psi}{\partial x} \frac{\partial^2 \psi}{\partial x \partial y} \right] + \frac{\delta}{(1 + \delta x)^2} \times \left[3\delta \frac{\partial^2 \psi}{\partial x^2} - \frac{3\delta^2}{1 + \delta x} \frac{\partial \psi}{\partial x} \right] - \frac{2\delta}{1 + \delta x} \frac{\partial}{\partial x} \Delta_2 \psi \\ & + w \frac{\partial w}{\partial y} + \Delta_2^2 \psi - Gr(1 + \delta x) \frac{\partial T}{\partial x} - Tr \frac{\partial w}{\partial y}, \end{aligned} \quad (3)$$

$$\frac{\partial T}{\partial t} = \frac{1}{Pr} \left(\Delta_2 T + \frac{\delta}{1 + \delta x} \frac{\partial T}{\partial x} \right) - \frac{1}{(1 + \delta x)} \frac{\partial(T, \psi)}{\partial(x, y)} \quad (4)$$

The rigid boundary conditions for w and ψ are used as

$$w(\pm 1, y) = w(x, \pm 1) = \psi(\pm 1, y) = \psi(x, \pm 1) = \frac{\partial \psi}{\partial x}(\pm 1, y) = \frac{\partial \psi}{\partial y}(x, \pm 1) = 0 \quad (5)$$

and the temperature is assumed to be constant on the walls as

$$\boxed{T(1, y) = 1, T(-1, y) = -1, T(x, \pm 1) = x}. \quad (6)$$

In this study, the resistance coefficient λ is used as the representative quantity of the flow state and is defined as

$$\lambda = \frac{4\sqrt{2\delta} Dn}{\langle w \rangle^2}, \quad (7)$$

where $\langle w \rangle$ is the non-dimensional mean axial velocity. Finally, to calculate the unsteady solutions, the Crank-Nicolson and Adams-Bashforth methods together with the function expansion and the collocation methods are applied.

Results

Steady solutions

With the present numerical calculations, we first investigated solution structure of the steady solutions for the flow through a rotating curved micro-channel with square cross-section. As a result, we obtained three branches of steady solutions as shown in Fig. 2(a). It is found that there exists no bifurcation relationship among the three branches of solutions. Streamlines and isotherms are shown in Fig. 2(b) for various values of Tr at $Dn = 1000$, $Gr = 100$ and $\delta = 0.001$, where we find that the steady solutions consist of asymmetric two- to four-vortex solutions. It is found that the streamlines of the secondary flow consist of two opposite vortices; one is an outward flow (anticlockwise direction) shown by solid line and the other inward flow (clockwise direction) shown by dotted lines. The flow is accelerated due to combined action of the centrifugal, Coriolis and buoyancy forces; centrifugal force is created due to the motion through a curved channel, Coriolis force due to the rotation of the channel while buoyancy forces because of the thermal gradient.

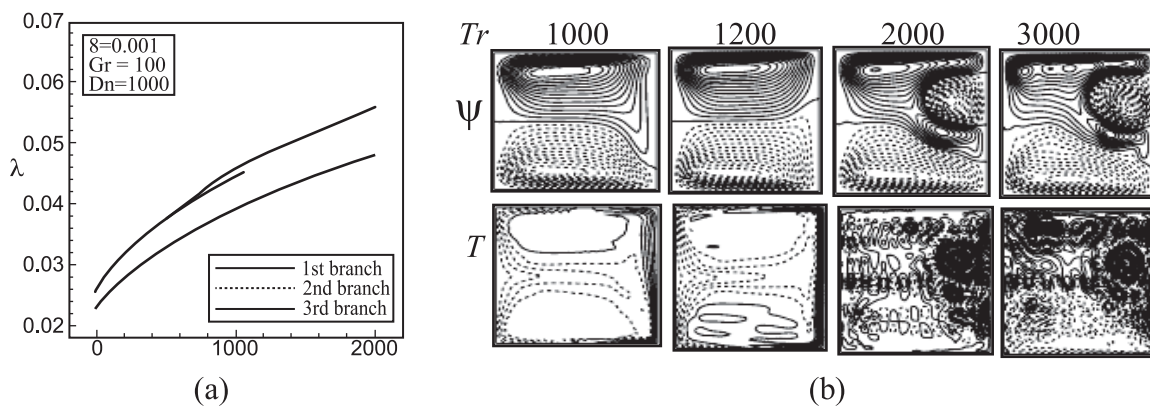


Fig. 2. (a) Solutions structure of steady solutions for at $Dn = 1000$, $Gr = 100$, (b) Streamlines and isotherms on the steady solution branches for $Tr = 1000, 1200, 2000, 3000$

Unsteady solutions

Positive rotation

In order to study non-linear behavior of the unsteady solutions, we investigate time evolution for positive rotation of the channel at $0 < Tr \leq 1500$. Figure 3(a) shows unsteady solution for $Tr = 0$, and it is found that the unsteady flow is a multi-periodic oscillation, which is well justified by drawing the phase space and power spectrum density of the solution as shown in Figs. 3(b) and 3(c) respectively. Streamlines and isotherms are shown in Fig. 3(d) for $Tr = 0$, for one multi-period of oscillation, and it is found that the unsteady flow at $Tr = 0$ oscillates in the asymmetric two-, three- and four-vortex solutions.

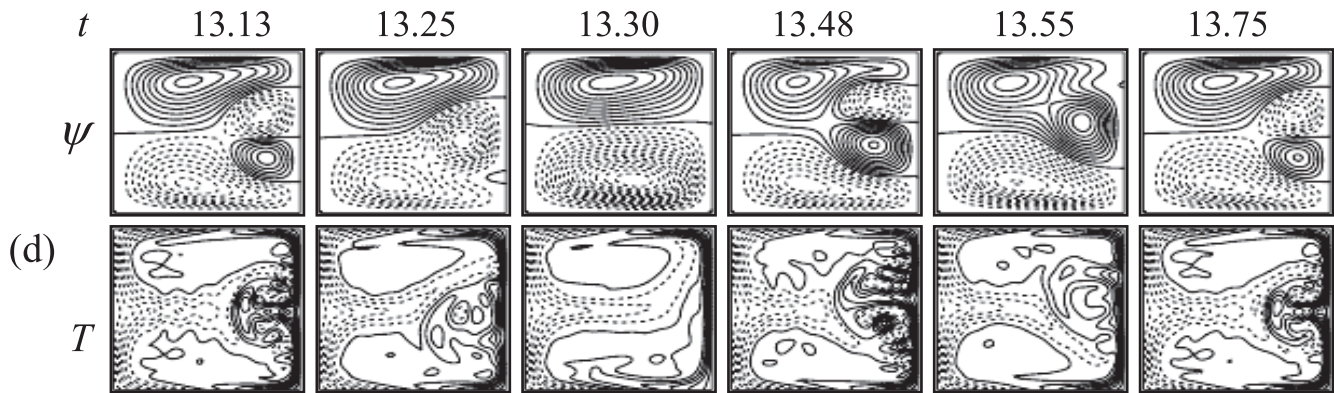
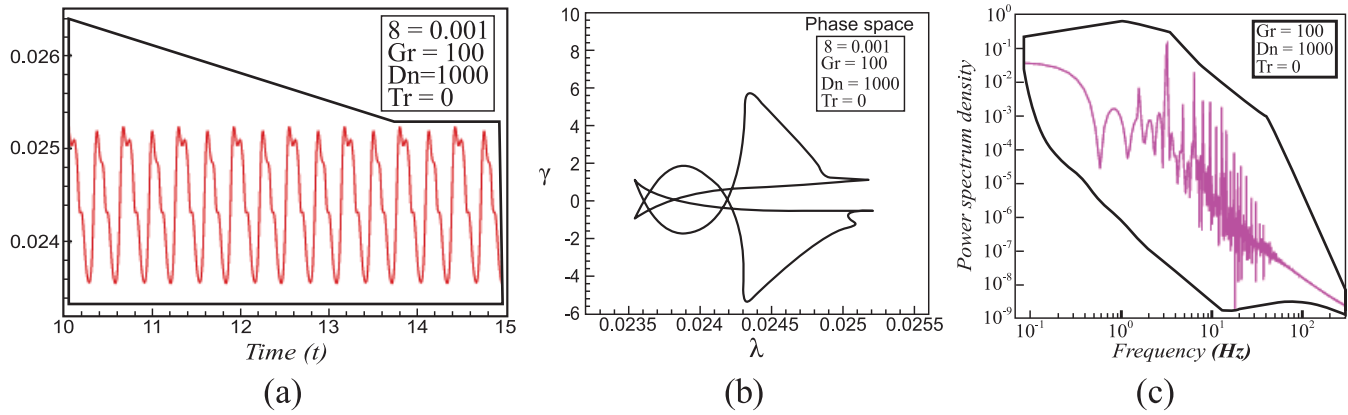


Fig. 3. Unsteady result for $\delta=0.001$ at $Tr = 0$, $Dn = 1000$ and $Gr = 100$. (a) Time evolution, (b) Phase space, (c) Power spectrum, (d) Streamlines and isotherms

Figure 4(a) shows time-dependent flow for , where it is found that the flow is chaotic. This type of chaotic oscillation is also called *strong chaos* (Mondal *et al.*, 2007). To observe the chaotic solution more precisely, we obtain the phase space justified by power spectrum density of the solution as shown in Figs. 4(b) and 4(c), respectively. Figures 4(b) and 4(c) show that there appears continuous line spectrum of different frequencies, which confirms that the flow presented in Fig. 4(a) is chaotic. In order to view the change of the flow characteristics for the chaotic oscillation, we obtain streamlines and isotherms as shown in the Fig. 4(d) for, and it is found that chaotic flow oscillates irregularly between four-vortex solution. Combined action of the centrifugal, Coriolis and buoyancy force help to increase the number of secondary vortices, and as the flow becomes chaotic, the number of secondary vortices increases and consequently heat is transferred substantially from the heated wall to the fluid.

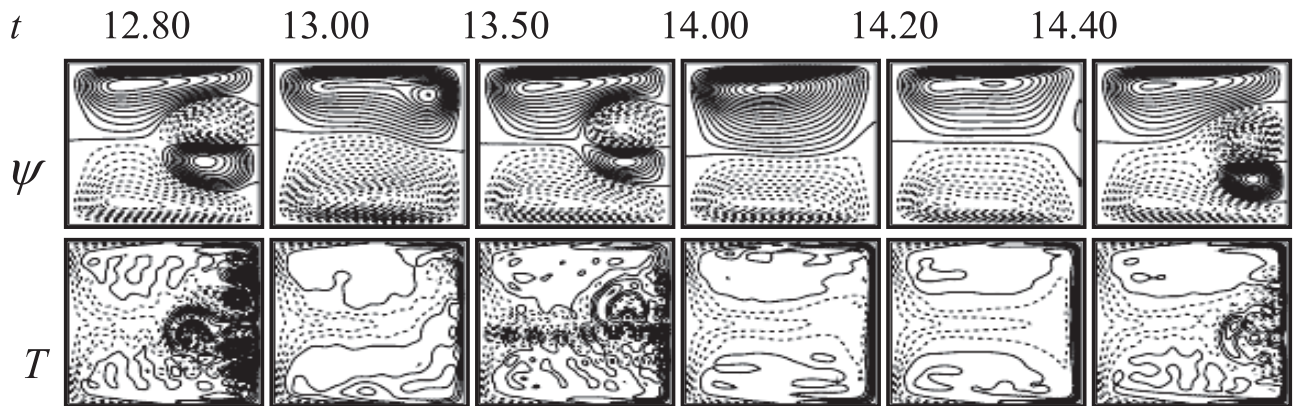
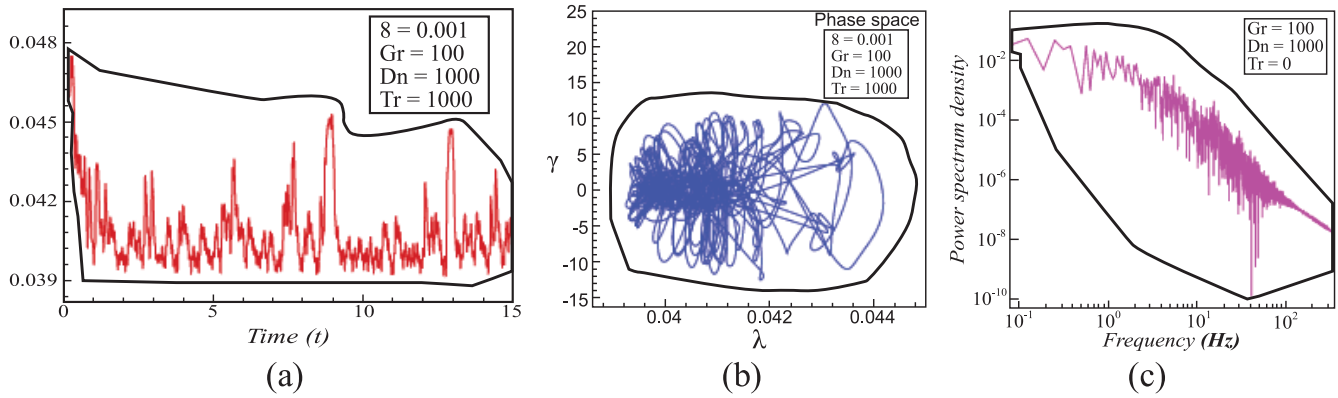


Fig. 4. Unsteady result for at $Tr = 1000$, $Dn = 1000$ and $Gr = 100$. (a) Time evolution, (b) Phase space, (c) Power spectrum (d) Streamlines and isotherms

Heat Transfer

In order to study the convective heat transfer from the heated wall to the fluid, variation of the steady values of the Nusselt number (Nu) with the Taylor number (Tr) is shown in Fig. 5. In the same figure, time-average of Nu is also plotted with the steady values of Nu for both periodic and chaotic solutions, and it is suggested that the occurrence of the periodic or chaotic flow enhances heat transfer in the flow. We calculated temperature gradients $\partial T/\partial x$ for both cooled and heated sidewalls. As seen in Fig. 5(b), $\partial T/\partial x$ on the cooled sidewall decreases in the central region around $y = 0$ as Tr increases. This is caused by the advection of the secondary flow in the outward direction around $y = 0$ due to the centrifugal force. It is also shown that $\partial T/\partial x$ tends to increase in the regions other than the central region. This is caused by the advection of the secondary flow in the inward direction there, which is a reverse flow of the outward secondary flow in the central region. As seen in Fig. 5(c) for heated wall, $\partial T/\partial x$ increases, as Tr goes up, over the whole region except for small Tr . This is because the secondary flow enhances $\partial T/\partial x$ not only in the central region but in other regions as well, if Tr is large.

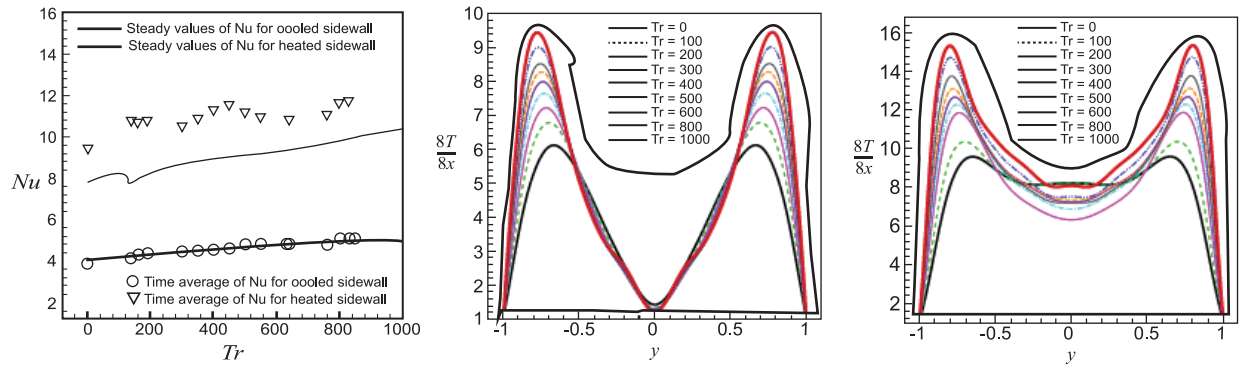


Fig. 5. (a) Variation of the Nusselt number (Nu) vs. Taylor number (Tr) for the cooled wall, (b) Temperature gradient at the heated sidewall

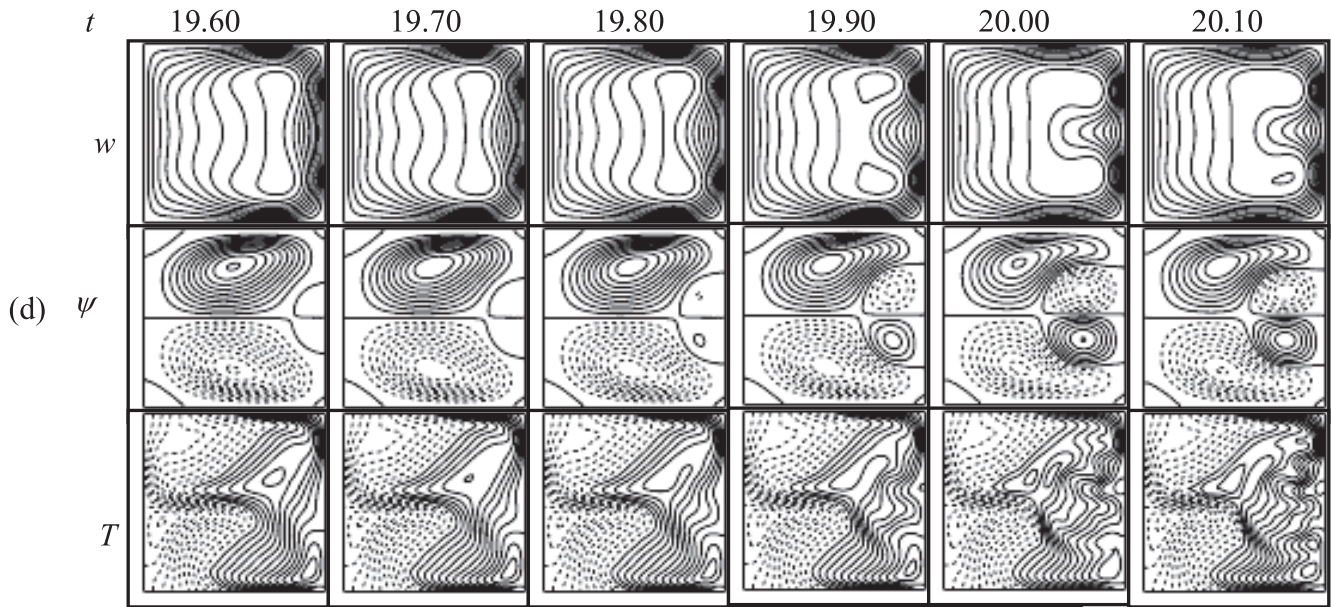
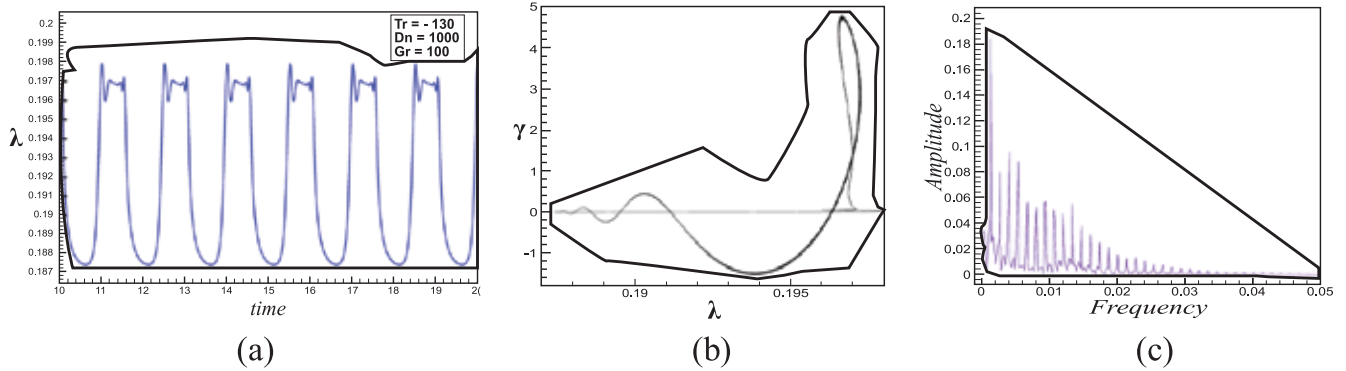


Fig. 6. Unsteady result for $Tr = -130$, $Dn = 1000$, $Gr = 100$ (a) Time evolution of λ (b) Phase space, (c) Power spectrum, (d) Streamlines and isotherms for.

Negative rotation

Here, we show time-dependent behavior of the flow for $Dn = 1000$ and $Gr = 100$ for at . Figure 6(a) shows time evolution result for $Tr = -130$, where we see that the flow is multi-periodic. To view the nature of the multi-periodic oscillation more explicitly, we draw the phase space and power spectrum for $Tr = -130$ as shown in Fig. 6(b) and 6(c), respectively. Streamlines and isotherms are shown in Fig. 6(d) for $Tr = -130$, and it is found that the unsteady flow at $Tr = -130$ oscillates in the asymmetric four-vortex solutions. Figure 7(a) shows time evolution results for $Tr = -100, -250$ and -500 , where we see that the unsteady flow is steady-state solution. Since the unsteady solution is steady-state, streamlines of secondary and axial flow and isotherms are shown in Fig. 7(b), where we see that the steady-state solutions are two-vortex for $Tr = -100$ and -500 but four-vortex for $Tr = -250$.

Finally, we draw phase diagram of the time-dependent solutions for in Fig. 8(a) for both positive and negative rotation. In Fig. 8, the circles indicate steady-state solution and the cross periodic solutions. To observe vortex-structure of secondary flows, we show pattern variation of secondary vortices for different values of Tr . Figure 8(c) shows vortex structure of secondary flows for $Dn = 1000$ and for , where it is found that the secondary flow is a two- to six-vortex solution at various values of Tr . It is found that maximum 6-vortex solution is attained at the small curvature ($\delta=0.01$), while four- and two-vortex for moderate ($\delta=0.5$) and strong ($\delta=0.1$) curvatures, respectively. It is found that the number of secondary vortices decreases as Tr increases. In this study, it has been found that dual solutions exist for the steady-state solution, two- to four-vortex for the periodic solution while two- to six-vortex for the chaotic solution. Therefore, it is recommended that chaotic solutions intensify heat transfer more effectively than the steady-state or periodic solution; this is because many secondary vortices are produced at the outer concave wall for the chaotic solution.

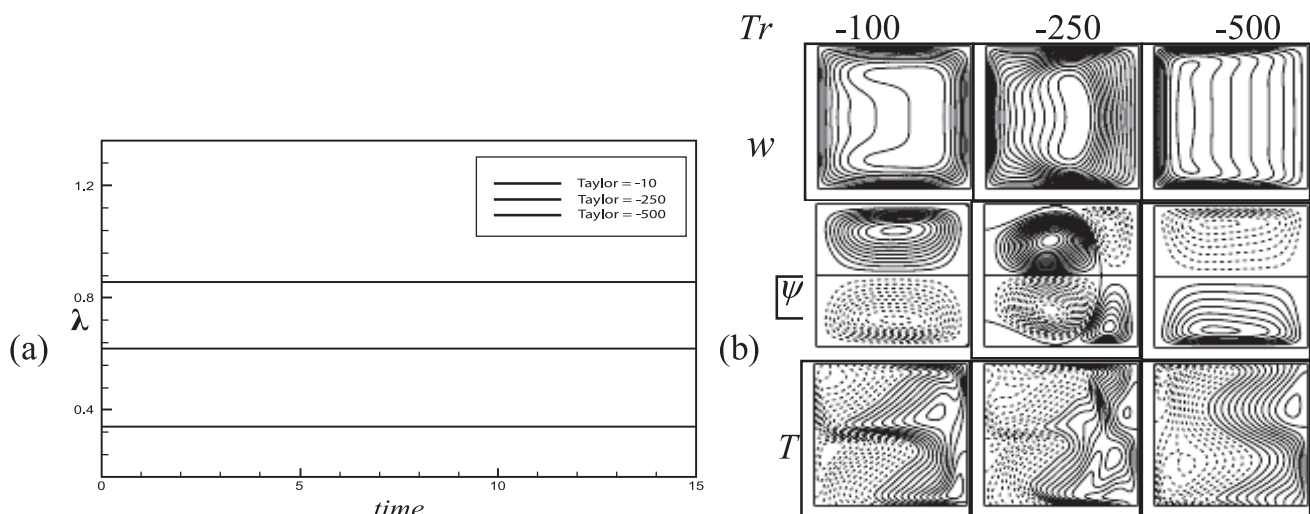


Fig. 7. Unsteady result for ($\delta=0.5$) and $Tr = -100, -250, -500$ at $Dn = 1000, Gr = 100$.

(a) Time evolution, (b) Streamlines and isotherms for ($\delta=0.5$)

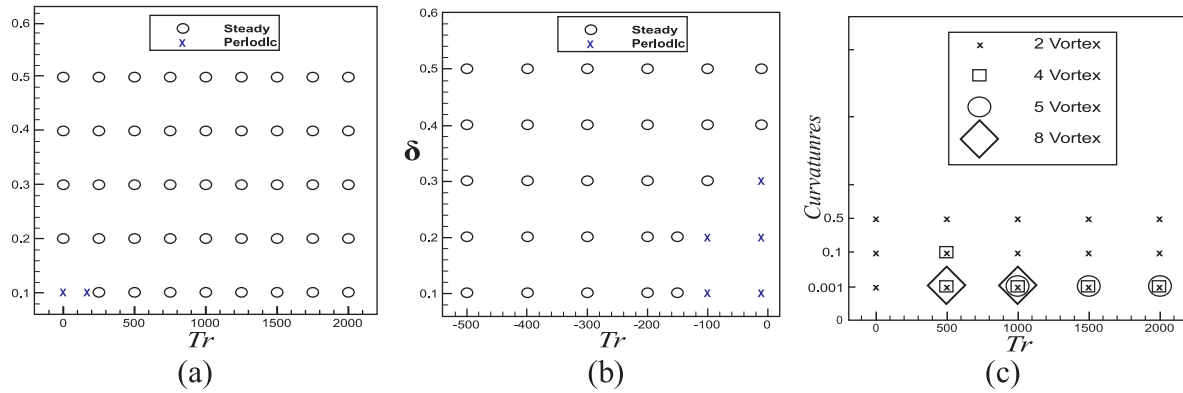


Fig. 8. Unsteady solutions. (a) Positive rotation. (b) Negative rotation. (c) Vortex-structure of secondary flows for various curvatures.

Validity of the numerical result

Here, we discuss the validity of our numerical result with the experimental studies. By using visualization method, Yamamoto et al. (2006) performed experimental investigations of the flow through a rotating curved square channel, where three of the walls, except the outer wall, rotate around the center of curvature at a constant rotational speed $Tr = 150$. In the present study, however, we investigate flow characteristics for rotating the whole system, and show the validity of the present study using the same curvature and rotational speed as Yamamoto et al. (2006) considered. Figure 9 shows experimental vs. numerical results for the rotating curved square channel flow for $Tr = 150$, where we see that our numerical results have a good agreement with the experimental investigations.

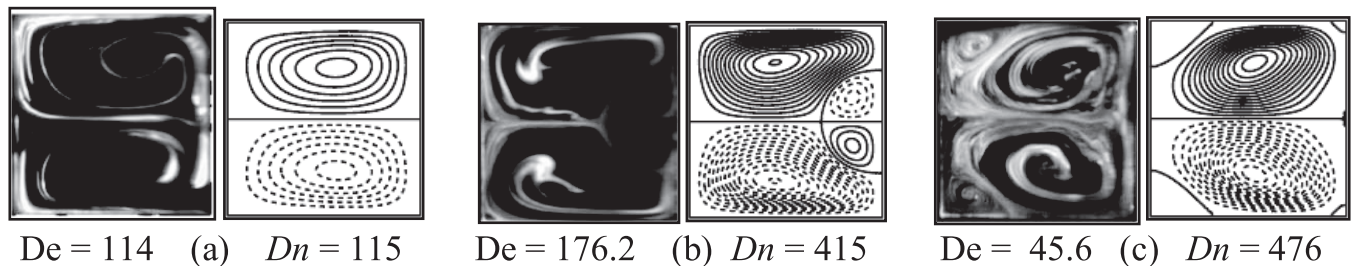


Fig. 9. Experimental vs. numerical results for rotating curved square channel flow at $Tr = 150$. Experimental result by Yamamoto *et al.* (2006) (left) and numerical result by the authors

Conclusion

In this study, a spectral-based numerical result is presented for the fluid flow and heat transfer through a rotating curved micro-channel for various curvatures. Numerical calculations are carried out for a constant Dn and Gr over a wide range of Tr for both positive and negative rotation of the channel. For positive rotation with curvature, we obtained four branches of asymmetric steady solutions comprising two to six-vortex solutions. Then we performed unsteady solutions by time evolution calculations justified by their phase spaces and power spectrum, and it is found that the unsteady flow undergoes through various flow instabilities if Tr is increased.

For moderate curvature, we investigated the steady solutions and obtained two branches of steady solutions consisting of two- to four-vortex solutions. Time evolution of the solutions shows that the multi-periodic flow turns into steady-state flow. For strong curvature, however, we obtained only a single branch of steady solution which is linearly stable. Time evolution calculation shows that the flow is steady-state for any value of Tr investigated in this study. Finally, we investigated flow characteristics in the rotating curved micro-channel with bottom wall heating while cooling from the ceiling, and it is found the unsteady flow undergoes in the scenario '*multi-periodic* \rightarrow *chaotic* \rightarrow *multi-periodic* \rightarrow *chaotic* \rightarrow *steady-state*', if Tr is increased in the positive direction. The present study shows that under combined action of the centrifugal, Coriolis and buoyancy forces, the number of secondary vortices increases for the chaotic flow, which plays a significant role in enhancing heat transfer from the heated wall to the fluid. The present study also shows that there is a strong interaction between the heating-induced buoyancy force and the centrifugal-Coriolis instability in the rotating curved micro-channel that stimulates fluid mixing and consequently increases heat transfer in the fluid.

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Neurotransmitters-Mediating Enzyme, Dopamine- β -Hydroxylase, Its Cofactors and Other Biochemical Parameters in the Serum of Epileptic Patients of Bangladesh

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Location: Department of Biochemistry and Molecular Biology, University of Dhaka

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 1500000.00

Introduction

Dopamin-b-hydroxylas (DBH) is the enzyme responsible for the biosyntheses of catecholamine neurotransmitter, noradrenaline from dopamine in the mammalian tissues and serum (Weinshilboum, and Axelroad, Reid and Kopin). The product, norepinephrine is important biochemically and pharmacologically and involved in the regulation of neuronal functions, behavior and emotion of higher animals. The changes of dopamine, norepinephrine (noradrenaline) and adrenaline (epinephrine) (Flartmark, T) cause a lot of neurological changes (Rahman *et al.* 1981a, 1981b, 2009), like, Parkinson's disease, epilepsy and mental retardation.

Epilepsy (Mannan) is a common and diverse set of chronic neurological disorders, but others require only a single seizure combined with brain alterations which increase the chance of future seizures. In many cases a cause cannot be identified; however, factors that are associated include brain trauma, strokes, brain cancer, and drug and alcohol misuse, among others (Van Praag)). The causes of epilepsy in childhood vary (Chang; Lowenstein). In about 2/3 of cases, it is unknown in 67.6%, congenital 20%, trauma 4.7%, Injection 4%, stroke 1.5%, tumor 1.5% and degenerative 1.5% (WHO, 2013). The DBH is present in the nervous systems, as well as in chromaffin cells of the adrenal medulla (AAN, 2012). It is the only enzyme involved in the synthesis of small-molecule neurotransmitters that is membrane-bound, making norepinephrine the only transmitter synthesized inside vesicles. It is expressed in noradrenergic nerve terminals of the central and peripheral tissues. Up to now we have published many research papers on Catecholamines and Indoleamines mediating enzymes, like AADC and DBH in the highly reputed International Journals (Rahman *et al.* 1980, 1981, Nagatsu *et al.*, Rahman *et al.*, 2012, Rahman *et al.* 2015). Now this piece of research on Epilepsy has been done on the levels of DBH and its cofactors in epileptic patients of Bangladesh, as these neurologically terrible diseases are prevalent in our country. DBH activity would be measured in the serum of patients suffering from epilepsy. The results would be compared with that of healthy individual of similar age groups. The enzyme kinetics of DBH – Km and Vmax values were calculated by using Line weaver and Burk Plots (Line weaver and Burk), using the serum of both epileptic samples and the normal control samples.

Objectives

In Bangladesh, a considerable number of people are suffering from epilepsy, but no significant research has been carried out on the status of catecholamines and their related enzymes, like DBH, in Epileptic Patients. Therefore, the main aims of this study were to find out the levels of DBH activity in the serum of patients suffering from epilepsy. The results would be compared with that of healthy individual of similar age groups. The DBH activity along with the cofactors of DBH (copper and ascorbic acid) were measured in the serum of patients and in healthy normal individuals. In addition, other important biochemical parameters, namely, zinc, glucose, protein, ALT, AST, levels were measured to establish a more detailed comparison between normal healthy individual and epileptic patients of Bangladesh.

Methodologies

Sample Collection - we have collected human serum samples of the epileptic patients from childhood to adulthood to old age, as the outdoor patients and weekly outdoor epilepsy clinics of the Neurology/Neuromedicine Departments of various Govt. hospitals and Institute of the country. About 5-10 ml of blood was collected from each individuals by venipuncture (Ethical Clearance were taken from the Ethical Review Committees of Dhaka University and that from National Institute of Neurosciences, Dhaka) and serum was collected from each sample.

Analytical Methods

DBH activity in human blood was measured according to the method of (Kato *et. al.*). The concentrations of ascorbic acid, cofactor of DBH was measured by dinitrophenyl hydrazine method modified by Lowry *et.al.* . The levels of Cu^{++} and Zn^{++} were determined by using atomic absorptions spectrophotometer (AAS, pye-Unicum, sp9). The total serum protein and glucose were estimated by available Kits based on the method of Lowry *et.al.* 1951 and the Nelson-Somogyi method (Nelson, N.), respectively. Serum ALT, AST, and other biochemical parameters were assayed in the epilepsy serum by using the respective assay Kits bought from the suppliers. All the data were analyzed by using the proper statistical methods to make conclusions of the level of significance. A p-value of ≤ 0.05 was the criterion for a statistically significant difference. Microsoft Excel and GraphPad Prism 4.0 (USA) were used for statistical analyses and graphics. Data were expressed as mean and standard deviation (Mean \pm SD).

Results

It was a very difficult task to collect the Epileptic blood samples from the Patients, specially that from the epileptic children. Most of the parents even did not like that the blood should be drawn from the patients, although the Doctors and Technicians were very co-operative in helping us sincerely. We had collected epileptic blood samples from the epileptic patients who had come to visit the doctors of the weekly Clinics of the Govt. Hospitals and Institute, the majority of samples were collected from the Neurology Department of Dhaka Medical College and Hospital and from the National Institute of Neuroscience and

Hospital (NINH), Agargaon, Dhaka. We had the permission of *Ethical Clearances of collectiny small amount of blood by venipuncture* from the Ethical Clearance Committees of Dhaka University and from the NINH. We could collect 55 Epileptic Blood Samples of various ages and males and females and 57 of that of Control Subjects. The Control Subjects had no history of any types of epilepsy. When we grouped them (in years) as 1 – 20 years (Control Subjects= 21 and Patients= 24), 21 - 40 years (Control 11 and Patients 17) and 41–Above years (Control 17 and Epilepsy = 4 patients) only as shown in Figure 1 The number of samples in each group were also reduced, as we found that some epileptic patients were already under treatments with the epileptic drugs from before they were identified as patients in this study, so their values were dropped from this study.

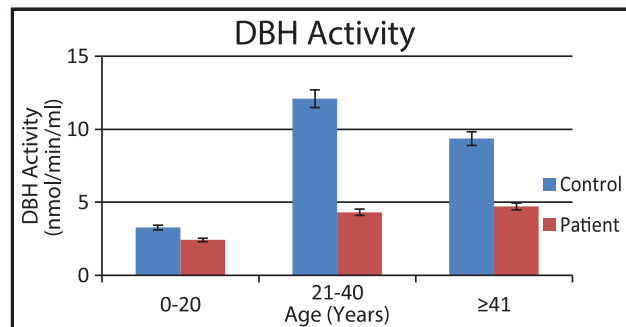


Fig. 1. The graphical presentations of DBH Activities in Control Subjects and Epileptic Patients (without any epileptic medications) in the various age groups in years as mentioned.

Data are presented as Mean ± SD. **P≤0.05

Figure 1 shows the DBH activity in the Serum of Control Subjects and Epileptic Patients without epileptic medications in 3 different age groups as mentioned above. The DBH activity is expressed as nmol/min/ml of serum as 1 Unit. The DBH activity in the serum of all control subjects and epileptic patients without medications of the above three age groups were also extremely variables due to variable ages and physiological conditions. The DBH activities were 3.27 ± 3.43, 12.78 ± 9.78, 9.36 ± 8.21 Units in the Control Subjects and 2.42 ± 2.30, 4.32 ± 4.14, 4.71 ± 4.53, in the Epilepsy Patients without medication age groups, respectively. The activities were decreased in all groups of epileptic patients as compared to that of control groups (*P≤0.05). The number of serum samples were variables due to the unavailability of sufficient amounts of serum in the respective categories. Km and Vmax values of DBH in epileptic and normal control individuals – the kinetics of DBH in the serum of normal individuals and epileptic patients were determined by using Lineweaver-Burk plots and from that plot the Vmax and Km values were calculated. Km and Vmax values were calculated from 3 plots each obtained from Group 1, Group 2 and Group 3 and each plot containing the serum samples of Control subjects and the epileptic patient of that particular age group. The results showed the values of Km and Vmax of each group were in agreements with the enzyme kinetic rules. In Group 1, Group 2 and Group 3, the Km values were 41.67, 40.1 and 38.46 nmol for the normal serum samples and 59.52, 47 and 45.45 nmol for the epileptic samples, respectively. Similarly, the Vmax values were 16.66 nmol/min/ml of serum(U), 21.28 U and 14.28 U for the normal subject and 3.25 U, 2.56 U and 2.44 U for the epileptic samples, respectively, for Group 1, Group 2 and Group 3.

Figure 2, shows the total serum protein contents in the 3 age groups of control subjects and that of the epileptic patients without any epileptic medications.

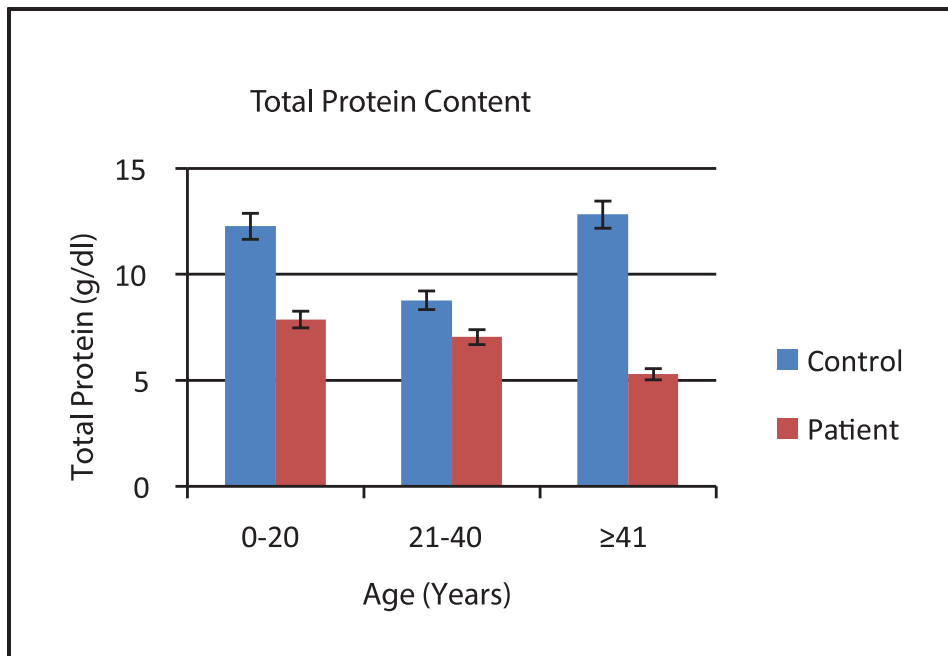


Fig. 2. The Graphical Presentations of Total Protein Contents in Control Subjects and Epileptic Patients without Medications in the various age groups in years as mentioned

Figure 2 shows the total protein contents in serum of control subjects and that of epileptic patients without any medications. The serum protein levels were found to be decreased in all of the 3 age groups of epileptic patients without medications as compared to that in the respective control age match subjects. The protein levels in the serum of the middle age group (Group 2) were found to be lower in both the control subjects and of that of epileptic patients. But the protein levels in the serum of epileptic patients were found to be significantly decreased as compared to control subjects. The protein levels in the serum of epileptic patients without medications were drastically decreased in the Groups 1 and 3 as compared to that in the respective control subjects. Ascorbic Acid (Vitamin C) acts as a strong reducing agent in the body and it is the coenzyme of DBH enzyme. It is a very unstable compound in the body, it participates in many biological reactions in the body, but in most of the cases it is difficult to express them. In the case of epileptic patients the serum levels of Ascorbic Acid was found to be almost same as that of Control Subjects in all the 3 respective age matched groups. Dietary intake, time of measurements of Ascorbic Acid after collection of serum, physiological conditions of the patients and controls might influence the levels.

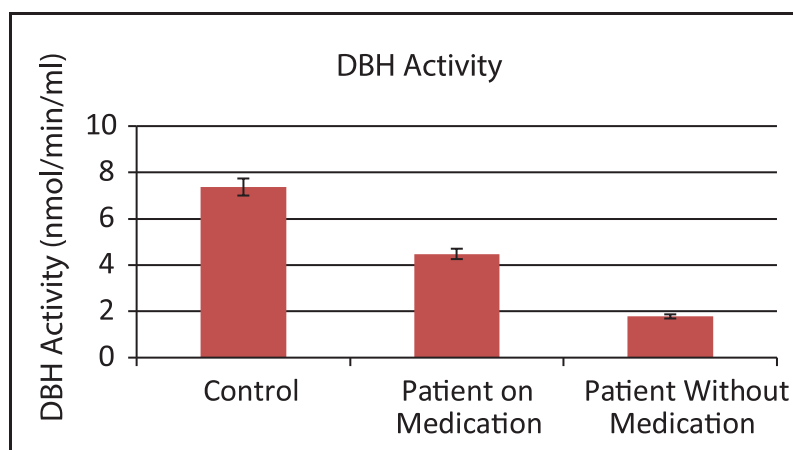


Fig. 3. The Graphical Presentations of DBH Activities in Control Subjects, Epileptic Patients with Medications and Epileptic Patients without Medications

Figure 3 shows the DBH activity in the Serum of Control Subjects, Epileptic Patients with medications and Epileptic Patients without Medications. The number of serum samples were variables due to the unavailability of sufficient amounts of serum in the respective categories. The DBH activity is expressed as nmol/min/ml of serum as 1U. The DBH activity in the serum of all control subjects (child-young, adults and old in age), all epileptic patients with medications (ages as in control group) and all epileptic patients without medications (age: as in the control group) were extremely variables due to the age effects. The DBH activities were 7.37 ± 7.81 , 4.48 ± 3.87 and 1.78 ± 1.61 Units for the Control Subjects, Epileptic Patients on Medications and Epileptic Patients without Medications, respectively. In general, the activities were decreased in both groups of epileptic patients as compared to that of control groups (* $P \leq 0.05$ and ** $P \leq 0.01$ as shown in Figure 3).

Copper is an important element required for humans for tissues and brain activities and it is the co-enzyme and components of many important enzymes, like, Dopamin- β -Hydroxylase (DBH). Table 10 shows the total Copper contents (mg/l) in the serum of Control Subjects, that of Epileptic Patients without Medications and Epileptic Patients with Medications. The values were (mg/l) : 0.092 ± 0.026 , 0.090 ± 0.022 and 0.085 ± 0.007 , for the Control Subjects, Epileptic Patients with Medications and Epileptic Patients without any Medications, respectively. The results showed that the concentrations of copper were decreased slightly in the serum of Epileptic Patients without medications. Zinc is an important element required for humans congenital organs and tissues and brains. It is also involved in the activations and proper functions of DNA- and neurotransmitters-linked enzymes, the co-enzyme and components of many important enzymes, like, Dopamin- β -Hydroxylase (DBH). The total zinc contents (mg/l) in the serum of Control Subjects, that of Epileptic Patients without Medications and Epileptic Patients with Medications. The values were (mg/l) : 0.100 ± 0.021 , 0.108 ± 0.072 and 0.255 ± 0.233 , for the Control Subjects, Epileptic Patients with Medications and Epileptic Patients without any Medications, respectively.

The results showed the increasing tendency in the epileptic patients as compared to the Control Subjects, but they are very variables in concentrations. In the case of epileptic patients the serum levels of glucose (mg/dl) were found to be decreased in almost similar patterns, but that was more decreased in the Epileptic Patients without medications as follows: 127.84 ± 67.14 , 122.55 ± 68.85 and $119.30 \pm 50.26^*$, in the Control Subjects, Epileptic Patients with Medications and Epileptic Patients without Medications, respectively. The results were very variables due to the present of age variable Patients. Dietary intake, time of measurements of glucose after ingestion of foods collection of Serum, physiological conditions of the Patients and Controls might influence the levels.

Table 1. The Glucose Contents (mg/dl) in the Serum of Control Subjects and that of Epileptic Patients with Medications and Epileptic Patients without Medications.

	No of Samples	Glucose (mg/dl)	
		Range	Mean \pm SD
Control	51	27.18 – 308.09	127.84 ± 67.14
Patient on Medication	24	23.68 – 276.92	$122.55 \pm 68.85^*$
Patient Without Medication	17	20.51 – 284.21	$119.30 \pm 54.26^*$

Data were presented as Mean \pm SD. * $P \leq 0.05$

Table 2. The ALT Activity (U/Ldl) in the Serum of Control Subjects and that of Epileptic Patients with Medications and Epileptic Patients without Medications

	No of Samples	ALT (U/L)	
		Range	Mean \pm SD
Control	46	8.38 – 125.71	29.79 ± 18.33
Patient on Medication	26	1.75 – 220.00	$54.43 \pm 58.36^*$
Patient Without Medication	20	8.91 – 57.62	27.60 ± 10.78

Data were presented as Mean

The activities of ALT were found to have increased in the serum of the epileptic patients on medications as compared to Control values and the values were also higher than that in the patients without medication group as shown in Table 2. The AST assays also showed the similar tendencies but with high variabilities. It meant that both ALT and AST had some adverse effects on the liver and heart of epileptic patients.

Conclusions

This is the first time that a systematic detailed research work has been done on the activities of Catecholamine Neurotransmitter Mediating Enzyme, DBH in the epileptic patients of Bangladesh. This is also for the first time that the DBH activities were assayed using the serum of both medicated and Non-Medicated Epileptic Patients of Bangladesh. The age ranges of Bangladeshi epileptic patients were the children group, the adolescence and adult group and old age group. In addition to serum DBH, other biochemical parameters, including Ascorbic Acid, Proteins, Glucose, Copper, Zinc, AST, ALT, were assayed using the epileptic blood serum and that of control human serum. The Enzyme Kinetics, K_m and V_{max} values of DBH Enzyme were determined using epileptic blood serum of epileptic patients and that of corresponding normal human control subjects. We could collect 55 Epileptic Blood Samples of various ages and males and females and 57 of that of Control Subjects. The Control Subjects had no history of any types of epilepsy. When we grouped them (in years) as 1 – 20, 21 - 40 and 41 – Above. The number of samples in each group were reduced as we observed that some epileptic patients were already under treatments of doctors of Neurology. The others were the new Epilepsy Patients identified by the doctors. The number of patients and Control Subjects were approximately 55 and 57, with 29 and 39 males; and 26 and 18 females, respectively. The DBH activities were decreased significantly ($*p \geq 0.05$) in all age groups of epileptic patients without medications as compared to that of control subjects, respectively. The serum protein levels were found to be decreased in all of the 3 age groups of epileptic patients without medications as compared to that in the respective control age match subjects. The protein levels in the serum of the middle age group (Group 2) were found to be lower in both the control subjects and of that of epileptic patients. But the protein levels in the serum of epileptic patients were found to be significantly decreased as compared to control subjects. The protein levels in the serum of epileptic patients without medications were drastically decreased in the Groups 1 and 3 as compared to that in the respective control subjects. The K_m and V_{max} values of serum DBH of epileptic and control values were in agreement with the enzyme kinetic rules. The Ascorbic acid contents were variables as ascorbic acid is an unstable compound. The glucose contents in serum of epileptic patients showed increasing tendency in the early stage of life. Copper Concentrations had decreasing tendency in all the categories and stages of life. AST and ALT- both enzymes activities were greatly affected in epilepsy. The overall findings of this research were exciting as the results showed that medications under the neurologists advice might improve the physiological conditions of the epileptic patients, but to cure fully would not be possible. Let us hope the best for them with the better treatment with better medicines diets.

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Effects of Individualism-Collectivism and Intelligence on Achievement Motivation

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Location: Department of Psychology, Jagannath University, Dhaka

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 400000.00

Introduction

The study has practical and theoretical relevance in the area of organizational psychology to recruit the human resources in banking, insurance, public service commission, army selection service and other private agencies as well as government sector where individuals are driven cultural attitude, intelligence and by their achievement motivation. The present study is to explore the effect individualism-collectivism orientation and intelligence on achievement motivation. Individualistically oriented group members may display greater accentuation of personal self-esteem and may not share the collective self-esteem of the groups and will show low achievement motivation. On the other hand, the collectively oriented participants would show high on achievement motivation. It is also expected that person high in intelligence score will tend to show high on achievement motivation and person low in intelligence score will tend to show lower in achievement motivation. It was thus, expected that motivation task as a continuum from individualism where persons are considered as distinct units clearly separable from their social context, to collectivism, where people think of themselves not so much as separate entities but rather as members of the groups to which they currently belong. The relevant research question is to specify whether the conditions under which the individualism-collectivism, intelligence and achievement motivation are related or affect each other.

Objectives

The objective of the study was designed to investigate the effects of individualism-collectivism, and intelligence on achievement motivation of the public and private bank employees of Dhaka city, as part of the innovation of and policy for personnel selection for human resource development.

Methodologies

The methodological details of the present study include the criteria of the sample, and its selection procedure, design of the study, experimental materials, and the framework of data analysis which are discussed herein:-

Design

A total of 100 bank employee in which 50 from public sector bank and 50 from private sector bank from Dhaka city was used as sample. A purposive sample selection technique was used for selecting only public and private sector bank employee as participants of the study. A stratified sampling technique was used to collect the data of the study. Data was collected from 10 private banks employee our (4) public banks employee.

Instruments Used

Individualism-Collectivism Scale (ICS)

To explore the objectives of the study the original version of Individualism-Collectivism measure developed by Saha & Ghosh (1999) was used in the present study. A total of 20 items were used in the Individualism-Collectivism Measure (ICM), where 10 items measured individualistic, and 10 items measured collectivistic values. Individualistic and collectivistic items were randomly arranged in order to avoid response set.

Achievement Motivation Scale (AMS)

A revised version of the Achievement Motivation scale originally constructed achievement motivation scale by Afsaruddin (1995) would be used to collect the data for the present study. The present study will use 20 items which covered Values of Personal Achievement, Molecular Family, Independence, Conformity, Self-reliance, Law Abiding, Autonomy, Personal Freedom, and Right to Privacy.

Adult Intelligence Test (AIT)

To explore the objectives of the study the Adult Intelligent Test (AIT) developed by researcher and was used in the present study. The Adult Intelligent Test was construct in which the researchers have used 25 items which covered intelligent component in relation to Problem Solving, Verbal Reasoning, Spelling and language, Mechanical Reasoning, Space Relations, and Relationship Problem. All the items were chosen those were found relevant and continent by the researcher to handle. Responses of the participants' preferences for each item were taken on a right answer or a wrong answer.

Procedure

For collecting proper information from participants, at first, permission was taken from concerned authority for data collection and rapport was established with participants. Participants were informed about the purpose and necessity of the present research in the Dhaka city. At first they simply briefed about the questionnaire and how to fill this question. Then, every participant provided one's with Personal Information Form (PIF). Participants were requested to hear questions, at first, verbally. Before answering these questions, they were requested to fill up their Personal Information Form (PIF). Participant's demographic variable such as income, education qualification was collected through PIF form. And they were assured that their information only will be used in research purpose and will keep confidential until their permission. Participants were also requested for keeping silent in the classroom and not to talk with others during fill-up of questions. After collecting information, then, the respondents were thanked for their cooperation and summated all scores.

Results

To find out the extreme groups in terms of Individualism-Collectivism score (I/C score) 100 data were arranged in order to rank to highest to lowest as ascending order.

Table 1. Mean differences of achievement motivation category between high Intelligence score (Q1) and low Intelligence score (Q4);

Achievement Motivation	Rank	N	Mean	Std. Deviation (SD)	t- Value
	Q1	25	81.44	1.91	12.63
	Q4	25	75.08	1.63	

Results shows that mean difference between high Intelligence score (Q1) (Mean = 81.44, SD = 1.91) between low Intelligence score (Q4) (Mean = 75.08, SD = 1.63) on achievement motivation is statistically significant (t-value = 12.63, $p < 0.05$). Thus, the mean differences between these two groups are found significant. To find out the differences of I/C score between Public bank employee (n = 100) and Private bank employee (n = 100), 't'-test was computed, and the results has been plotted in the table given below:-

Table 2. Mean differences of I/C scores between public and private bank employees;

I/C Score	Types of Job	N	Mean	Std. Deviation (SD)	't' Value
	Public	50	65.56	2.77	5.141
	Private	50	62.92	2.35	

Results shows that mean difference of individualism and collectivism between public Bank Mean = 65.56, SD = 2.77; and Private Bank Mean = 62.92, SD = 2.35, t-value = 5.141, $p < .05$. The mean differences between these two groups are significant.

Conclusion

The hypothesis was that there would be difference of achievement motivation score between high Intelligence group and low Intelligence group. The mean differences between these two groups are found significant. Thus, the hypothesis is being accepted by the findings obtained. The other hypothesis was that there will be also differences of individualism-collectivism score in relation to public and private bank employees. The mean differences between these two groups are found significant. The results suggested that the there is significant difference between individualism-collectivism score of the public and private bank employees. Thus, the hypothesis is accepted by the results obtained.

Some people have an intense desire to accomplish and show excellence others are not concerned about achieving things. David McClelland studied this phenomenon for over twenty years at Harvard University and proposed the Achievements Motivation Theory. According to McClelland achievement motivation theory power, affiliation and achievement are three important needs to help to understand human motivation in organizational settings. Thus, the results of the present study has been supported the finding of the earlier studies i.e. Triandis (1994), Crocker & Luhtanen, 1990; Markus & Kitayama, 1991; Triandis, 1989, McClelland, Atkinson, Clark and Lowell (1953).

Thus, it has been concluded that high in individualistic persons are likely to be achievement oriented. The results show that the high individualistic persons have high achievement motivation and the respondents with low in individualistic scores are shows low in achievement motivation tendencies and the achievement motivation is affected by human intelligence. The results show that high intelligent score have shown higher in achievement motivation and low intelligence score have low achievement motivation. The results also suggested that the there is significant difference between individualism-collectivism and achievement motivation score of the public and private bank employees. Thus, the results show that the persons with high individualistic attitudes tend to show high in achievement and on the other hand, person low in individualistic tend to show low in achievement motivation score.

Publications from this Research

- Saha, A.K., and Arman, A. 2016. Differences of Individualism-Collectivism and Intelligence on Achievement Motivation. In Jitendra Mohohon (Eds.) *Idea of Excellence: Multiple Perspective*, Bureau of Publications, Punjab University. (Chandigarh. (India).
- Saha, A.K., and Arman, A. 2016. Individualism-Collectivism, Intelligence and Achievement Motivation. Paper Presented at the International Conference on Business Management, Economics & Social Sciences (ICBMESS 2016) jointly organized by AMDISA (Hyderabad), GBME (USA) & Uttara University, Bangladesh. The Westin, December 21- 23, 2016.

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Contesting Identities, Ethnicity and Nation Building: Toward an Inclusive Approach for Managing Diversities and Differences in the Context of Chittagong Hill Tracts, Bangladesh

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Location: Department of Anthropology, University of Dhaka

Duration: Two years (2015-2017)

Expenditure of the project: Tk.1800000.00

Introduction

Bangladesh is a land of diversity. The country is blessed with diverse ethnic communities. Apart from Bengali communities, ethnic people of Bangladesh have a significant contribution to various struggles against feudalism, colonialism and the liberation movement in the 1970s. However, in the process of nation-building activities, ethnic people in Bangladesh are one of the most deprived, neglected and discriminated groups in all spheres of social, cultural, religious, economic, and political rights. They have hardly been recognized in national history and development process. The mistrust and sense of deprivation resulted in decade long armed conflict in Chittagong Hill Tracts (CHT) which is home to major ethnic groups of Bangladesh.

However, after decades of crisis, Bangladesh government and ethnic community leaders agreed to political solution which is popularly known as ‘The CHT Peace Accord’ in 1997. Since then, various efforts have been undertaken to accelerate the implementation of ‘Peace Accord’ for building peace in the CHT region. In line with the broad issue of ‘peace building in the CHT region’, the study has four different thematic areas for detail investigation. They include:

- Mapping Diversity, Inequality, and Estimating the Cost of Social Distance in the CHTs.
- Understanding Social Justice, Trust Building and the Formation of Social Capital in CHTs.
- Developing Consociational Regional Model for Inclusivity and Peace-building by Assessing Policies, Institutional Arrangements and Governance.
- Modelling and Managing Diversity as an Impetus for Nation Building.

Objectives

A. General Objective of the Study

To develop models for nurturing cultural diversity and achieving a more inclusive national integration, unified nationhood and sustainable development in the Chittagong Hills Tracts of Bangladesh.

B. Specific Objectives of the Study

- To understand and analyse the salient features underpinning cultural diversities in the CHTs to pave the way towards flourishing cultural pluralism, multi-ethnic solidarity and development; and
- To know about the contesting features that are hindering to establish harmony among the Bengali people and ethnic groups, presently separated by the confronting interests of ethnic, cultural and religious affiliations; and
- To develop a comprehensive anthropological account with an intention to lay the foundation for lasting peace in the CHTs addressing the issues and concerns of different stakeholders.

Methodologies

For the purpose of this anthropological study, both quantitative and qualitative techniques of data collection methods have been used. Most of the data were collected by using participatory, interactive and ethnographic methods and tools. Primary sources comprised the observation of participants and in-depth interviews with a range of respondents. Informal and formal interviews with ethnic and Bengali people, community leader, journalists, human rights activists and local administration and different stakeholders were the major sources of information. Secondary data were collected from books, articles, journal, newspaper, GO-NGO and media reports, statements, and fact findings reports of different actors (development and human rights groups/individuals and others).

Data were collected from various urban, rural and peri-urban locations of all the three districts of CHT. Respondents were selected through a combined process of snowball, purposive and random sampling methods considering the diversity of identity, occupations and age, and organization. The respondents were also selected from various social, occupational, and civil society organizations. As part of the study, a number of Key Informant Interviews (KII) were conducted with leaders, thinkers, academicians and experts from both ethnic and Bengali communities. The study report has been prepared on the basis of triangulation and analysis of data and information. Thus, the major techniques of data collection used in this study include: i) Use of Key informants, ii) Focus Group Discussion, iii) Narrative Analysis, iv) In-depth Interview (conversational study), v) Keen Observation, vi) Case Studies, and vii) Semi-structured interview.

Results

The implementation status, challenges and recommendations regarding CHT peace accord have been well documented in the study. The major findings of the study are given below:

- The common people of CHT are peace-loving and very much eager to co-operate with one another. For the cohesion and trust-building among people for a durable peaceful society they recommend the fulfilment of their basic needs and security.

- It is understood that proper Implementation of CHT Peace Accord is must for bringing peace in CHT and the people of both indigenous and Bengali community. There are different perceptions regarding peace accord which is a big hindrance towards the implementation of the CHT peace accord. Leaders of both indigenous and Bengali communities have urged mainstream political parties to come forward to minimize the misperceptions within the communities and take initiative to accelerate the CHT accord implementation process. Socially inclusive development initiative is recommended by the local people for mainstreaming CHT people in general and Indigenous people particular in nation development process
- Taking consideration of the dynamics of inter and intra-ethnic communities (small vs. large ethnic communities), inter and intra Bengali communities (*adi* Bangali vs. settler Bangali), inter and intra-communities (Ethnic vs. Bengali communities) and inter and intra-government bodies (military vs. civil administration), the study strongly recommend for developing an inclusive (with rationale participation of all the communities and stakeholders in various decision making process) platform to ensure the peace and sustainability of any development initiative in the CHTs. The study suggests that peace can only be built in the region by resolving ‘conflicts ‘and reducing ‘distrust’ that exist within the communities and among the communities.
- Land problem is the core problem in CHT. Both indigenous and Bengali communities have underscored that if this issue is addressed, other problems will be resolved repeatedly. This issue is held responsible for holding back the aims and objectives of peace building process. Government should enhance the capacity of CHT Land Commission by providing adequate fund, manpower and logistic support to ensure smooth functioning of the Commission.
- It has been found that transferring administrative and decision-making power to the regional councils is yet to be materialized. Govt initiatives are requested and recommended to make regional councils more functional which will eventually bring trust among the local communities about taking decision on their development issues independently.
- The indigenous people have been found worried about rehabilitation of IDPs and repatriated refugee. At the same time, they show their dissatisfaction about deforestation in CHT for commercial cultivation like rubber plantation. They urge for govt. initiative for immediate actions to cancel leasing out land to rubber plantation and other commercial cultivation.
- Creating a value of mutual respects, sharing and understanding among different groups and prioritizing the needs of local ethnic communities, building consensus among different local stakeholders for taking any decision for development intervention, accepting the idea of territoriality and practicing democracy are strongly recommended for managing diversities and differences in the CHT region.



Inclusive Development Model Towards Peace in the CHTs

Conclusion

A chronic cycle of conflict over the last few decades have shaped and reshaped the politics, identity and cultural fabrics/mosaics of the CHT region. Thus, one of the purposes of this study was to seek broader sense of people's mindsets in CHT from grassroot 's voice perspective. The study clearly reveals that a majority of the grassroot people are not aware of the details of peace accord but the fact cannot be neglected that their basic demands, like land issue and security are associated with the clause of the peace accord and its process.

The politics of CHT is complicated, rooted in the post-colonial period. Peace is not possible overnight. It requires proper strategies and frameworks and certainly practical implication. Implementing the CHT Peace Accord is necessary but at the same time, it is important to think about the peace beyond the CHT Peace accord. Beside this, a number of other steps have to be taken immediately to build trusts among various ethnic groups who have been living in the region.

First of all, security has to be established in the region. This security means the security of life and living without fear as a majority of the CHTs people are always living with fear: fear of losing life and losing land. The second important issue is the building of trust and mutual respects among the communities living in the CHTs. Both Pahari and Bengali still treat each other as opponents. All the major communal conflicts are the result of mistrust. Steps need to be taken to bring all communities under same umbrella for building trust. Thirdly, as there is always an accusation that new elite groups are given priority and privileged and powerless groups are neglected. People's Participatory Planning is crucial to involve grassroots people for ensuring equality and justice. Fourthly, consensus needs to be taken locally for all development projects. If there is any doubt related to any development issue, it should be made clearer to different groups. The Government and its various agencies working in the CHTs have to keep one thing in their mind that local ethnic communities are still very susceptible that their land may have been taken by the Bengali communities. For ensuring the peaceful coexistence of all the communities by maintaining the diversity, an inclusive economic and social development model has to be developed. Implementation of any major development plan in the CHT region, a bottom-up approach has to be taken.

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Studying the Impact of Government Policies, Comparative Advantages, Value Chain Activities and Nutrition Security of Livestock Product Production in Bangladesh

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Location: Department of Agricultural Economics, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 2259000.00

Introduction

Livestock farming on commercial and scientific line is a recent endeavour and it was started practically during eighties in Bangladesh. It is emerging as a popular commercial venture and rapidly shaping up into an industry. Gainful impacts in terms of employment generation and poverty alleviation are observed in this sector. There is a growing need for information about detail economic parameters from production to marketing to enhance the competitiveness of this sector locally and internationally. While farmers need to know more about the economic indicators such as cost and profitability, research on this aspect is very limited and controversial (Saadullah, 2001, Alam 1994; Rao and Odermatt 2006; Khan 2007). Moreover, there is a lack of knowledge on detailed economic parameters of livestock production systems especially at farm level and policy making level. So, these reasons create the necessity of conducting research on detailed economic indicators considering not only profitability but also demand and supply, risk and uncertainty, marketing system and efficiency, comparative advantage as well as impact of existing different government policies on production and profitability of livestock products. That is why, this study will focus on in-depth economic analysis for policy making on livestock sub-sector in Bangladesh.

Objectives

The broad objective of the present study is to design and suggest policy options for the livestock industry through analyzing the impact of existing government policy supports towards the industry and its backward and forward linkage also. The specific objectives of the study are:

- To analyze the existing backward linkages of the livestock industry and efficiency of these linkages to increase livestock production and profitability;
- To analyze the impact of government policies on livestock production and its comparative advantage for both export promotion and import substitution;
- To describe and analyze the marketing system, marketing efficiency and value chain activities of the livestock products; and
- To develop and suggest some policy guidelines for the competitiveness as well as to address the risk and uncertainty factors of the livestock industry.

Methodologies

Selection of the Study Area

This study was based on field survey of farmers who practiced broiler farming. Some areas of Dhaka, Gazipur, Mymensingh, Kishorganj, Chittagong, Comilla, Rangpur, Barisal, Sylhet were purposively selected. Data were collected during the month of July, 2016 through face to face interview with the respondents.

Period of the study

Data for the study were collected from 27th June to 20th July 2016

Methods of Collecting Data

The data for the present study were collected from primary sources. Primary data were collected by the Research Associate through personal interview with the respondents.

Model specification for quantitative analysis

A profit function approach was used to examine impacts of prices and fixed factors on farmers' resource allocation decisions. This is because profit function has a duality relationship with the underlying production function. An advantage of a profit function model is that it is specified as a function of prices and fixed factors, which are exogenous in nature and, therefore, are free from possible endogeneity problem associated with a production function model. The basic assumption is that farm management decisions can be described as static profit maximization problem. Specifically, the farm household is assumed to maximize profits from growing specific farm, defined as the gross value of output less variable costs, subject to a given technology and given fixed factor endowments. We used a flexible functional form, the translog function that approximates most of the underlying true technology.

The general form of the translog profit function, dropping the *i*th subscript for the farm, is defined as:

$$\ln(\pi) = \alpha_0 + \sigma_{i-1} \alpha_i \ln(p_i) + \frac{1}{2} \sigma_{i-1}^3 \sigma_{j-1} \gamma_{ij} \ln(p_i) \ln(p_j) + \sigma_{i-1}^3 \sigma_{k-1} \delta_{ik} \ln(p_i) \ln(z_k) + \sigma_{k-1} \beta_k \ln(z_k) + \frac{1}{2} \sigma_{k-1}^5 \sigma_{h=1} \theta_{kh} \ln(z_k) \ln(z_h) + \varepsilon \dots \dots \dots (1.1)$$

Where,

π = profit (tk/year) (total revenue less total cost of variable inputs)

p_i = price of *i*-th input

$i = j = 1$, cost of feed (tk/year)

$= 2$, cost of day old chicks (tk/year)

$= 3$, cost of labor (tk/year)

z_k = quantity of fixed factor, *k*

$k = h = 1$, age

$= 2$, experience

$= 3$, education

$= 4$, No. of broiler

$= 5$, Household size

$\alpha_0, \alpha_i, \gamma, \beta, \delta, \theta$ are parameters to be estimated.

ε = random error

Where, $\gamma_j = \gamma_i, \delta_k = \delta_i$ and $\theta = \theta$ for j, i and k and the function is homogeneous of degree one in prices of all variable inputs and outputs.

Results

Findings revealed that the production of all layer chicken practices were profitable. Average total cost for per 100 layer per year for all farms was estimated Tk. 121353 and it was estimated Tk. 124562, Tk. 118855 and Tk. 113722 for small, large and medium farm respectively. Average net return for per 100 layer per year for all farms was estimated Tk. 30847 and it was estimated Tk. 27014, Tk. 31487 and Tk. 44382 for small, large and medium farm respectively. Average benefit cost ratio (BCR) for all farms was 1.25 and it was highest in large farm that was 1.39. In small and medium farm it was 1.22 and 1.26 respectively. The farmers earned maximum profit from large farms and large farms were more profitable comparing with small and medium farms. Linear regression model reveals that the key variables included in the model were individually or jointly responsible for variation in profitability of layer chicken farming. In this regression analysis, among nine explanatory variables feed cost, labor cost and electricity cost had positive impact on layer chicken farming. The main influencing factor was feed cost of all types of layer chicken practices. Most of the farmers in the study area faced the problems like high price of day old chick, diseases and excess price of feed. It was more convincing to conclude that linkages should be in a manner that farmers would be able to purchase inputs smoothly in a reasonable price and sell outputs in proper price which would make the business worthy to farmers.

Broiler production provided returns to the farmers. Benefit-Cost was optimal. Sample farmers showed their opinion if yield and income would increase, it would be able to encourage them to continue broiler production.

Benefit-cost ratio was calculated by dividing gross return by total cost. It implies return per taka invested. It helps to analyze the financial efficiency of the farm. The benefit-cost ratio of broiler farming was 1.18 on total cost basis implying Tk.1.18 would be earned by investing every Tk. 1.00 for broiler production. Further benefit-cost ratio of broiler farming was 1.26 on total variable cost basis implying Tk.1.26 would be earned by investing every Tk. 1.00 for broiler production.

Day old chicks and labour demand is positive with the increase in broiler price. The responsiveness of DOC and labour demand increases. This is expected because these are the important variable input in broiler production. However, results also show that with the increase in broiler price will decrease feed demand, because an increase in the output price is likely to be carried on to a corresponding increase in feed price. But this should not be a major cause of concern because farmers use relatively fixed amount of feed in the production process.

Translog profit model revealed that the key variables included in the model were individually or jointly responsible for variation in net return of broiler production. In this regression analysis three explanatory variables and five fixed factors were used and most of the included variables in this model had positive impact on broiler production.

Conclusion

In the regression analysis, among nine explanatory variables feed cost, labor cost and electricity cost had positive impact on layer chicken farming. The main influencing factor was feed cost of all types of layer chicken practices. Most of the farmers in the study area faced the problems like high price of day old chick, diseases and excess price of feed. It was more convincing to conclude that linkages should be in a manner that farmers would be able to purchase inputs smoothly in a reasonable price and sell outputs in proper price which would make the business worthy to farmers.

The overall performance of Translog profit model reveals that the key variables included in the model were individually or jointly responsible for variation in net return of broiler production. In this regression analysis three explanatory variables and five fixed factors were used and most of the included variables in this model had positive impact on broiler production. The main influencing factors were DOC price, education level and number of broiler in broiler farming. The predominance of medium to low knowledge level indicates respondents' insufficient awareness of scientific broiler farming. Inadequate knowledge of broiler farming practices pertaining to housing, heat detection balanced feeding and vaccination was reported as one of the problems perceived by farm owner regarding minor farm operations in broiler farming. Hence it is imperative to impart training to the respondents in scientific broiler management.

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Effects of *Syzygium cumini* (jam) Seed Extract on the Memory Loss of Alzheimer's Disease Model Rats

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Location: Department of Biochemistry and Molecular Biology, Jahangirnagar University

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 1600000.00

Introduction

Alzheimer's disease (AD) is the most prominent dementia-related disease and characterized by the presence of insoluble amyloid beta peptide ($A\beta$) fibers in or around the brain neurons of the affected person. Therefore, agent(s) capable of inhibiting brain amyloid deposition might delay the occurrence or retard the progress forwards of AD and related neurobehavioral symptoms (Serpel 2000, Hashimoto *et al.* 2016)

Here, we report whether, chronic oral administration of *Syzygium cumini* (locally known as Jam)-seed extract exerts protection against the progressive cognitive decline in the $A\beta_{1-40}$ -infused AD model rats. After 12 weeks of feeding with *S. cumini* seed extract (at 300 mg/kg BW), we evaluated the learning-related memory of the rats by 8-arm radial maze task, where we determined two types of memory errors, namely reference memory errors (RMEs) and working memory errors (WMEs). After completion of memory tests, rats were sacrificed and the levels of lipid peroxide (LPO), the $A\beta_{1-40}$ -burden, $A\beta_{1-40}$ -oligomers, proinflammatory $TNF\alpha$, brain derived neurotrophic factor (BDNF), Tyrosine-kinase B (TrkB), postsynaptic-density protein 95 (PSD-95) and Synapse-associated protein (SNAP-25) were determined in the corticohippocampal tissues of the brain. In addition, *in vitro* antioxidative effects of *S. cumini* seed extract were evaluated.

Objectives

The primary purpose of this project was to determine whether chronic administration of Jam-seed extract protects the progression of cognitive decline in the $A\beta_{1-40}$ -infused Alzheimer's disease (AD) model rats, if so, then what are the underlying mechanisms.

Methodologies

Syzygium cumini (Jam) was purchased from local market. Their seeds were separated, sun-dried and powdered by grinding. The grinded seed powder was extracted by using methanol. Twenty male Wistar rats (50-weeks-old) were randomly divided into 2 groups: $A\beta_{1-40}$ -infused Alzheimer's disease (AD) model rats [control group (n = 10)] and *S. cumini* -pre-administered AD model rats [Test group (n = 10)].

After 8 weeks of oral pre-administration, the rats from both groups were subjected to surgical procedures to generate AD model rats (Hashimoto *et al.* 2002). After complete recovery from surgical stress they were subjected to eight-arm radial maze task (for memory test) and extract feeding was continued until the end of behavioral experiments (Gamoh *et al.* 1999). After the behavioral studies for memory evaluation were completed, the rats were sacrificed to collect blood, the hippocampus and cerebral cortex. Tissues were homogenized in ice-cold 0.32 M sucrose buffer (pH 7.4) containing 2 mM EDTA, and 0.2 mM phenylmethylsulfonyl fluoride and stored at -80°C until analyses were performed. Oxidative Stress in the tissues was evaluated by Lipid Peroxidation (LPO) assay (Hashimoto *et al.* 2002). And the brain-derived proteins were estimated by Enzyme Linked Immunosorbent Assay (ELISA). In vitro antioxidative studies of *S. cumini*-seed extract were performed by the methods described previously (Hossain *et al.* 2009, Hashimoto *et al.* 2005).

Results

No significant differences were observed in body weight or food intake, measured after 12 wks, between Control ($\text{A}\beta_{1-40}$ + Vehicle-administered) and *S. cumini*-seed extract-administered AD model rats ($P < 0.05$). Figure 1(A) shows the effect of chronic administration of *S. cumini* seed extract on reference memory-related learning ability in AD rats. The score is expressed as mean number of reference memory errors (RMEs) with data averaged over blocks of six trials. The effect of oral administration of *S. cumini* on working memory related learning abilities of the AD rats is shown in Figure 1(B). The score is expressed as mean number of working memory errors (WMEs) with data averaged over blocks of six days. The analysis revealed a significant main effect of blocks of trials and groups on the number of RME and WME.

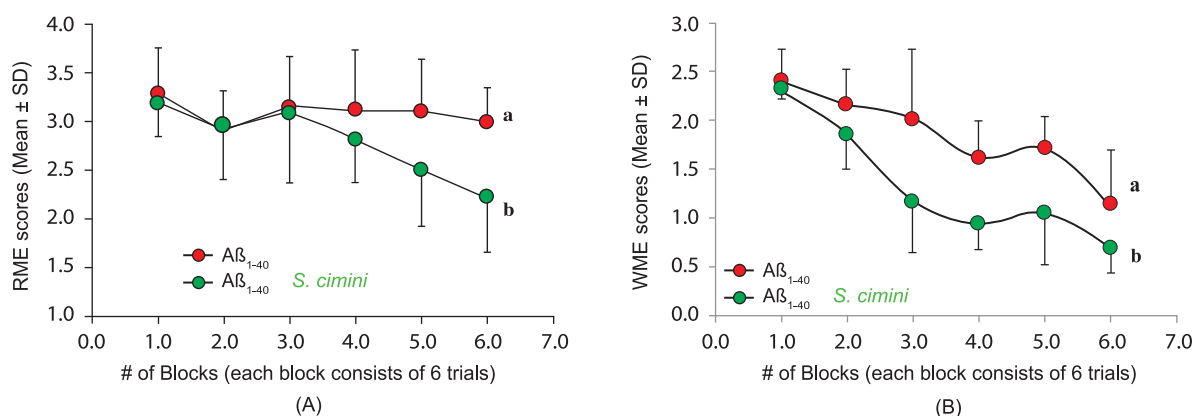


Fig. 1. Effects of oral administration of *S. cumini* extract on reference memory error (RME) (A) and working memory error (B). Data are the mean \pm SD for each block of six trials showing the number of reference memory error until the rat acquired all the rewards. Data were analyzed by randomized block two-way (block and group) ANOVA.

The levels of LPO significantly decreased by ~28% in the plasma of the *S. cumini*-fed ($A\beta_{1-40} + S. cumini$) rats, in the cerebral cortex (by~26.5%) and hippocampus (by~33%) of the *S. cumini* seed extract-administered AD model ($A\beta_{1-40} + S. cumini$) rats (Figure 2), as compared to those of the $A\beta_{1-40}$ -infused AD control rats.

The levels of $A\beta$ peptide1–40 significantly decreased in the detergent-insoluble fraction (DIF) of cortex (~18%) and hippocampus (>20%) homogenates of ($A\beta_{1-40} + S. cumini$) rats (Figure 3). The oral administration of *S. cumini* also decreased the levels of proinflammatory TNF α and invariably increased the levels of the brain cognition/synaptic plasticity-related proteins (Figure 4).

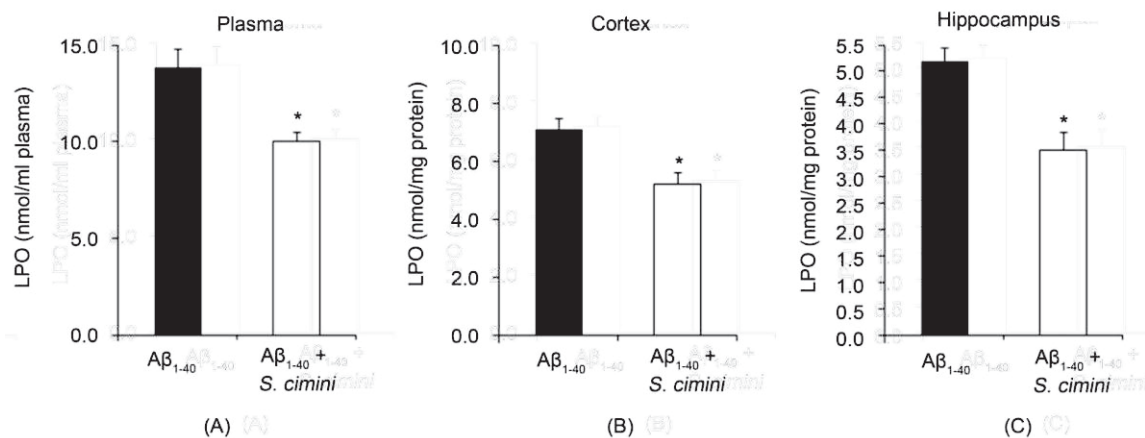


Fig. 2. Effects of oral administration of *S. cumini* seed extract (SC) on the plasma (A), cerebral cortex (B) and hippocampus (C) lipid peroxide (LPO) levels of the $A\beta_{1-40}$ -infused Alzheimer’s disease (AD) model rats. Results are mean \pm SEM for 7-9 rats each with duplicate determinations. Bars with different notations are significantly different at $P < 0.05$.

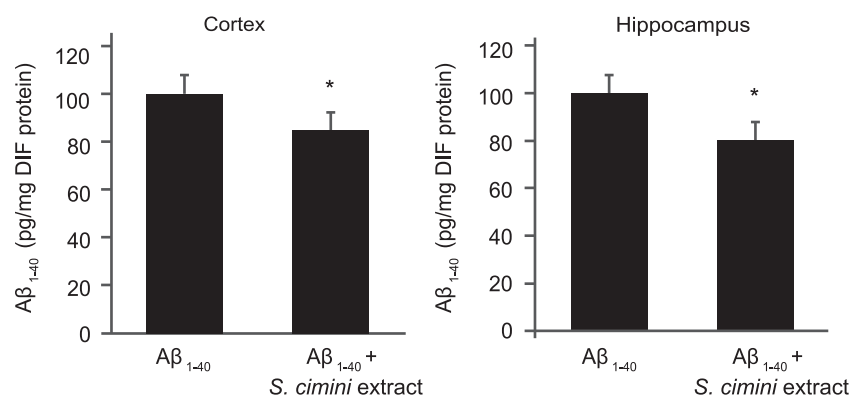


Fig. 3. Effects of oral administration of *S. cumini* seed extract on the levels of $A\beta_{1-40}$ in the detergent-insoluble membrane fractions (DIF) of cortex and hippocampus. DIF was prepared as described previously [38]. Each bar represents the mean \pm SEM ($n = 7 - 8$). The data were analyzed by unpaired student’s t -test. * $P < 0.005$.

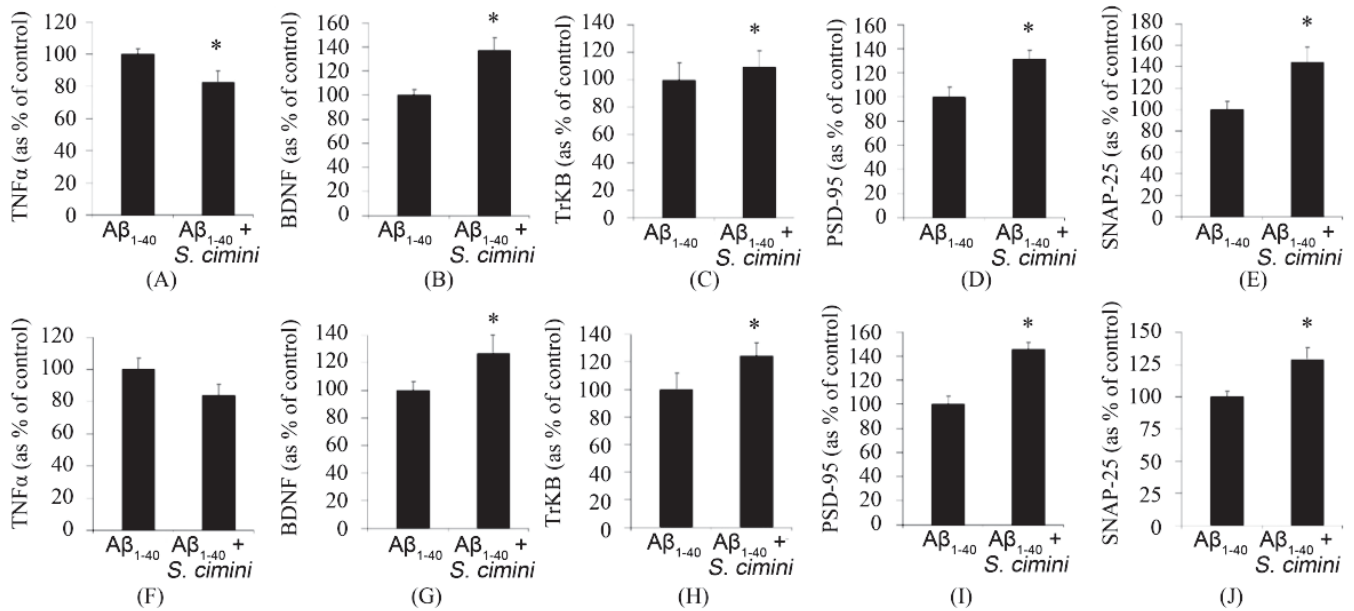


Fig. 4. Upper panel: Effects of oral administration of *S. cumini* seed extract on the levels of (A) TNF α , (B) BDNF, (C) TrKB, (D) PSD-95 and (E) SNAP-25 in the cortex of AD model rats. Lower panel: Effects of oral administration of *S. cumini* seed extract on the levels of (F) TNF α , (G) BDNF, (H) TrKB, (I) PSD-95 and (J) SNAP-25 in the hippocampus of AD model rats. Each bar represents the mean \pm SEM (n = 7 - 8). The data were analyzed by unpaired student's t-test. *P < 0.05.

Conclusion

The oral administration of *S. cumini* seed extract significantly ameliorated the learning-related memory impairments of A β ₁₋₄₀-infused AD model rats. The ameliorative effects were associated with suppressions of the levels of LPO both in the brains and plasma of A β ₁₋₄₀ + *S. cumini* rats. The effects could be attributed to antioxidative potentials of *S. cumini* seed extract. The levels of proinflammatory TNF α decreased and the levels of brain cognition/synaptic transmission-related proteins, including BDNF, TrKB, PSD-95 and SNAP-25 rose after oral administration of *S. cumini* to AD model rats. Finally, it is concluded that *S. cumini* could be used as prophylaxis in the neurodegenerative diseases, such as Alzheimer's disease. However, the exact mechanism of action(s) of *S. cumini* extract on the BDNF, TrKB, PSD-95 and SNAP-25 proteins remains to be investigated. Thus, further experimentation is a must.

Publication from this Research

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Antibiotic Free Organic Broiler Meat Production Using Different Medicinal Plants

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Location: Department of Poultry Science, Bangladesh Agricultural University, Mymensingh.

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 1600000.00

Introduction

Broiler production is one of the most important and promising industrial sector for the economic development in Bangladesh. Unfortunately, farmers are using antibiotics with broiler feed to improve growth and feed efficiency, which adversely affects on human health. For this reason European Union has banned the use of antibiotics in animal production from 2006. Now a day, consumers are aware about organic poultry meat which is free from antibiotic. Using on medicinal plants and herbs like green tea (*Camellia sinensis*), neem (*Azadirachta indica*) and garlic (*Allium sativum*) in broiler diets are new phenomenon in the world. The biological, physiological and pharmaceutical effects of these plants are due to bioactive compounds such as flavonoids, nimbin, and allicin which are safe for human. They have anticarcinogenic, antimicrobial, antioxidant, anti-ulcer, anti-fungal and immunomodulatory properties (Mukhtar and Ahmad, 1999; Agrawal, 2002; Chowdhury *et al.*, 2002; Subapriya and Nagini, 2005; Ashayerizadeh *et al.*, 2009; Hossain *et al.*, 2012a,b). They have shown many beneficial effects in animal such as improvement of general health, feed conversion ratio, growth rate, egg production as well as resistance to diseases (Subapriya and Nagini, 2005; Kumar *et al.*, 2010; Mansoub, 2011; Hossain *et al.*, 2012a). Limited researches have done with them in Bangladesh context. However, most of the farmers do not aware about their beneficial effects on poultry. So, this investigation will identify the potentiality of these medicinal plants for altering antibiotic from broiler diet to produce antibiotic free safe broiler for human consumption as well as to develop farmers' awareness.

Objectives

The objectives of the present research were as follows;

- To investigate the effects of green tea, neem and garlic as feed additives on growth performance, meat yield, blood biochemical parameters and profitability of broiler;
- To find out appropriate dose of green tea, neem and garlic for formulating antibiotic free broiler diet; and
- To develop awareness of poultry farmers by proper training through of organic poultry meat or human consumption.

Methodologies

Five (5) experiments were conducted at Bangladesh Agricultural University Poultry Farm, Mymensingh during the research period. The dietary groups for experiment-1 was control (basal diet; no additives), antibiotic (basal diet + antibiotic), NLP-0.25% (basal diet + 0.25% neem leaf powder), NLP-0.50% (basal diet + 0.50% neem leaf powder) and NLP-0.75% (basal diet + 0.75% neem leaf powder). The dietary groups for experiment-2 was control, antibiotic, NLE (basal diet + 2% neem leaf extract), NLE (basal diet + 4% neem leaf extract) and NLE (basal diet + 6% neem leaf extract). The dietary groups for experiment-3 was control, antibiotic, garlic powder (basal diet + 0.25% garlic powder), garlic powder (basal diet + 50% garlic powder) and garlic (basal diet + 0.75% garlic powder). The dietary groups for experiment-4 was control, antibiotic, garlic (basal diet + 0.25% garlic powder), garlic (basal diet + 0.50% garlic powder), green tea (basal diet + 0.25% green tea powder) and green tea (basal diet + 0.50% green tea powder). The dietary groups for experiment-5 was control, antibiotic, garlic (basal diet + 0.25% garlic powder), garlic (basal diet + 0.50% garlic powder), and garlic in water (basal diet + 1 clove/2lit water). All types of data were recorded regularly and the following parameters were measured and analyzed:

- a) Body weight gain, feed intake, feed conversion ratio
- b) Dressing parameter and meat yield
- c) Internal organs and bone development
- d) Serum cholesterol, HDL, triglyceride, glucose
- e) Profitability

All recorded data were analyze using SAS (2009) to estimate variance components with a completely randomized design. Duncan's multiple comparison tests were used to examine significant differences among the treatment means.

To develop knowledge and awareness, seminar and training programs were conducted. About 100 farmers were participated in these programs. Farmers are trained on safe broiler production, management and other different aspects about broiler rearing and marketing. They are committed to produce safe broiler in their farm.

Results

Results from experiment-1 indicated that body weight, body weight gain and total feed intake were not significant however, better feed conversion ratio (FCR) was observed in NLP 0.25% group as such as antibiotic group. Dressing parameters and meat yield were not different. Serum biochemical parameters were also not different among the treatments. For experiment-2 body weight, body weight gain and FCR were significantly higher in NLE 2% group as such as antibiotic group however, significant better feed consumption was observed in control and antibiotic group compare to the others. Dressing parameters like skin, liver, abdominal fat were significant among the treatments but meat yield was not different.

Serum biochemical parameters were not different among the treatments but TG was lower in higher NLE group. For experiment-3 body weight, body weight gain and total FCR were not significant different among the treatment groups. Total feed intake in different dietary levels showed significant difference. This experiment also reported that there was reduction in the serum glucose and cholesterol concentration in garlic supplemented group when compared to the control and antibiotic group. In case of dressing parameter, garlic group showed lowest abdominal fat compare to the other groups. With regards to profit, antibiotic groups showed higher profitability. Results in experiment-4 indicate that body weight and body weight gain were significantly higher and FCR was improved in garlic groups compare to the green tea group however, significant feed consumption was observed among the treatments. Dressing parameters and meat yield were not different. Serum glucose, cholesterol and triglyceride were significantly different among the treatments whereas, garlic and green tea groups show the lowest value. For experiment-5 body weight and body weight gain were significantly higher in control, antibiotic and garlic in water groups compare to garlic 0.25% and garlic 0.50% groups. Higher feed intake was found in control group compare with other groups. Significantly better FCR was observed in antibiotic group compare to the control, garlic 0.25% and garlic 0.50% groups. However, the difference was same between antibiotic and garlic in water group.

Conclusions

- Results of the project indicate that addition of neem, garlic and green tea to broiler diet had no negative effect on feed intake, body weight gain, meat yield, bone development, carcass parameters in most of the cases but had positive effect in some cases. Moreover, it has positive effect on serum biochemical parameters (cholesterol, triglyceride and glucose).
- Green tea, neem and garlic up to 0.50% could be added in broiler feed to extract their benefit. Addition with water rather than feed gives more benefit.
- It can be suggested that these medicinal plants and herb could be a potential feed additives in broiler diet for alternating antibiotics.
- Findings open the opportunity to add new feed additives in the broiler diets which might create an extra income and employment specially tea and neem gardeners, and garlic producers.

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Targeting Effectiveness and Productive Outcomes of the Social Safety Net Programs in Rural Bangladesh: An Evaluation

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Location: Department of Statistics, Shahjalal University of Science and Technology, Sylhet

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 2999500.00

Introduction

The social safety nets programmes in Bangladesh work not only to protect individuals from severely vulnerable conditions but also graduate them from poverty condition (Ahmed *et al.*, 2014; Khuda, 2011; World Bank, 2008). One of the vital economic roles of each of the government is to ensure equitable distribution of national income. To serve this purpose, the government of Bangladesh is spending a considerable portion of the GDP on social safety net programs as transfer payments and other conditional transfers (MOF-GoB, 2014-15). Since safety net programs are the basis of the country's social protection approach and are the mainstay of the poverty alleviation strategy, therefore, it is important to study the links between productive outcomes of social safety net programs and poverty reduction. To ensure the optimum utilization of the fiscal resources for social safety nets, the ground level information is essential for evaluating the productive outcomes and the program effectiveness.

Objectives

The general objective of the study is to explore the targeting effectiveness and productive outcomes of the social safety net programs already administered in rural Bangladesh to generate information and knowledge for sharpening different stakeholders' understanding regarding the selected programs. The specific objectives are:

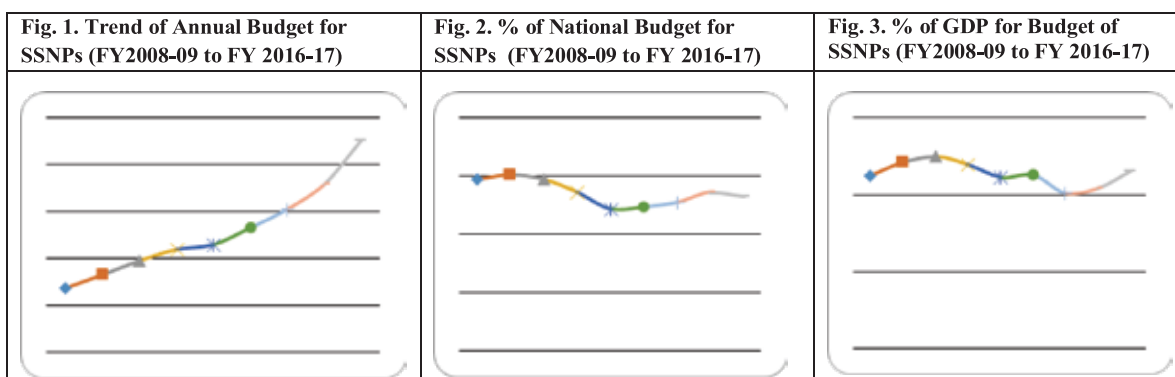
- To unveil the errors in the selection of beneficiaries of safety net programs and identify the factors of mistargeting;
- To explore the gap between the budget and disbursement of the different kinds of safety net programs at different tiers of local government;
- To measure the gap between the allocated budget and receipt in different kinds of safety net programs at household level;
- To document the potential productive impacts of public safety nets at the household and community levels;
- To identify the performance efficiency of the major safety net programs and explore the determinants for inefficiency; and
- To strengthen the different stakeholders' understanding about social safety net programs to redesign the programs and improve their effectiveness through providing information and knowledge based on solid evidence derived from the study.

Methodologies

The study has adopted both quantitative and qualitative techniques to gather the data and information on targeting effectiveness and productive outcomes of the selected social safety nets programmes executed in rural areas of Bangladesh. Considering the budget allocation and number of beneficiaries at national level as well as protection and promotion issues, the study covered the information of 14 SSNPs; of which four programmes viz., OAA, AWDW, AFID and HFF under *allowances to vulnerable groups*, six programmes, viz., VGF, VGD, TR, OMS, GR and AR under food security, two programmes, viz., EGPP and RERMP under *employment generation*, and two programmes viz., PESP and SESP under *Human Development*. The study adopted cluster sampling methodology and covered 130 clusters taking at least 30 rural clusters (primary sampling units of the BBS) from each of the four domains (old divisions). The *Village Mapping through Participatory Rural Appraisal (PRA)* has been applied to identify the beneficiary and eligible non-beneficiary households in each of the clusters. Based on the recognized sample size determination formula, the sample size for the study estimated at 3380 rural households. In addition, the qualitative data and information have been collected through conducting 30 FGDs.

Results

The review of the selected safety nets programmes in Bangladesh reveals that the selection criteria and benefit package for most of the programmes have changed over time. The study intends to explore budgetary allocation for SSNPs (Figures 1-3). It is clear from the Figures that though the annual budget for SSNPs has shown an exponentially increasing trend over time, however, the trend is found all most declining in case of percentage of national budget for SSNPs and it is found constant for percentage of GDP for budget of SSNPs.



Profile of the Surveyed Households along with SSNP Benefits

The analysis of housing conditions and possession of durable goods of the surveyed households suggest that the economic condition in the study households is inferior to that in the national rural households of Bangladesh. The comparison between SSNP beneficiary and non-beneficiary households suggests that beneficiary households had better profile in terms of economic condition than the non-beneficiary households. The findings indicate that there is no significant gap between the allocated budget and benefit receipt for different kinds of cash transfer SSNPs executed in the rural areas of Bangladesh. The main expenditure heads of the received benefits from SSNP were found food consumption, followed by health care expenditure.

Extent of targeting errors

Based on the existing criteria for the beneficiary selection for different social safety net programmes in Bangladesh, the study explores that inclusion error was highest for income threshold for both *old age allowance* and *allowance for the widowed, deserted and destitute women*. The inclusion error was found extremely high for VGD beneficiary selection due to female-headed household criteria, followed by monthly income criteria. The error due to female-headed household was found noteworthy for the beneficiary selection for *rural maintenance programme*. The inclusion error for safety nets programmes related to relief activities was found very notable for the criteria ‘household affected by natural disaster’.

The study also attempted to find the inclusion error using some general eligibility criteria *viz.*, *perception of interviewer*, *food expenditure*, *land ownership*, *PPI value* and *modified PPI value* in addition to the programme-specific criteria. Among the five general criteria, the inclusion error was found lowest by perception method and highest by PPI value criteria for almost all the selected programmes. Accumulating the currently beneficiary households for all the programmes, the inclusion error is found 7.6% by the perception of the interviewer, 29.6% by poverty line food expenditure, 24.4% by absolute landless criteria and 17.7% by modified PPI value criteria. Since PPI value criteria overestimate the inclusion error using the cut-off point 35, hence the study findings recommend to revise the cut-off point of PPI value or adopt the modified PPI value method after a thorough investigation using a large sample data.

The amount of exclusion error was found about 80% by food expenditure method, landlessness criteria and modified PPI value criteria for *old age allowance*, *allowances for the widowed women*, and *allowance for disabled*. The high percentage of exclusion error indicates that a very significant number of households still left behind to receive the benefits from social safety nets programmes of government of Bangladesh.

Causes for Exclusion from SSNPs and Identification of Factors of Mistargeting

Several causes were identified for not being included in the targeted SSNPs. Among them improper selection, non-cooperation from public delegate of local government, nepotism, and no political exposure were appeared as the most notable reasons. The factor analysis extracted six factors as the causes for not being included in the expected social safety nets programmes. These six factors are *poor capacity of implementing authority*; *corruption and political bias of the local authority*; *lack of ability*; *selection bias rather than poor cooperation of local authority*, and *resource scarcity and bureaucratic complication*.

Consequences of the Benefits Received from SSNPs

To study the impacts of the SSNPs, the study compared the status of some basic economic indicators of the households for the year 2013 and 2015 in the line ‘before-after comparison’. It is found that the food insecurity status and self-assessed adverse socioeconomic condition have decreased remarkably for beneficiary households in comparison to eligible non-beneficiary households.

Performance Efficiency of the Major Safety Net Programmes

The performance efficiency of different safety nets programmes has been evaluated through stochastic frontier analysis considering several outcome variables based on the objectives of the programme. Both the Cobb-Douglas and Trans-log (restricted and unrestricted) functional forms have been used to estimate the technical efficiency of the SSNPs. The stochastic frontier analysis has been performed by (i) selecting the appropriate frontier functional form and (ii) tests of the hypotheses regarding the necessity of technical inefficiency effect model. Following Table shows the results of the stochastic frontier model analysis.

Table 1. Performance efficiency of the selected safety nets programs with respect to the targeted outcome variable using production frontier Model

Selected SSNP Program	Outcome Variable	Functional form of the production frontier	Efficiency (%)	Comment on inefficiency effect model
Old age allowance	Food Expenditure	Unconstrained trans-log stochastic frontier model	71.96	Technical inefficiency effect model is essential
	Health Care Expenditure	Unconstrained trans-log stochastic frontier model	40.39	Technical inefficiency effect model is essential
Allowances for the widowed, destitute & deserted women	Food Expenditure	Unconstrained trans-log stochastic frontier model	81.18	Technical inefficiency effect model is essential
	Health Care	Unconstrained trans-log stochastic frontier model	39.82	Technical inefficiency effect model is essential
Allowances for Disabled	Food Expenditure	Cobb-Douglas production frontier Model	79.35	Technical inefficiency effect model is not essential
	Health Care	Cobb-Douglas production frontier Model	38.29	Technical inefficiency effect model is essential
Vulnerable Group Development (VGD)	Investment in HRD	Unconstrained trans-log stochastic frontier model	48.47	Technical inefficiency effect model is essential
	Investment in Business	Cobb-Douglas production frontier Model	69.01	Technical inefficiency effect model is not essential
	Savings	Cobb-Douglas production frontier Model	36.65	Technical inefficiency effect model is not essential
Employment Generation Programmes (EGPP /RERMP/ REOPA)	Total Income	Cobb-Douglas production frontier Model	64.49	Technical inefficiency effect model is essential
	Food Expenditure	Unconstrained trans-log stochastic frontier model	72.26	Technical inefficiency effect model is not essential
	Investment in Business	Cobb-Douglas production frontier Model	37.21	Technical inefficiency effect model is not essential
	Physical Investment	Unconstrained trans-log stochastic frontier model	22.16	Technical inefficiency effect model is essential
	Savings	Unconstrained trans-log stochastic frontier model	59.41	Technical inefficiency effect model is not essential
Primary Education Stipend Project (PESP)	Investment in HRD	Unconstrained trans-log stochastic frontier model	52.87	Technical inefficiency effect model is essential
Secondary Education Stipend Project (SESP)	Investment in HRD	Cobb-Douglas production frontier Model	57.64	Technical inefficiency effect model is essential

Conclusion

The study will help to harness the effectiveness of public resources allocations to safety nets as the findings on targeting error will assist the stakeholders to find out ways to guard against and minimize the leakages. On the other hand, this study would contribute to increasing the efficiency of SSNPs by addressing the inefficiency coefficients.

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Serosurvey of Q Fever (*Coxiella Burnetii* Infection) in Sylhet Dairy Cattle for the Development of Adoptive Targeted Surveillance and Sustainable Control System

Suman Paul and Syed Sayeem Uddin Ahmed

Location: Dept. of Epidemiology and Public Health, Sylhet Agricultural University, Sylhet

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 2430000.00

Introduction

Coxiella burnetii, the causative agent of Q fever in humans and animals is a zoonosis, and domestic ruminants such as cattle, sheep, and goats are considered the primary source of human infections (Angelakis and Raoult, 2010). *C. burnetii* can also produce health and production problems in domestic ruminants including cattle. Infection in cattle usually remains unrecognised (Rodolakis, 2009).

Q fever has a worldwide distribution and is endemic in many European countries (ECDC, 2010; Frankel *et al.*, 2011). Q fever in humans and animals has also been reported from neighbouring countries like India (Vaidya *et al.* 2010). Hence, it is expected that *C. burnetii* infection is also present in animals in Bangladesh. High level of *C. burnetii* antibodies was found in goat milk samples in a pilot study recently carried out in Mymensingh (Unpublished data, information obtained from personal communication).

Apparently *C. burnetii* infection is prevalent in cattle population in Bangladesh and the disease host, vector and risk factors favourable for this infection are available in this geographical area. However, we have little knowledge of those epidemiological parameters of *C. burnetii* infection in cattle in Bangladesh. Development of disease control system based on the knowledge gained from a serosurveillance- will greatly reduce the frequency of occurrence of *C. burnetii* infection in cattle in Bangladesh.

Objectives

- To estimate the frequencies in terms of herd level and individual cow level seroprevalence of *C. burnetii* in dairy cattle population of Sylhet division, Bangladesh. Diseases being diagnosed will be based on sero-surveillance;
- To identify major risk factors of *C. burnetii* antibody positivity in dairy cattle based on observational epidemiological studies. Moreover, undertake intervention study to assess how the seroprevalence be reduced in study areas. The magnitude of modifiable risk factors will be measured based on relative measures of association, and impact of association will be measured by population attributable fractions;

- Mapping frequency of *C. burnetii* antibody positivity and associated risk factors - to perform spatio-temporal analysis in order to identify high risk areas for surveillance and intervention studies and subsequent risk management. Moreover, disease suitability maps will be produced based on host, parasite and risk factors distribution; and
- To develop framework to support the design of risk based adoptive control programme that can be used in decision making for control of *C. burnetii* in dairy cattle of Bangladesh.

Methodologies

In initial phase, a cross sectional study was carried out to determine whether milk samples in approached to be pooled, tested for the presence of Q fever antibodies by ELISA without loss of accuracy, followed by individual testing of positive pools. Total 122 pooled (each pool contained milk of three individual cows) samples of skimmed milk were prepared. Both 122 pooled and 366 individual samples were tested for the presence of Q fever antibodies.

In the letter phase, another study was carried out with an aim to estimate the prevalence and to identify the determinants of Q fever in dairy cattle in Sylhet Division. To ascertain study objectives a cross sectional study was carried out from July 1 through December 31 2016. A total of 1763 individual animals from 925 farms were enrolled using multistage random sampling. A face to face interview was performed with the 925 farm owners by filling up pretested questionnaire contained individual animal and farm level information's. For the diagnosis of disease, Enzyme-linked Immunosorbent Assay (ELISA) was conducted on milk samples from all enrolled animals (n=1763).

Subsequently, spatial distribution of Q fever among the dairy cattle in Sylhet division was assessed using the geo-coordinates of cattle farms collected during sample collections. A pure spatial cluster analysis was performed following scan statistics and Bernoulli model.

Results

According to obtained results from the analysis, the sample prevalence of pooled and individual samples was 6.83% and 7.01%, respectively. Of this prevalence, the cost savings was about 50% or above and time needed for test was reduced by half due to following the pooling strategy (Table 1). With the increase of pool size, there was no significant difference but it was always cost effective (Figure 1).

Table 1. Comparison of Costs & Time of Pool over Individual

Parameter	Cost to detect one Positive US \$	Test Time Hours (approx.)
Pooled Sample	25.70	7.04
Individual Sample	51.38	13.3

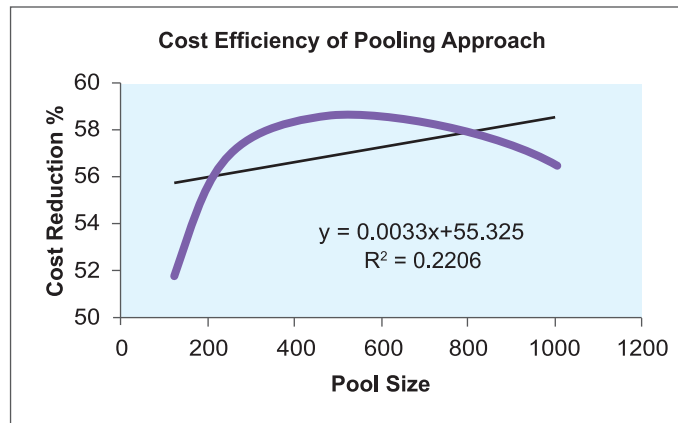


Fig. 1. Scenario of cost efficiency of sample pooling strategy

An individual animal level prevalence was estimated 5.67 % (CI; 4.69% - 6.85%). Farm level prevalence was 9.62% (CI; 7.88%-11.69%). Highest prevalence was observed in Sunamgonj district bot at individual (Figure 2) and farm level.

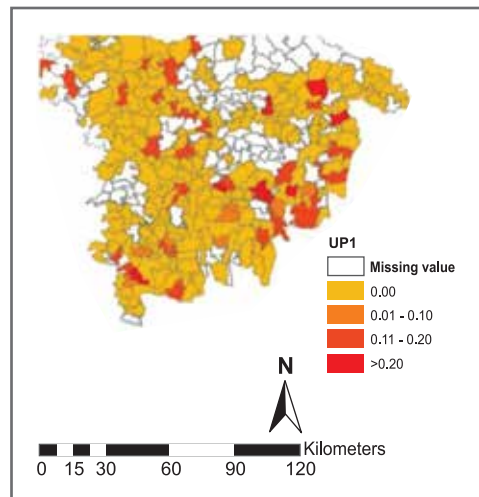


Fig. 2. Animal level prevalence of Q fever caused by *C. burnetii* estimated from 1763 randomly collected milk samples from 925 farms of Sylhet division.

Table 2. Final model of multivariable logistic regression analysis of plausible determinants of Q fever at farm level from a case control study with 178 milk samples (89 case and 89 controls) collected from 925 cattle farms of four districts of Sylhet

Variables	Odds Ratio (95%CI)	P-value
Herd size		
Large	2.09 (1.13-3.88)	0.02
Small	1	
Rearing other farm animals		
Yes	2.56 (1.38-4.78)	0.01
No	1	

From multivariable logistic regression, herd size (OR=2.09) and rearing other farm animals along with dairy cattle (OR=2.56) were determined as risk factors for farm level Coxiellosis (Table 2). In case of individual animal level analysis the risk factors were rearing other farm animals along with dairy cattle, removal of dung and previous history of udder injury. (Table 3)

Table 3. Final model of multivariable logistic regression analysis of plausible determinants of Q fever in individual cattle from a case control study with 200 milk samples (100 case and 100 controls) collected from 925 cattle farms of four districts of Sylhet.

Variables	Odds Ratio (95% CI)	P-value
Rearing other farm animals		0.03
Yes	2.14(1.07 -4.28)	
No	1	
Removal of dung		0.02
Open place	2.24 (1.09 -4.57)	
Do not store	0.33(0.09 -1.31)	
Pit	1	
Previous history of udder injury		0.01
Yes	2.79(1.27 -6.15)	
No	1	

Local assessment of clustering identified clusters at the unions in Moulvibazar, Sunamganj and Sylhet district. There was no cluster identified in the Habiganj district (Figure 2). The findings are highly relevant for targeted surveillance and control programme.

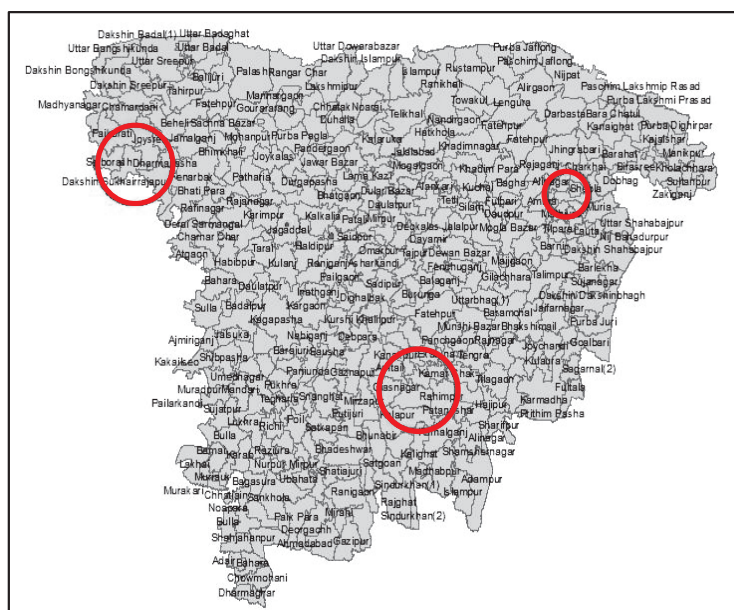


Fig. 3. Location of clusters of *C. burnetii* seropositivity in Sylhet Division

Conclusion

This report used data from three observational studies and has demonstrated the usefulness of such studies to draw a valid inference on the epidemiology of *C. burnetii* seropositivity in dairy cattle of Sylhet division of Bangladesh. The main conclusions which can be drawn from this report are:

It is evident that the pooling strategy described in the present study was highly cost-efficient for screening and diagnosis of *Coxiella burnetii* infection. The strategy would be most feasible for reasonably inexpensive large-scale screening, prevalence studies, time management and even diagnostics because of financial limitation.

This study confirms the existence of organism in that population. Though the intensity of the disease is still low, but it could be an alarming in near future. Large herd found to be more prevalent as well as risk factor for Q fever than small herd. It was also revealed that the farms rearing dairy cattle together with other farm animals carried positive association to disease in comparison with the farms did not bear multiple species of animals. Furthermore, farms which did not store the removed dung was more protective than those used pit or scattered openly. Besides, cows with previous udder infection were found more susceptible to disease comparatively from healthy animals. Therefore, outcomes of this study could be used as tools for adoptive surveillance and effective control and prevention of the disease.

This study identified hot spots of Q fever infection of dairy cows in Sylhet division. Local assessment of clustering identified clusters at the unions in Moulvibazar, Sunamganj and Sylhet district. The findings are highly relevant for targeted surveillance and control programme

Using the findings of this report, pertinent bodies responsible for disease control and prevention could implement adoptive targeted surveillance and control strategies for *C. burnetii* infections in the cattle population of Sylhet division.

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Mathematical Models for Storm Surge Wave in the Surf Zone

Ashabul Hoque and Gour Chandra Paul

Location: Department of Mathematics, University of Rajshahi, Rajshahi

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 1125000.00

Introduction

The wave breaking in the near shore area is a very important phenomenon in wave hydrodynamics. When waves propagate to the near shore zone, wave profiles become steeper and eventually waves break. When the wave breaks, a part of wave energy is transformed to turbulence that causes a decrease in wave height. During the wave breaking, a large amount of air bubble entrains into water, causing a large-scale disturbance in flow, which plays an important role in the surf zone. A limited number of studies (Furbuther, 1970; Hwung et al., 1993; Hoque and Aoki, 2017) were investigated the energy dissipation based on several ideas. In this project, our objective is to find out the contribution of air bubbles on wave height, wave direction and wave energy dissipation.

Objectives

The objective of this study is to investigate the wave heights and wave directions for 2-D breaking waves in the coastal area.

Methodologies

1. Development of Model Equations

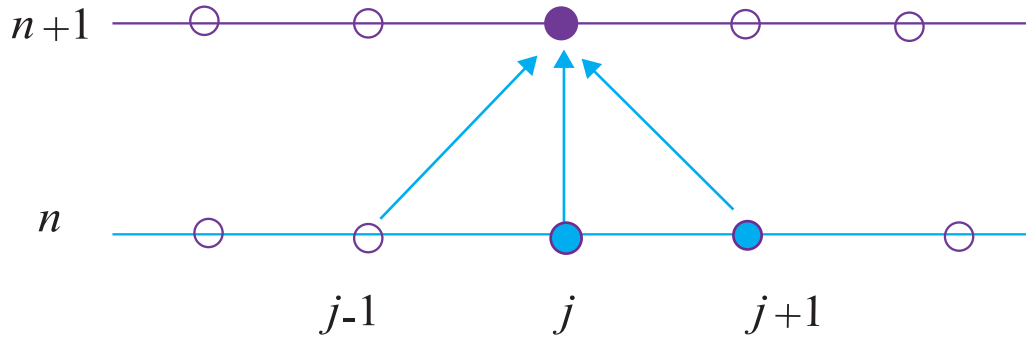
The energy balance equation can be written for 2-dimension as

$$\frac{\partial(E c_g \cos \theta)}{\partial x} + \frac{\partial(E c_g \sin \theta)}{\partial y} = -D \quad (1)$$

where E , c_g and D represent wave energy, group velocity and energy dissipation rate, respectively. The void fraction distribution and developed energy dissipation model are found as

$$C(z) = C_0 \left(\frac{z+y}{y} \right) \quad (2)$$

$$D = \alpha \rho_w g w_r \frac{y}{2} \left(\frac{C_0}{1 - C_0} \right) \quad (3)$$



where y is the vertical distance to the free surface, w_r is the still water depth, α is a penetration depth of entrained air and C_0 denotes the reference void fraction at the mean water surface. The boundary conditions are automatically satisfied: $C(z) = C_0$ at the surface $z = 0$ and

$$C(z) = 0 \text{ at } z = -y.$$

2. Numerical technique

To discretize the model equations, Lax-Wendroff scheme is used, which is actually a two-steps scheme but can be recast as one level

After discretization of Eq. (1), yields

$$A_{i+1,j} = A_{i,j} - \frac{\Delta x}{2\Delta y} (B_{i,j+1} - B_{i,j-1}) + \frac{1}{2} (A_{i,j+1} - 2A_{i,j} + A_{i,j-1}) - \Delta x D_{i,j} + O(\Delta x^2, \Delta y^2)$$

where $A = Ec_g \cos \theta$ and $B = Ec_g \sin \theta$ and $\theta = \tan^{-1}(B/A)$.

3. Domain and input

The following bathymetries are used. The input parameters are used as water depth, wave period, incident wave angle and deep water wave height.

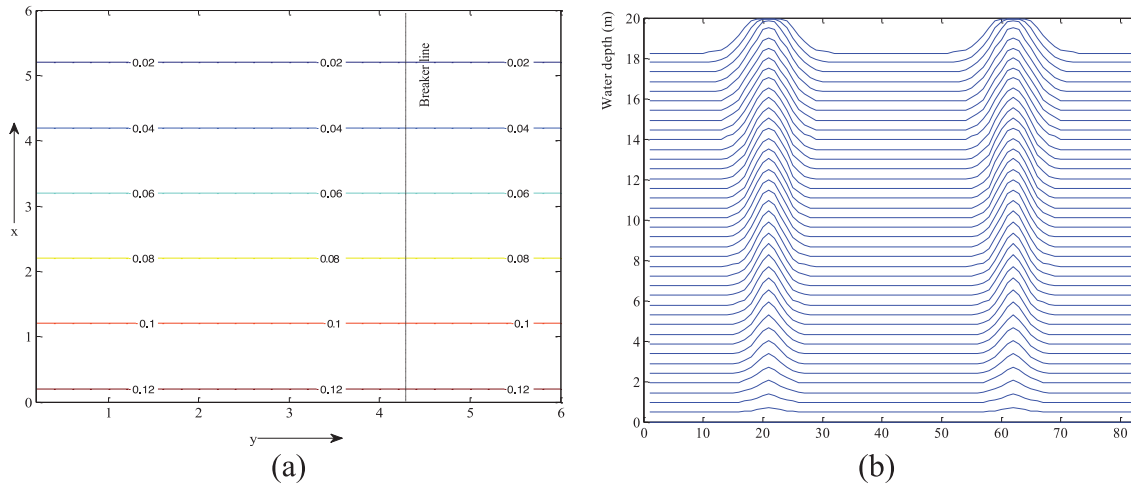


Fig. 1. Bathymetry (a) planar and (b) parabolic

Results

The distributions of the wave height and angle are computed which are shown in Figs. 2 and 3. The wave heights and directions are depicted with arrows. At each grid point, the length of the arrow denotes the height of the wave and the vertical arrow shows the direction of the wave. From deep water to breaker line, wave heights increases and wave angles keep almost constant. But after breaker line (Fig. 2), wave heights decrease gradually with decreasing water depth and wave angles change almost 90° to the shore line.

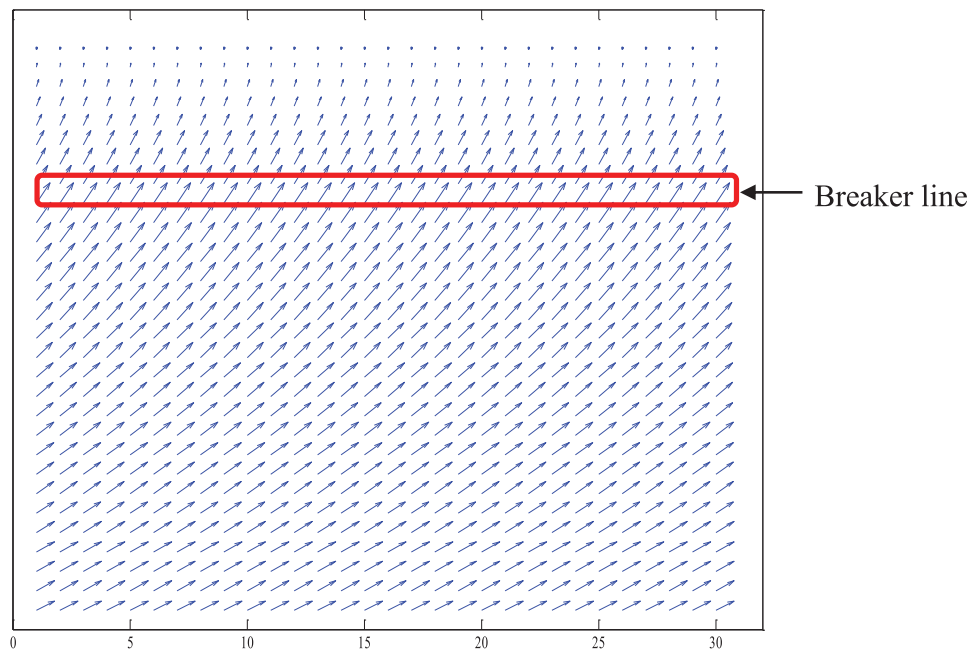


Fig. 2. Results of wave height and wave angle for straight and parallel bathymetry. Initial wave height and wave angle were taken as $H = 0.02$ m and $\theta = 30^\circ$, respectively. The final wave height and wave angle were obtained as $H = 0.0045$ m and $\theta = 86^\circ$, respectively.

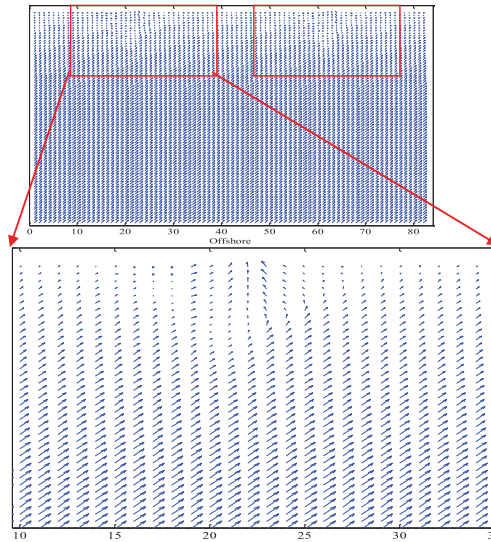


Fig. 3. Wave height and angle for parabolic bathymetry. Initial wave height and wave angle were taken as $H_0 = 0.12$ m and $\theta = 60^\circ$, respectively.

Conclusion

A simple air bubble model was developed that was used to calculate wave heights for two-dimensional case. A numerical method, namely, Lax-Wendroff scheme was used here. Results for wave height and wave direction for breaking waves were calculated and presented in Figs. 2 and 3. We observed that the wave heights were increased up to breaker line, after that it decreased gradually with decreasing water depth and wave angles also changed almost 90° with the shore line.

Publication from this Research

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Paul, A. K., Paul, G. C. and Hoque, A. 2018. Determination of Gas Exchange between Air and Water in the Coastal Area. A F Mujibur Rahman Foundation-Bangladesh Mathematical Society National Mathematics Conference-2018, Department of Mathematics, Dhaka University, Dhaka, Bangladesh.

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Bioremediation Perspective of Textile Effluent Dyes by Indigenous Bacteria

Ananda Kumar Saha, Biswanath Sikder and Moni Krishno Mohonto

Location: Department of Zoology, Rajshahi University, Rajshahi

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 2500000.00

Introduction

The textile industry plays an important role in the world economy as well as in our daily life, but in the same time, it consumes large quantities of water and generates huge amounts of wastewaters (Guendy, 2007; Tom *et al.*, 2011). The chemical reagents used in textile sector are diverse in chemical composition ranging from inorganic to organic. The major chemical pollutants present in textile wastewater are dyes containing carcinogenic amines, toxic heavy metals and pentachlorophenol (Subhathra, 2013). It is estimated that 10 to 20% of the dyes used in textile processing is lost in effluent during the dyeing process. Dye bearing effluents are complex, most often non-biodegradable and exhibit toxicity to both aquatic and non-aquatic biota. Rapid industrialization and urbanization that results in the discharge of large amount of waste in the environment, is one of the main reasons for pollution.

Textile and dyeing industries one of the major industries in Bangladesh are the main sources for release of colored effluents (mainly consisting of dyes) to the environment (Islam, 2011). Hence, the present study was designed for isolation and characterization of indigenous bacteria which were able to biodegrade textile effluent dyes effectively.

Objectives

In light of the presumptive evidence, this investigation was designated to fulfill the following objectives:

- Investigate the potential of bacterial isolations from textile industries wastewater and drains (textile effluent adapted bacteria) in some azo dye biodegradation;
- Analyze the bioremediation of azo dye degradation to environmental friendly non-toxic form;
- How to use the cost – effective raw materials in the dye biodegradation process; and
- Extraction of genomic DNA and PCR amplification of 16SrDNA for identification of bacterial isolates.

Methodologies

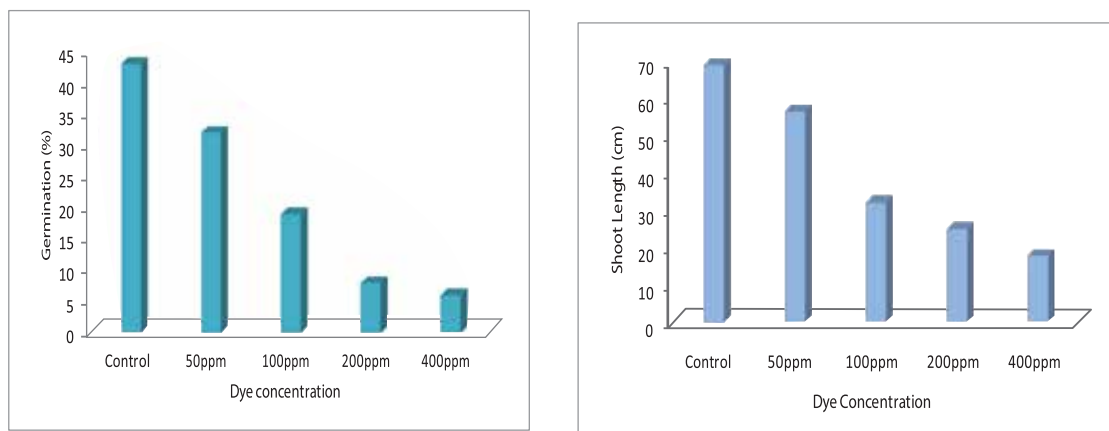
Effluents samples were collected from different Textile Dyeing Industries in Sathia, Sirajgonj, Gazipur, Madhapdi, Narshingdhi, Bangladesh. Then, physical properties such as colour, odor, pH of the collected samples were observed. Then chemical properties such as Total Solids (TS), Suspended Solids (SS), Dissolved Solid (DS), Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) of the collected samples were measured using standard protocols. Then, the bacteria were isolated from the collected samples. Purified cultures of bacteria were then used for characterization and identification. Dye declourizing ability of the isolated bacteria was measured using UV-Visible spectrophotometer. Then efficacy of bacterial isolates to convert toxic compound of textile effluent into non-toxic compound was measured by seed germination test using standard protocol. The potential bacterial isolates were then characterized by antibiotic sensitivity test and different biochemical tests such carbohydrate utilization tests were performed. Then, 16S rDNA was isolated from the bacterial isolates which were then purified and amplified using PCR. The sequence analysis was performed using the ABI 3130 genetic analyzer and Big Dye Terminator version 3.1 cycle sequencing kit. Finally, the isolates were identified based on alignment of partial sequence of 16S rDNA with the existing sequences available in the database.

Results

Table 1. Physico chemical characteristics of textile effluents.

Sample	Nature of sample	TS (mg/l)	TDS (mg/l)	pH	COD (mg/l)	BOD (mg/l)
Sample 1	Water	3700	2300	6.3	710	270
Sample 2	Sludge	4800	2100	6.8	750	280
Sample 3	Water	4300	2500	7.4	620	250
Sample 4	Sludge	4100	2700	6.0	785	310

Seed germination rate of leguminous crops were affected by textile effluent as shown below in figure 1.



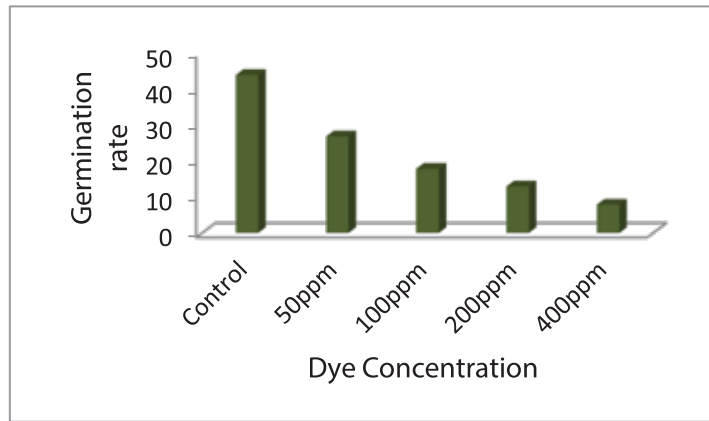


Fig. 1. Effect of textile dye on germination rate (*P.sativum*, *C.arietinum*, *L.esculentum*).

Root and shoot length of leguminous crops were varied by the effect of textile dye as shown below in figure 2 and 3.

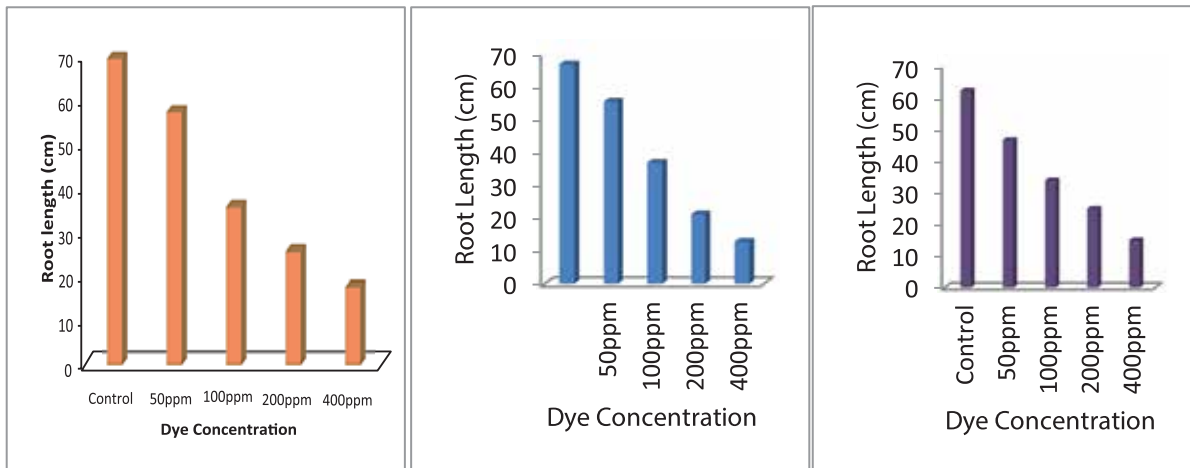


Fig. 2. Effect of textile dye on root length (*Pisumsativum*, *Cicerarietinum*, *Lens esculentum*).

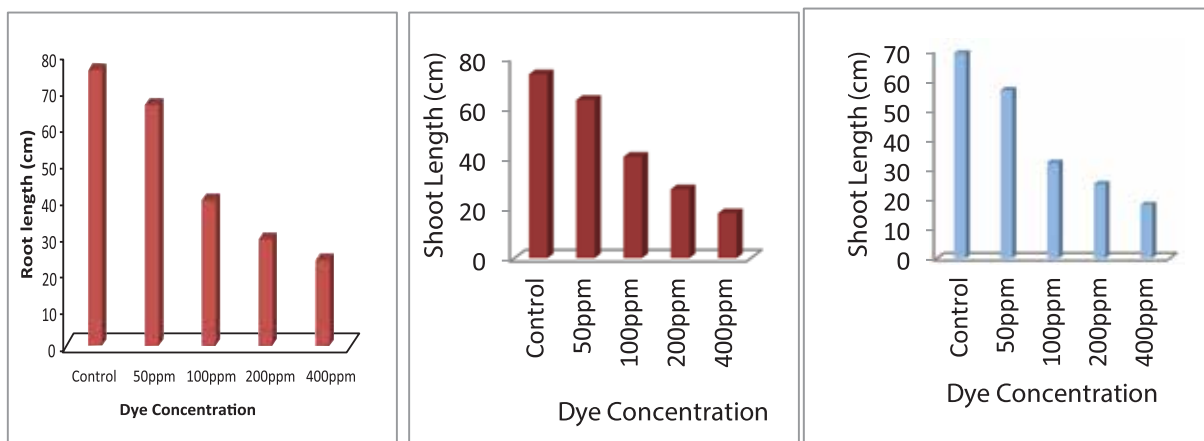


Fig. 3. Effect of textile dye on shoot length (*Pisumsativum*, *Cicerarietinum*, *Lens esculentum*)

The isolates exhibited maximum growth at pH 7 and 28°C temperature. The isolates B, C, D were resistant to most of the tested antibiotics while isolate A was resistant to ampicillin, amoxicillin and cephalixin.

All the four isolates revealed positive result to glucose. The isolate B, C & D showed positive result to cellulose, fructose, galactose, maltose, sucrose, xylose and lactose. All isolates were positive to MacConkey Agar Test except isolate A. All isolates were positive to catalase test except isolate D. All isolates were negative to Methyl Red and Voges-Proskauer Test. But, all isolates were positive to Citrate Utilization Test.

Decolourization efficacy of the isolated bacteria was affected by dye concentration as shown below in figure 4.

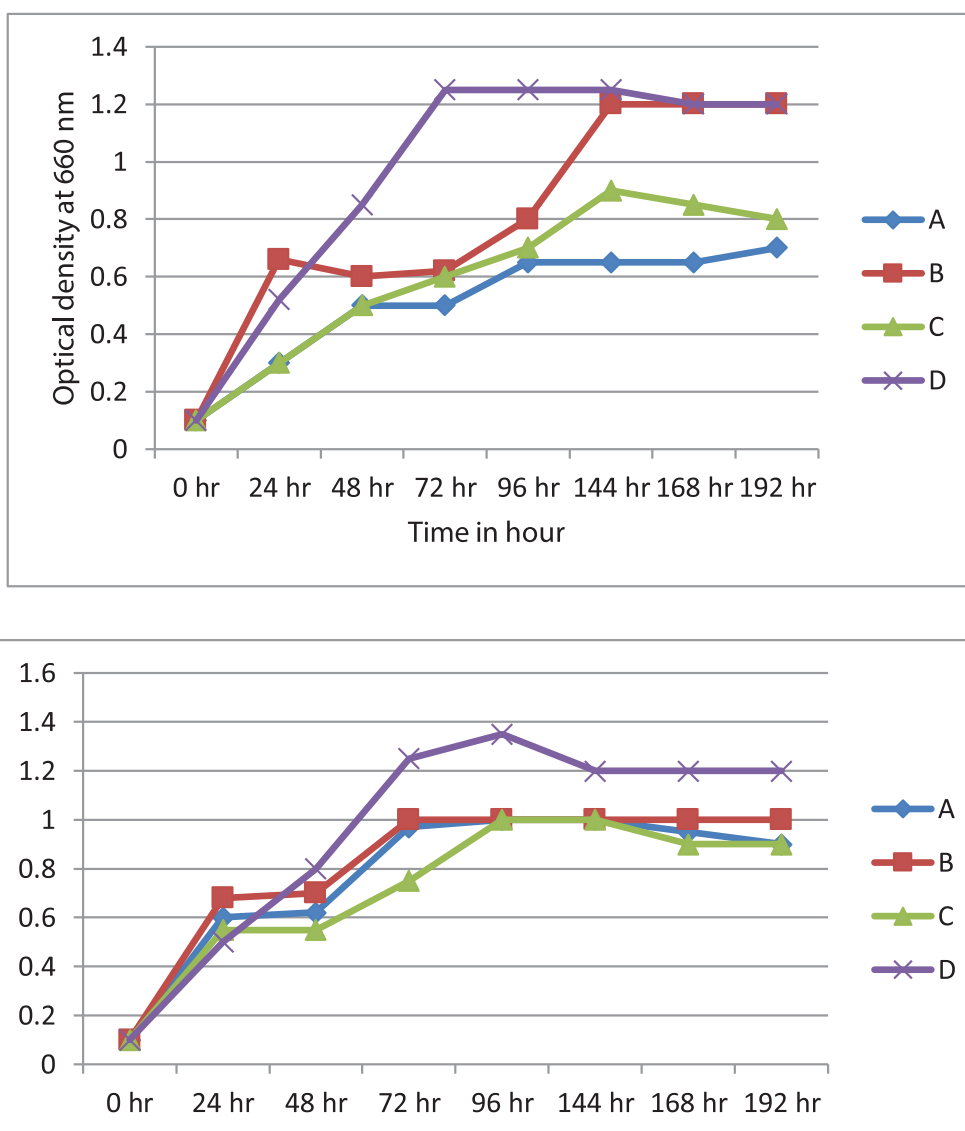


Fig. 4. Decolourization of textile effluent (100 ppm and 200 ppm)

Table 2. Bacterial isolates identified with 16S rDNA sequencing.

Isolates	Resembles with NCBI BLASTn suite		
	1 st matching	Identities	Sequence ID
B	Enterobacter sp. S20112	99%	KF956573.1
C	Bacterium MJ20	99%	KM232698.1
D	Enterobacteraerogenes strain HK 20-1	99%	AY335554.1

Conclusion

It may be concluded that the bacterial isolates can be utilized for the bioremediation of various textile industrial effluents in order to save the ecosystem from harmful effects of various dyes. Hence, we are trying to conduct the experiment in the industrial level so that in future we can use the bacteria in bioreactor to clean up industrial waste before releasing these in the environment.

Publication from this Research

Saha, A. K., Sultana, N., Mohanta, M. K., Mandal, A. and Haque, M. F. 2017. Identification and Characterization of Azo Dye Decolourizing Bacterial Strains, *Alcaligenesfaecalis* E5. Cd and A. faecalis Fal. 3 Isolated from Textile Effluents. *A. Sci. Res. J. for Eng., Tech., and Sci. (ASRJETS)*, 31(1), pp.163-175.

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Fabrication of Bio-Nanofibers for New Generation Electronic Paper

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Location: Forestry and Wood Technology Discipline, Khulna University, Bangladesh

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 2000000.00

Introduction

Organic Light Emitting Diode (OLED) technology is the dominating display technology of 21st century. Glass or transparent plastics are used as the substrate materials for lying of conductive and emissive layers of vacuum deposition or photolithography system in OLED technology. Glass films are bendable and can be found in desired qualities. However, the glass substrates, because of their brittleness, are confined to batch processing which limits the mass production of displays to meet the ever increasing demand. The alternative is plastic substrate, the flexibility of which allows for continuous roll-to-roll (R2R) processing. Particularly, the flexible plastics have extremely high coefficient of thermal expansion (CTE) values exceeding 200 ppm/k which so far delay the practical R2R process. Fiber reinforcement into plastics has recently attended the attraction to overcome the thermal expansion of plastic. After cellulose, chitin is the second most abundant natural bio macro-molecule in the world, existing mainly in the exoskeleton of crabs and shrimps. These exoskeletons have strictly hierarchical organizations consisting of α -chitin nanofibers, proteins and calcium carbonate (Raabe *et. al.* 2005, Chen *et. al.* 2008). Furthermore, as chitin nanofibers consist of an antiparallel extended crystalline structure, they have excellent mechanical properties, including a high Young's modulus, high fracture strength and low thermal expansion (Vincent and Wegst, 2004; Wada and Saito, 2001).

Objectives

- To develop a simple and cost effective technique to extract chitin nanofibers from shrimp shells;
- To fabricate optically transparent films from those extracted chitin nanofibers and characterize its properties.

Methodologies

Dried shrimp shells were demineralized using 10 % HCl solution for 24 hours to remove mineral salts. The treated sample was dispersed in 4% NaOH solution for 12 hours to remove residual proteins. In order to remove pigment, the samples were immersed in 50% ethanol. The yield was measured to be around 14.3%. The chitin sample then was dispersed in water with a concentration of 1 wt% to form slurry. Several drops of acetic acid were added to the chitin slurry to adjust the pH value 3–4 to facilitate fibrillation. The suspension was subjected to different mechanical treatment such as high speed blender (37000 rpm) for 10 minutes, ultrasonic treatment for 10 minutes at 650 W power (frequency 20-25 KHz) and mixture of ultrasonic and high speed blender for 10 minutes All of them were kept in a never-dried condition.

The fibrillated chitin nanofibers were neutralized and dispersed into distilled water at 0.1 wt% of nanofiber contents. After stirring, 260 g of water suspension was vacuum-filtered through PPTe membrane filter (0.2 μ m) to produce a wet nano-sheet of 45 mm in diameter. The wet chitin sheet was separated firstly from the filter paper and oven dried at 110°C and 2 N/mm² pressure for 6 minutes. The chitin nano-sheets were coated with an approximately 2 nm layer of platinum by an ion-sputter coater and observed with a field emission scanning electron microscope (JSM-1600F, JEOL Ltd.).

The dried nano-sheets were impregnated with neat acrylic resin and vacuumed for 12 hours at a reduced pressure of 0.08 mPa. After reinforced of nano-sheets into resin matrix, the impregnated composites were cured using ultraviolet light. The chitin/resin composites thicknesses were approximately between 100 to 120 μ m. The fiber content of chitin reinforced nanocomposites was 23-28 wt%.

The regular light transmittances of chitin/resin composites were measured using a UV-visible spectrometer (U-4100, Hitachi High-Tech. Corp.) with an integrating sphere 60 mm in diameter at wavelengths from 200 to 1000 nm. CTE was measured by a thermo mechanical analyzer (TMA/SS6 100), SH Nanotechnology Inc. Specimens were 25 mm long, 3 mm wide and 100-110 μ m thick with a 20 mm span.

Results

To extract chitin nanofibers efficiently, chitin can be isolated from the cuticle by a series of decalcification and deproteinization steps using acid and alkali treatments, respectively. Fan *et al.* (2007) reported that protonation or cationization of the C2 amino groups present on the crystallite surfaces of the squid pen β -chitin under acidic conditions is one of the most significant conditions for the nanofiber conversion. Thus, we added acetic acid to the pure chitin slurry, adjusted the pH value to 3–4, and then placed the mixture of different mechanical process.

Colloidal structure was obtained irrespective of all mechanical process indicating that the chitin-fiber slurry was homogeneously dispersed in water. This is due to the presence of positive charges (NH_3^+) to the surface of the chitin nanofibers which formed by the protonization of the amino groups of chitin in the acidic media (Shams *et al.*, 2011, 2013). FE-SEM images of fibrillated chitin under different mechanical treatment were observed in Fig.1. When treated with high speed blender, the nanofibers showed homogeneous fibrillation and a well-constructed chitin nanofibers were fabricated (Fig 1a).

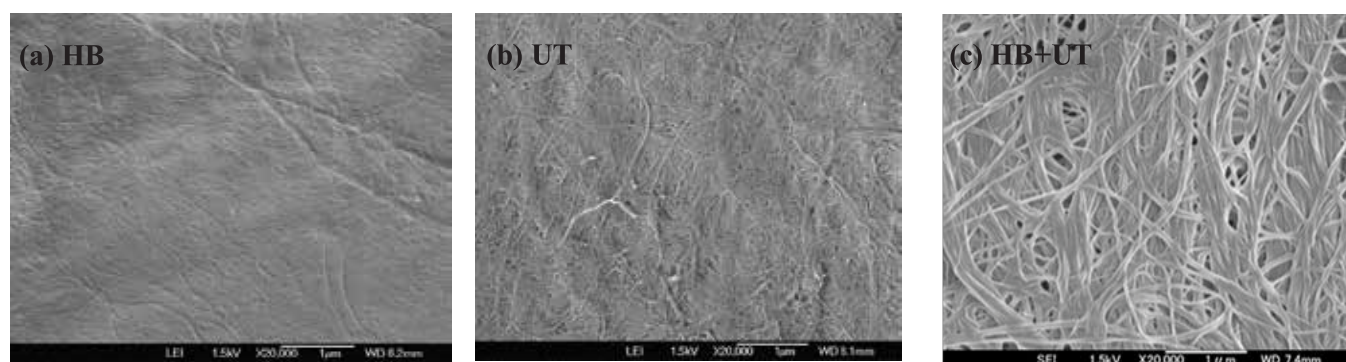


Fig. 1. FE-SEM image of chitin nanofibers at (a) High speed blender (HB), (b) Ultrasonic treatment (UT) and (c) Mixture of ultrasonic and high speed blender (HB+UT).

Homogeneous fibrillation of chitin nanofibers was observed in ultrasonic treatments 1 however, fiber bundles were seen in SEM images (Fig 1b). Hence combination of high speed blender and ultrasonic treatment was carried out. It was clearly showed that, a well-formed nanofibrous network without any sorts of particles agglomeration was observed under mixture treatment (Fig 1c). Figure 2 shows the light transmittance against wavelength measurements for the chitin nanofibers/acrylic resin sheet under different treatment. At a visible wavelength of 600 nm, the chitin/acrylic resin nanocomposite derived from mixture treatment transmitted around 70% of light. Compared to the light transmittance of pure acrylic resin, the fibrillated chitin fiber networks degraded the light transmission by only 20%. Despite the fact that the refractive index of the acrylic resin (1.536) was not precisely matched to that of the chitin (1.56) (Vigneron *et al.*, 2006), the high transmittance of the neat resin was almost maintained due to the small diameter of chitin nanofibers. Furthermore, chitin nanofiber-reinforced acrylic resin films exhibited considerably low thermal expansion, as can be seen in Fig 3. The coefficient of thermal expansion (CTE) from 20 to 150°C of the acrylic resin sheet was measured to be 213 ppm/K. By adding 28 wt% of chitin nanofibers, the CTE of the acrylic resin dropped to 15.6 ppm/K, approximately 1/14th of its original value. Thus, the incorporation of chitin nanofibers contributes to the significant improvement of the thermal expansion of acrylic resin.

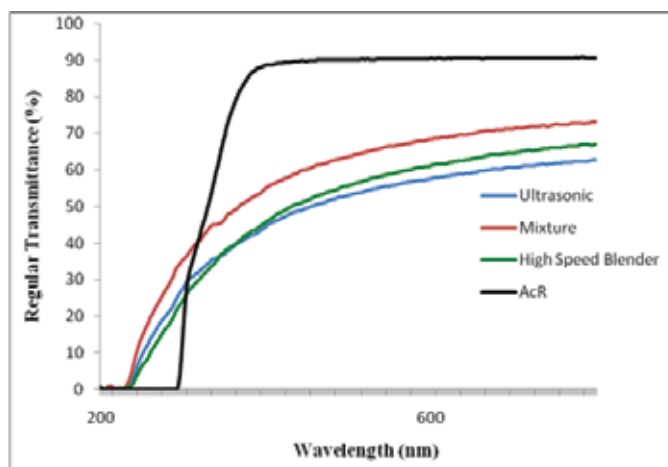


Fig. 2. Regular light transmittance of chitin/resin nanocomposites at different mechanical treatments.

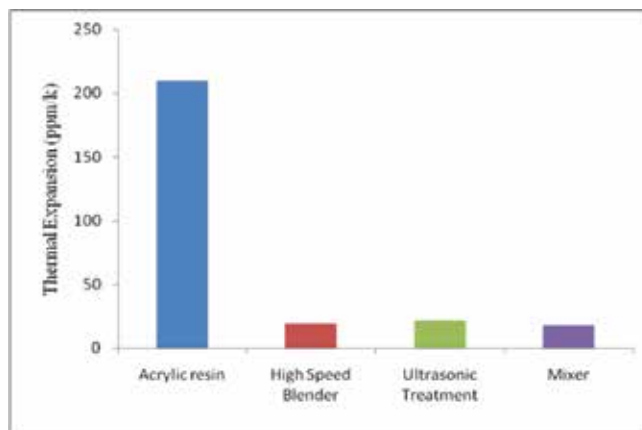


Fig. 3. CTE of fibrillated composite films as a function of different mechanical treatment.

Conclusion

In this study, we have succeeded to fabricate chitin nanofibers from shrimp shells using different mechanical treatments. The chitin/acrylic resin nanocomposite showed 70% of light transmittance for mixture treatment. In addition, the chitin nanofiber found to be effective for improving the thermal expansion of acrylic resin. Because the fibers are small enough to retain the transparency of the neat acrylic resin and reduce the thermal expansion of the acrylic resin. So, this material could have potential applications in optoelectronic devices, e-paper and different transparent materials instead of glass or plastic.

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Morphological, Pathogenic and Molecular Characterization of *Colletotrichum* Species from Mango (*Mangifera indica*) in Bangladesh and Their Management by Bioactive Natural Compounds from Sunderbans and Coastal Areas

Md Rejaul Islam and Md Golam Hossain

Location: Agrotechnology Discipline, Khulna University

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 2300000.00

Introduction

Mango, a highly valued fruit crop in Bangladesh. But the yield is very low compared to neighboring countries (Hossain and Ahmed, 1994). There are many constraints that are responsible for the low yield of mango, diseases are one of them. Among all of the diseases of mango, anthracnose is the most common disease which is caused by *Colletotrichum gloeosporioides*. In Bangladesh 25 to 30% loses (Reza and Kader, 1995) of total production of mango due to anthracnose and stem end rot diseases.

There are so many strains of *Colletotrichum* species occurring disease or remain as endophytic. *Colletotrichum* species causing diseases in different parts of the country may not same morphologically, pathogenically and genetically (molecular). Molecular biology has brought many powerful new tools to fungal taxonomists including the potential for rapid identification of isolates, methods for rapid determination of virulence or toxicity of strains, and the means to elucidate the relationships among fungal species. Chemical control of anthracnose of mango is very expensive, harmful effect of the fungicide is responsible for air, soil and water pollution and causes serious health hazards (Alam, 1987). Botanical extract are biodegradable (Bajwa and Schaefer, 1998) and their use in crop protection is a practical sustainable alternative. It reduces environmental contamination and health hazards (Ramasoota, 2001).

There are 334 species of plants under 245 genera and 75 families in the Sunderbans. So, there will be possibility to find bioactive natural compounds from the plants of Sunderbans and coastal areas for treating mango fruits avoiding harmful chemicals.

Objectives

- To investigate the diversity of the genus *Colletotrichum* isolated from Mango of Bangladesh on the basis of morphology, pathogenicity and molecular characters; and
- To evolve appropriate control measure.

Methodologies

Location of the study: Plant Pathology Laboratory, Agrotechnology Discipline, Khulna University, Bangladesh.

Morphological Characterization of *Colletotrichum*

Morphological characterization was done on the basis of morphological characters.

Molecular characterization of *Colletotrichum*

Molecular characterization was done following Random amplified polymorphic DNA RAPD analysis.

Management by bioactive natural compounds from Sunderbans

Endophytic fungi isolated from *Heritiera fomes* and *Soneratia apetala* which were collected from Sundarbans, Bagherhat and Satkhira districts of Bangladesh. *Colletotrichum gloeosporioides* was identified on the basis of morphological characteristics and rDNA ITS analysis. The screening of antimicrobial compounds from endophytes is a promising way to meet the increasing threat of drug-resistant strains of human and plant pathogens. Extracts of endophytes were obtained using ethyl acetate solvents. TLC was done using n-hexane and ethyl acetate. These endophytic fungi were evaluated through disk diffusion method for growth inhibition against mango pathogen *C. gloeosporioides*.

Results

Morphological Characterization of *Colletotrichum*

All of the isolates varied significantly ($p < 0.05$) among different plant parts and also among the origins. They followed the order $F < FLC < T < L$ and $S2 < S4 < S9 < S1 < S8 < S3 < S6 < S5 < S7$, respectively. Mycelial growth, size of conidia, acervuli (No. cm^{-2}) ranged from 9.5-10.6 mmday^{-1} , 17.82-30.26 and 1.00-5.40 μm , respectively. Mycelial color (5), texture (6) and setae were present. Isolates were clustered into four distinct groups.

Table 1. Cultural variation of *C. gloeosporioides* among different plant parts of mango grown on OMA media after 18 days of incubation at 25°C

TGP	Cultural characters					
	CC	S	A	SC	CM	
F	White fluffy	Hyaline	Present	Present	Cylindrical	Present
L	White dense	Hyaline	Present	Present	Cylindrical	Present
FLC	Light grey	Hyaline	Present	Present	Cylindrical	Present
T	Dark olive	Hyaline	Present	Present	Cylindrical	Present

Note: TOI=Types of Isolates, TGP=Topography, CC=Conidial Color, S=Setae, A=Acervuli, SC=Shape of Conidia, CM=Conidial masses

Table 2. Morphological variation of *C. gloeosporioides* among 9 different districts origins.

O	Parameters (Mean±SD)					
	MGR	CS	NOA	MC	MT	S
S1	10.09±0.29a	25.86±3.55a	2.59±1.14ab	2.00±1.46a	2.65±1.67a	1.79±0.41a
S2	10.20± 0.33a	23.97± 4.41a	3.06± 1.05a	2.40± 1.71a	2.90± 1.91a	1.70± 0.48a
S3	10.01± 0.30a	23.55± 4.18a	2.42± 1.34ab	2.54± 1.56a	2.92± 1.89a	1.77± 0.44a
S4	9.98 ±0.17a	25.98± 3.16a	2.65 ±0.96ab	2.09 ± 1.38a	3.18 ± 1.99a	1.73 ± 0.47a
S5	10.08 ±0.28a	25.50 ±2.85a	2.09 ± 0.95ab	1.78 ± 1.30a	3.00 ± 2.00a	1.67 ±0.50a
S6	9.99 ±0.16a	23.67 ± 2.46a	2.11 ± 0.99ab	2.00 ± 0.94a	2.76 ± 1.68a	1.82 ± 0.39a
S7	9.99 ± 0.22a	23.52 ± 1.70a	1.94 ± 0.92b	2.71 ± 1.63a	3.25 ± 1.87a	1.79 ± 0.41a
S8	10.12 ± 0.31a	24.38 ± 2.85a	2.53 ± 1.45ab	2.58 ± 1.78a	3.58 ± 1.73a	1.92 ± 0.29a
S9	10.05 ± 0.27a	25.30 ± 4.25a	2.62 ± 1.33ab	2.70 ± 1.57a	2.80 ± 1.55a	1.90 ± 0.32a

Note: DMRT was represented in small letters. Same letters of each column are not significantly different ($p < 0.05$)

Table 3. Cluster analysis of 140 *C. gloeosporioides* isolates

Groups	Isolates	Member of clusters
G1	22	F1 F2 F5 F9 F11 F12 F13 F14 F15 F18 F20 F21 F42 F45 F46 F47 F48 F51 L1 L2 L29 T8
G2	40	F3 F4 F6 F7 F8 F10 F28 F29 F31 F32 F34 F38 F40 F49 F50 L5 L9 L12 L15 L16 L19 L20 L21 L25 L30 L32 L33 L34 L41 L43 L48 L51 L55 L59 FLC1 FLC11 FLC12 FLC15 T3 T9
G3	57	F16 F17 F19 F22 F23 F25 F26 F30 F33 F35 F37 F41 F43 F44 L4 L7 L8 L10 L14 L22 L24 L26 L27 L28 L31 L35 L36 L37 L38 L42 L44 L45 L46 L47 L49 L52 L53 L54 L56 L57 L58 FLC2 FLC4 FLC5 FLC6 FLC7 FLC9 FLC13 FLC14 FLC16 T1 T2 T5 T7 T10 T12 T13
G4	21	F24 F27 F36 F39 L3 L6 L11 L13 L17 L18 L23 L39 L40 L50 FLC3 FLC8 FLC10 FLC17 T4 T6 T11

Note: G1=Group 1, G2=Group 2, G3=Group 3, G4=Group 4

Table 4. Morphological grouping of *C. gloeosporioides* among 140 isolates

G	Parameters (Mean±SD)					
	MGR	CS	NOA	MC	MT	S
G1	10.38±0.20 ^a	28.72±1.53 ^a	3.83±0.85 ^a	2.23±1.41 ^{ab}	2.05±1.36 ^{bc}	1.64±0.49 ^b
G2	9.97±0.18 ^b	24.96±3.24 ^b	2.04±0.85 ^b	1.57±0.98 ^b	1.60±0.71 ^c	2.00±0.00 ^a
G3	9.98±0.24 ^b	23.64±2.76 ^{bc}	2.29±1.04 ^b	2.74±1.61 ^a	4.39±1.42 ^a	2.00±0.00 ^a
G4	10.04±0.24 ^b	22.63±2.55 ^c	1.93±1.01 ^b	2.52±1.54 ^a	2.67±1.56 ^b	1.00±0.00 ^c

Note: G=Group, DMRT was represented in small letters. Same letters of each column are not significantly different ($p < 0.05$)

Molecular Characterization

Molecular identification of the *C. gloeosporioides* was carried out through amplification of rDNA ITS regions by means of *C. gloeosporioides* (OPA 5) specific primer PCR combining the use of ITS4 and ITS5 universal primers. In the present investigation an attempt was made to carry out morphological and molecular characterization of Colletotrichum isolate (CI) associated with anthracnose disease of mango. On the basis of morphological and cultural characteristics the pathogen was identified as *C. gloeosporioides*. For molecular identification random amplified polymorphic DNA (RAPD) primers and internal transcribed spacer (ITS4 and ITS5) primers were tested on the genome of Colletotrichum isolates and the data provided characteristic genetic evidence of 100% similarity.

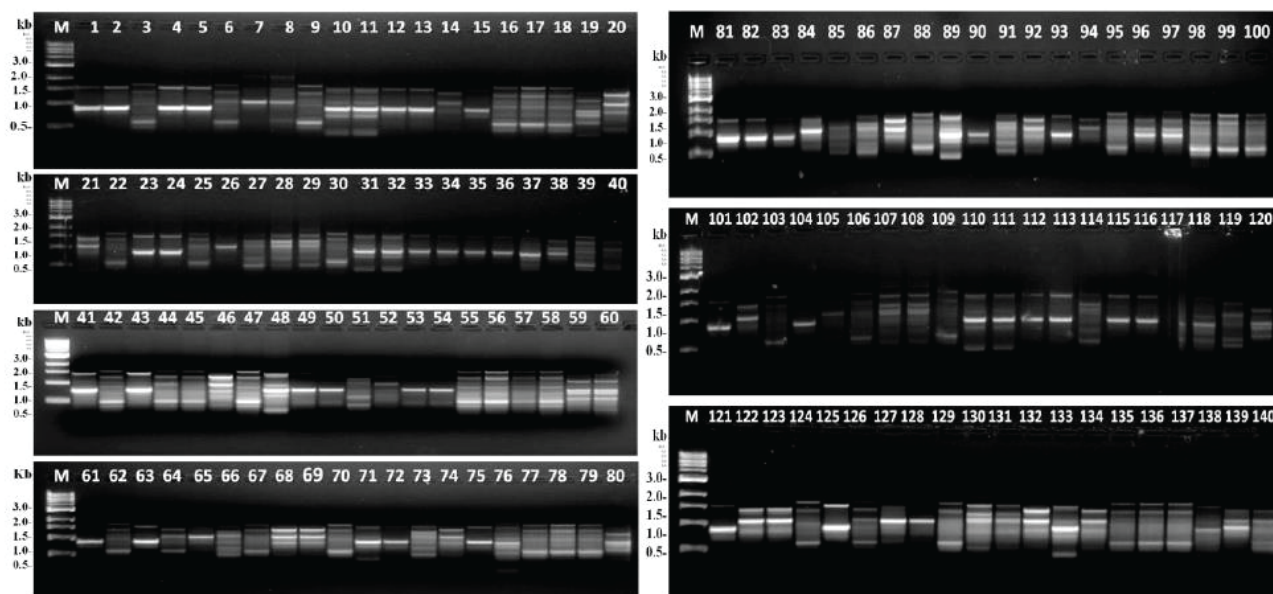


Fig. 1. 140 isolates of *C. gloeosporioides* polymorphic bands produced after amplification using primer OPA-18 with 1 kb ladder (Molecular weight markers)

Table 5. Member of clusters with percentages similarity level of 140 isolates of *C. gloeosporioides*

C	Member of clusters	SL (%)	Types of Isolates				To
			F	L	FLC	T	
C1	F1 F2 F3 F4 F5 F6 F21 F22 F35 F42 F43 F46 L17 L42 L58 FLC3 FLC11 FLC13 FLC17 T11	40	12	3	4	1	20
C2	F7 F8 F13 F14 F17 F19 F23 F24 F27 F33 F34 F36 F37 F41 F50 L18 L19 L41 L51 L52 FLC15 T1	40	15	5	1	1	22
C3	F9 F10 F11 F38 F39 L22 L31 L32 L44 L47 L49 L56 L57 L59 FLC1 FLC14 FLC16 T2 T8 T9 T10 T13	60	5	9	3	5	22
C4	F12 L20 L23 L24 L27 L28 L29 L30 L33 L36 L37 L43 L45 L46 L48 L55 FLC8 FLC12	20	1	15	2	-	18
C5	F15 F25 F26 F40 F49 F51 L1 L21 L25 L34 L35 L50 L53	100	6	7	-	-	13
C6	F16 F18 F20 F28 F45 F48 L4 L7 T3	20	6	2	-	1	9
C7	F29 F30 F31 F32 F44 F47 L5 L6 L8 L9 L11 L13 L26 L38 FLC2 FLC4 FLC5 FLC6 FLC9 FLC10 T5 T7 T12	20	6	8	6	3	23
C8	L2 L3 L10 L12 L14 L15 L16 L39 L40 L54 FLC7 T4 T6	100	-	10	1	2	13
Total			51	59	17	13	140

Note: C=Cluster, F= Fruits, L= Leaves, FLC=Flower cluster, T=Twigs, To=Total

Management by bioactive natural compounds from Sunderbans

Endophytic fungi isolated from *Heritiera fomes* and *Soneratia apetala* which were collected from Sundarbans, Bagherhat and Satkhira districts of Bangladesh. *Colletotrichum gloeosporioides* was identified on the basis of morphological characteristics and rDNA ITS analysis. The screening of antimicrobial compounds from endophytes is a promising way to meet the increasing threat of drug-resistant strains of human and plant pathogens. Extracts of endophytes were obtained using ethyl acetate solvents. TLC was done using n-hexane and ethyl acetate. These endophytic fungi were evaluated through disk diffusion method for growth inhibition against mango pathogen *C. gloeosporioides*. Isolates of SM1 was showed significant ($p < 0.0001$) antagonistic activity 10.22 mm and SM2 9.35 mm at 200 μ l/ml concentrations against *C. gloeosporioides* which was indicated by the formation of clear zone of inhibition.

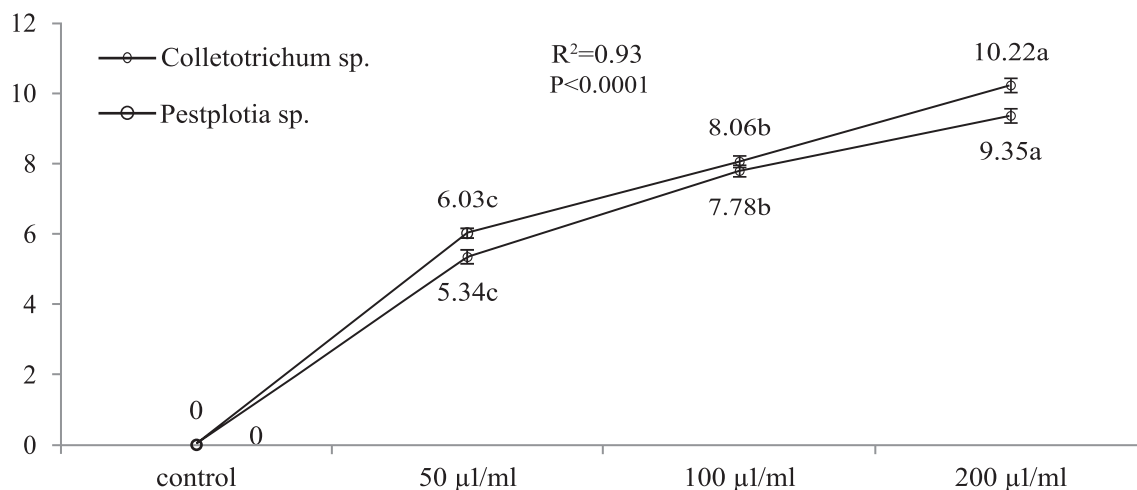


Fig. 2. Antifungal activity of secondary metabolites of endophytes against *C. gloeosporioides*

Conclusions

The present study revealed that morphological variation of *C. gloeosporioides* existed among different plant parts as well as among different source of origins of mango cultivars in respect of mycelial growth rate, conidial size, number of acervuli, mycelial color, texture and setae.

- Diverse genetic variability variation of *C. gloeosporioides* were found on the basis of molecular characters.
- Metabolite of entophytic fungus from the Keora and Sundori plants of the Sunderbans is a possible source of new antibiotics for *C. gloeosporioides*.

Publications from this Research

Gomasta, J., Islam, M. R., Sultana, S., Alam, A. 2017. Post-harvest application of botanical extracts from the sunderbans for controlling disease and extending shelf life of mango (*Mangifera indica* L.). *Int. J. Multidis. Res. and Dev.*, 4: 220-223.

Alam, A., Adhikary, S. K., and Ahmed, M. 2016. Modification of sporulation medium for isolation and identification of *Colletotrichum gloeosporioides*-a causal agent of anthracnose of *Mangifera indica* L. *Global J. Bot. Sci.*, 4: 43-52.

Alam, A., Adhikary, S. K. and Ahmed, M. 2017. Effectiveness of selected homeopathic medicines against *Colletotrichum gloeosporioides*. *Asian J. Plant Pathol.*, 11: 118-139.

Alam, A., Adhikary, S. K. and Ahmed, M. 2017. Morphological characterization of *Colletotrichum gloeosporioides* causing Anthracnose of *Mangifera indica* L., *Asian J. Plant Pathol.*, 11: 102-117.

Monitoring and Assessment on Heavy Metals in Salt Marsh Cosystems, *Spartina alterniflora* to Climate Change Impact of the Cox's Bazar Coast, Bangladesh

Md Ashraful Azam Khan and Aysha Akhter

Location: Institute of Marine Sciences and Fisheries, University of Chittagong

Duration: Two years (2015-2017)

Expenditure of the project: Tk. 1225000.00

Introduction

Salt marsh plant, *Spartina alterniflora* are defined as vegetated areas that are subject to periodic flooding as a result of fluctuating water levels of adjacent saline water bodies (Adam, 2007). They largely occur in the intertidal zone between land and the sea and are covered by salty or brackish water for at least some of the time (Doody, 2008). Salt marshes generally occur in sheltered conditions, where wave action is low enough for fine sediment to settle and accumulate (He *et al.*, 2016). Salt marshes generally develop in areas that are protected from the full force of the surf, in locations such as river mouths and sheltered bays and are typically vegetated by a variety of unique low shrubs, herbs and grasses (Clarke and Benson, 2008; Pan *et al.*, 2016; Adam, 2007; Zhao *et al.*, 2014).

The present study was set up to assess whether salt marshes act as sinks or sources for macro nutrients and heavy metals and to describe the effects of sediment addition on growth and element uptake of salt marsh vegetation. Field studies on the processes that determine the assessments of nutrients and heavy metals in salt marsh ecosystems are difficult due to large spatial variation of environmental conditions within the salt marsh ecosystem. The present study is significant in two ways; firstly, very few researches had been conducted on *Spartina* sp. bed especially along with the Cox's Bazar coast and secondly the texture and the composition of heavy metals and organic substances will be bringing out through this present study which might indicate the characteristics of the salt marsh grass, *Spartina* sp. of Cox's Bazar coast.

Objectives

Risk assessment studies were carried out in this research to monitor the heavy metals from salt marsh plant samples of the Cox's Bazar coast, Bangladesh. The main objectives of this research were:

- Monitor and assess the heavy metals in *Spartina* bed; and
- Risk assessment of heavy metals in *Spartina alterniflora*, salt marsh ecosystems.

Methodologies

Study site and sampling

This study was carried out in the Cox's Bazar coast, Bay of Bengal, Bangladesh (Figure 1). The Cox's Bazar coast is located on the Cox's Bazar, approximately between latitude 21°20'N and longitude 91°45'E. The bed of the coast is sandy-muddy in the upper region towards the lower region where tidal water has free flow. The sampling sites were chosen from these areas where the salt marsh vegetation is highly natural. Four stations had been selected for the sampling of this study were Station 1 (Bakhkhali River), Station 2 (500m north from Beximco Fisheries), Station 3 (500m south from Majir Ghat) and Station 4 (100m upper from Fishery Ghat). Salt marsh plant, *Spartina alterniflora* samples were collected four times from the sampling stations in 2016-2017. Salt marsh plant samples were collected using a hand scissor sampler from all sites at comparable depths (~ 1 m below the surface) to avoid confounding effects of depth and with comparable densities (~50-70 ind.) and kept in a polythene bag.

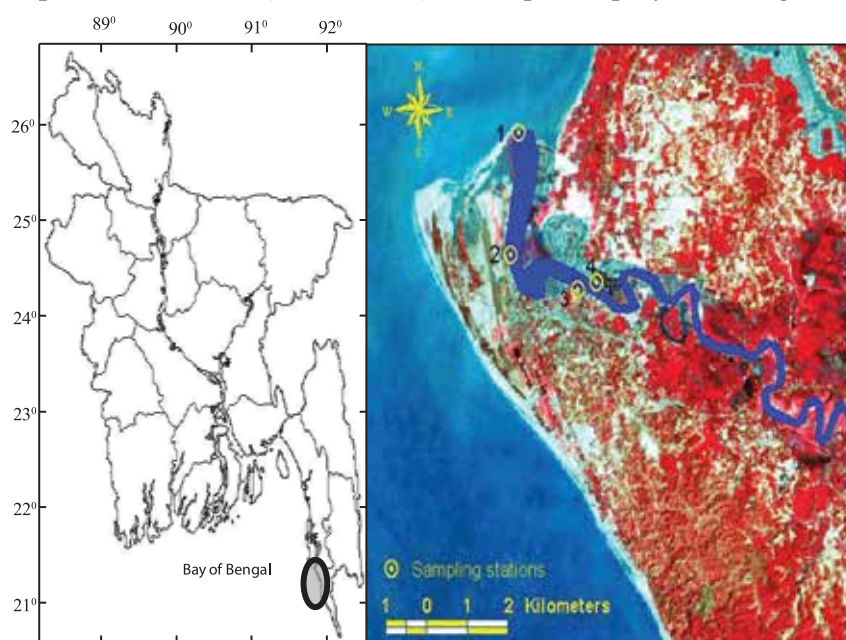


Fig. 1. Map of the Cox's Bazar coast, Bangladesh.

Determination of heavy metals

For the digestion of salt marsh plant samples, 1.0g of dried and homogenized samples were weighed and placed into an acid washed PTFE digestion vessel. The digestion of total plant samples (fraction < 63 μm) were performed with a mixture of HNO_3 – HCl – HF (concentrated, merck) at hot-plate and cooling system (US EPA, 1999). Sample solutions were analyzed for heavy metals using flame photometer AAS. Analytical reagent blanks were prepared with each batch of the digestion set and then analyzed for the same elements as the samples. Standards for each metal from analytical pure solutions were prepared for the calibration of the instrument and around 95% precision and accuracy were observed for all. Quality assurance and accuracy were checked by analysis of standard plant materials: NBS SRM 1566.

Assessment of Precision and Reproducibility

The precision of the analytical method was determined by the standard reference [SR %] values (MacFarren et al., 1970) for each element in relation to standard reference materials (see below).

$$SR [\%] = \{ [Ce - Cc] \pm 2\delta / Cc \} \times 100$$

Where, Ce is the experimental value; Cc is the certificate value; δ is the standard deviation. For SR < 25% is excellent; 25% < SR < 50% is moderate acceptable; 50% < SR < 100% is considerable acceptable; SR > 100% is unacceptable. The reproducibility is presented as a relative standard deviation RSD [%].

Assessment of Degree of Contamination

A contamination factor [C^i_f] to describe the contamination of a given toxic substance in a basin was suggested by Hakanson (1980):

$$[C^i_f] = C^i_{0-1} / C^i_n \text{-----} (1) \quad C_d = \sum_{i=1}^7 C^i_f \text{-----} (2)$$

For the description of contamination degree the following terminologies have been used:

- $C_d < 7$ low degree of contamination,
- $7 \leq C_d < 14$ moderate degree of contamination,
- $14 \leq C_d < 28$ considerable degree of contamination,
- $C_d \geq 28$ high degree of contamination.

Results

Concentration of heavy metal in salt marsh plant, *Spartina alterniflora*

The concentrations of Fe, Cu, Zn, Cd, and Pb in *Spartina alterniflora* at the Cox's Bazar coast, expressed as $\mu\text{g}\cdot\text{g}^{-1}$ are shown in Table 1. The concentration of Fe and Zn were higher in all the stations compared to the other metals of this study. It is also found that the concentration of Fe is the highest in station 4 compared with other stations. The comparisons of heavy metal concentration at different stations are shown in Figure 2. Maximum concentrations of Fe were found in Station 4 was $110.49 \mu\text{g}\cdot\text{g}^{-1}$. The correlation matrices of heavy metals in the plants are shown in Table 2 and the analysis of variance at 5% significance level are shown in Table 2. Comparison of detected values of heavy metals with recommended values of unpolluted salt marsh plants were presented in Table 3.

Table 1. Heavy metal concentrations in salt marsh plants (*Spartina alterniflora*) of Cox's Bazar coast (Mean value \pm SE).

Metal ($\mu\text{g/g}$ dry weight)	Study Site				*Elemental Background conc.
	Station 1 (Bakhkhali River)	Station 2 (Beximco Fisheries)	Station 3 (Majir Ghat)	Station 4 (Fishery Ghat)	
Fe	48.65 \pm 1.4	69.86 \pm 3.30	100.13 \pm 1.75	110.49 \pm 0.46	-
Cu	10.55 \pm 0.33	7.18 \pm 0.27	10.95 \pm 0.35	12.18 \pm 0.07	63.0
Zn	21.54 \pm 0.69	25.60 \pm 0.62	25.47 \pm 0.79	18.69 \pm 0.19	85.2
Cd	0.12 \pm 0.02	0.20 \pm 0.02	0.24 \pm 0.06	0.25 \pm 0.01	3.5
Pb	1.69 \pm 0.02	1.47 \pm 0.02	1.72 \pm 0.02	1.98 \pm 0.01	2.0

Detection limit (ppm): Fe: 0.01, Cu: 0.001, Zn: 0.008, Cd: 0.0005 and Pb: 0.01. * Source: FAO/WHO (2000).

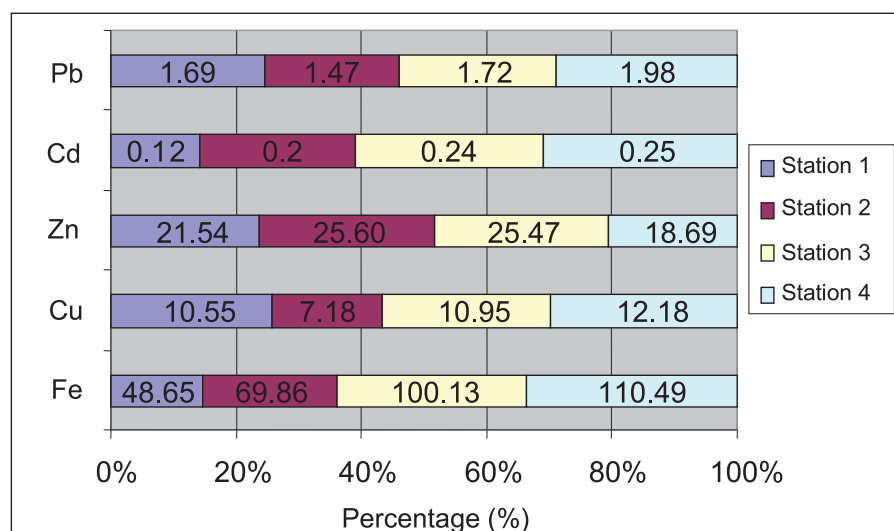


Fig. 1. The comparisons of heavy metal concentration in salt marsh plants at different stations of Cox's Bazar coast.

Assessment of Salt Marsh Plant Bed Contamination by Comparison of Concentrations with those from Background Plant Concentrations

The calculated contamination factor (C_i^f) values of heavy metals of salt marsh plant samples of the Cox's Bazar coast, Bangladesh (Table 2 and 3) are moderate to considerable degree for Pb and Zn, low to moderate degree for Cd, Cu and Fe according to the Hakanson classification (1980). The contamination degree Cd values are also provided in Table 2 and 3. Cd values indicate that low to moderate degree of heavy metals pollution at Fishery Ghat and Majir Ghat sites suggesting serious anthropogenic pollution at these sites, while Beximco Fisheries and Bakhkhali river sites indicate low degree of contamination. This result indicate that Fishery Ghat and Majir Ghat sites are moderate degree polluted zone and the Beximco Fisheries and Bakhkhali river sites are low degree polluted zone of salt marsh vegetation ground along the Cox's Bazar coast, Bangladesh (Taylor, 1972).

Table 2. Contamination factors (C_i^f) and degree of contamination (C_d) of salt marsh plant samples of the Cox's Bazar coast, Bangladesh.

StudySite	C_i^f					C_d
	Pb	Cd	Zn	Cu	Fe	
Station 1 Bakhkhali River	0.37	0.60	0.26	0.24	0.33	1.80
Station 2 Beximco Fisheries	1.01	0.55	0.84	0.34	0.60	3.34
Station 3 Majir Ghat	1.31	0.71	1.03	0.48	0.11	3.64
Station 4 Fishery Ghat	1.65	0.09	1.36	0.09	0.61	3.80
Reference	1.0	1.0	1.0	1.0	1.0	5.0

Conclusion

The results presented above demonstrate that the Cox's Bazar coast of Bangladesh is unquestionably facing heavy metal pollution. The metal concentrations in salt marsh plant samples are at moderate to considerable degree levels. The metal pollution observed also affected the aquatic ecosystem, mainly at Fishery Ghat and Majir Ghat sites for salt marsh vegetation area. High concentrations of Pb, Zn and Cu determined at salt marsh plant samples may indicate a fresh and continuous concentration from domestic and industrial discharges. The control mechanism behind the observed ecological effects of heavy metal pollution could be attributed to the suitability of salt marsh vegetation bound metals, mineralization, flocculation and coagulation, bioavailability, as well as hydrological conditions (Salla *et al.*, 2011). Behind these, there is a good agreement between applied ecological assessment techniques such as FAO/WHO (2000) guideline, degree of contamination (Cd) for salt marsh plant samples.

Bangladesh is a developing country where industrial and urban developments, agriculture and shrimp farming mostly occur in coastal areas. Besides, newly developed tourist areas and industries, through increased input of wastes, impose a further stress on the Cox' Bazar coast, Bangladesh. Above all, it is recommended that pollution be prevented at source, through cost-effective and pragmatic means, so as to reduce the heavy metals and other pollutants entering the Cox's Bazar coast.

Table 3. Metal analysis results in salt marsh plant, *Spartina alterniflora* ($\mu\text{g/g}$ dry weight) from the AAS of standard reference materials at the Bay of Bengal coast, Bangladesh (2016-2017).

Metal ($\mu\text{g/g}$ dry weight)	Certified value	Study Site											
		Station 1 (Bakkhali River)			Station 2 (Beximco Fisheries)			Station 3 (Majir Ghat)			Station 4 (Fishery Ghat)		
		Measured value	SR [%]	RSD [%]	Measured value	SR [%]	RSD [%]	Measured value	SR [%]	RSD [%]	Measured value	SR [%]	RSD [%]
Fe	-	48.65 \pm 1.4	-	4	59.86 \pm 3.30	-	2	100.13 \pm 1.75	-	2	110.49 \pm 0.46	-	3
Cu	63.0	10.55 \pm 0.33	38	4	7.18 \pm 0.27	29	8	10.95 \pm 0.35	34	4	12.18 \pm 0.07	59	8
Zn	85.2	21.54 \pm 0.69	14	5	25.60 \pm 0.62	15	6	25.47 \pm 0.79	48	5	18.69 \pm 0.19	31	6
Cd	3.5	0.12 \pm 0.02	33	6	0.20 \pm 0.02	36	8	0.24 \pm 0.06	6	16	0.25 \pm 0.01	28	11
Pb	2.0	1.69 \pm 0.02	16	7	1.47 \pm 0.02	42	4	1.72 \pm 0.02	28	4	1.98 \pm 0.01	27	8

SR-Standard Reference Material; RSD-Relative Standard Deviation

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Effects of *Spirulina platensis* on Pain and Inflammation in Rats

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Location: Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka

Duration: One year (2016-2017)

Expenditure of the project: Tk. 1100000 .00

Introduction

Pain is frequently the first symptom that triggers the urge to seek the attention of a physician from which diagnosis are guided. It can be categorized into nociceptive, inflammatory, neuropathic, and functional pain (Woolf, 2004). Early sensation to pain is a function of the nociceptive phenomenon that alerts the body to respond via activated nociceptors. Withdrawal response is aimed at preventing tissue damage but can however function in tissue healing process if an initial withdrawal response has not prevented tissue damage. Pro inflammatory cytokines, growth factors, kinins, prostanoids, proteases, and ions diffuse into the extracellular fluid from damaged tissue and could stimulate nociceptors to initiate pain and subsequent activation of pain pathways within the nervous system (Schölz and Woolf, 2002). This generated pain, known as inflammatory pain, originates from the activation of nociceptors and nervous system sensitization from inflammatory mediators. Healing property of pain is protective, but too much inflammation is detrimental because of its tissue damaging consequence. This excessive inflammatory pain causes sufferings and increases morbidity.

Analgesics used to treat pain traditionally follow WHO analgesic ladder, stepping through paracetamol, NSAIDs and finally opioids. Among them, diclofenac sodium (DS) is a commonly prescribed NSAID to treat pain associated with inflammation. Orthodox analgesics have many side effects (Rainsford *et al.*, 2008). It has been observed that, oral DS could produce significant analgesia both after single administration of a high dose (100 mg/kg) (Subhan *et al.*, 2008) as well as after a much lower dose (10 mg/kg/day) for 7 consecutive days (Santos *et al.*, 2004) in animal models of pain. Strikingly, both of these dose schedules of DS analgesic were associated with adverse effects like gastric ulcer.

Recently many studies have been conducted worldwide in search of alternative approach to modern analgesics in order to replace them, reduce their dosage, or minimize their adverse effects using different herbal products (Maroon *et al.*, 2010; Anand and Bley, 2011; Hussein *et al.*, 2013; Golechha *et al.*, 2014; Nesa *et al.*, 2014). Among them *S. platensis* (world's largest natural protein source), has been suggested as an important medicinal herb (Neekhra *et al.*, 2014). Apart from high nutritional value, *S. platensis* has also shown immuno-modulatory (Hayashi *et al.*, 1994), cardio-protective (Khan *et al.*, 2005), reno-protective (Gaurav *et al.*, 2010),

anti-hyperlipidemia compounded with anti-oxidant property (Makhlouf and Makhlouf, 2012), protective against heavy metals poisoning (Abdel-Daim *et al.*, 2013), anti-diabetic (El-Baz *et al.*, 2013), hepato-protective (Yoshinari *et al.*, 2014; Sharoud, 2015), neuro-protective (Alam and Hendawi, 2015), and anti-viral (Chen *et al.*, 2016) effects in different animal models. In accordance with several preclinical studies, *S. platensis* was also reported to be effective as anti-cancer (Liu *et al.*, 2000), preventive against allergy and rhinitis (Mao *et al.*, 2005; Cingi *et al.*, 2008), preventive of arsenic poisoning (Misbahuddin *et al.*, 2006), preventive of anaemia (Selmi *et al.*, 2011), hepato-protective (Mazokopakis, 2014), and cholesterol-lowering effects (Mani *et al.*, 2015) in different clinical studies. In addition, 400 mg/kg body weight/day *S. platensis* was shown to produce significant analgesia (Elgendy and Diam, 2014) and anti-inflammatory effects (Joventino *et al.*, 2012) after ≥ 3 weeks' oral administration in rats. Moreover, no adverse effect was seen even after 5000 mg/kg body weight/day oral *S. platensis* for 14 days in rats (Chen *et al.*, 2016).

Objective

On the basis of this background, the present study was designed to evaluate the effects of oral administration of *S. platensis* (400 mg/kg body weight/day for 21 consecutive days) on pain and inflammation in Long Evans rats as well as to compare these effects with those of DS (10 mg/kg body weight/day for 7 consecutive days).

Procurement and maintenance of animals

We obtained 42 Long Evans rats of both sexes (200 \pm 20 gm) from the animal house of BSMMU and housed in specially constructed plastic cages (45X30X15 cm³) with 3-4 rats/cage under a 12/12 hours light/dark cycle (Ali *et al.*, 2012) in the pain laboratory of the department. The rats were familiarized to the laboratory condition for 7 days before commencement of the experiment. Our team made efforts to reduce the sufferings and number of animals used. Each animal was used only once and sacrificed immediately after the experiment. Corresponding to the thermo-neutral zone for rodents, the ambient room temperature was maintained at 27.5 \pm 0.5°C, (Refinetti and Horvarth, 1989). Standard laboratory food (Islam *et al.*, 2001) and cooled boiled water ad libitum were provided for all the rats throughout the experimental period. All the experiments were performed at daytime (between 08:00 and 16:00 hours) to avoid the circadian influences (Moallem *et al.*, 2008) in accordance with the international guidelines on the use of laboratory animals and on the basis of codes for ethics in animal research in the International Centre for Diarrheal Disease Research, Bangladesh (ICDDR, B).

Dose schedule

Ten (10) mg/kg body weight (Hasani *et al.*, 2011) powder of DS (Biopharma, Bangladesh) and 400 mg/kg body weight (Neekhra *et al.*, 2013) powder of *S. Platensis* [Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka, Bangladesh] were dissolved in 5 ml/kg body weight of normal saline (NS) (Popular infusion limited, Bangladesh) and their solutions were prepared.

Experimental design

On the basis of oral treatments, all the rats were divided into group I (negative control, only NS for 21 consecutive days, n=21), group II (positive control, DS for 7 consecutive days, n=21) and group III (experimental, *S. platensis* for 21 consecutive days, n=21). On the basis of tests applied, rats in each group were again divided into subgroup 'a' (tail immersion test, n=7), and 'b' (formalin test, paw edema test, n=7). One hour after the last dose of oral treatment, all the rats were subjected to the above mentioned pain and inflammatory tests.

Tail immersion test (Vogel *et al.*, 2002)

After 7 days of room environmental acclimatization, 21 rats were separated for tail immersion test [Ia (7), IIa (7), IIIa (7)]. Each rat was placed in a plexiglass mechanical restraining cage for 10 minutes/day, for another 7 consecutive days, for instrumental acclimatization. Then on the very first day of study, at 8.00 am, each rat was kept individually in that cage for 5 minutes for adjustment with the tail hanging freely. Then a 500 ml glass beaker containing 400 ml of water (preheated to $52 \pm 0.1^\circ\text{C}$) was taken and a laboratory thermometer was placed inside. The distal 5 cm of the freely hanging tail of the rat was immersed into that preheated water and latency period of the tail-flick was recorded. The mean of the measurements obtained from 3 similar consecutive maneuvers, performed at 5 minutes interval, was taken as the baseline latency (BL). Then on the final experiment day (at day 7 or 21), just one hour after the last dose of treatment (NS/DS/ *S. platensis*), another tail immersion test was done and mean of 3 tail withdrawal latencies at 5 minutes interval was recorded as test latency (TL). To reduce the tissue damage, a highest latency of 15 seconds was considered as cut off time. The antinociceptive effect was expressed as percentage of the maximum possible effect (% MPE) as follows: $[(\text{TL}-\text{BL}) / (\text{Cut off time} - \text{BL}) \times 100]$

Formalin test (Ali *et al.*, 2012)

After 7 days of room environmental acclimatization, 21 rats were separated for formalin test [Ib (7), IIb (7), IIIb (7)]. Then each rat was placed in the observation cage of the plexiglass formalin test box (34X34X34 cm³) for 1 hour daily for 7 consecutive days, for instrumental acclimatization. Then on the day of experiment (at day 7 or 21), just one hour after the last dose of treatment (NS/ DS/ *S.platensis*), fifty (50) μl of dilute formalin (2.5%) was injected subcutaneously into the exposed planter aspect of the restrained rat's right hind paw, with an insulin syringe. Then the rat's pain behaviors were observed for following 60 minutes placing it into the observation cage of the formalin box. This 60 minute observation period was recorded as, the early phase [first 5 minutes (1st to 5th)], the interphase [middle 10 minutes (6th to 15th)] and the late phase [last 45 minutes (16th to 60th)]. With the help of a mirror fixed below the observation cage (at 45 $^\circ$ angle) observation was made by counting (with a stop watch) the total frequency of jerking, total duration of flexing and total duration of licking of the injected paw during this period.

Formalin induced Paw edema test

Anti-inflammatory effects of DS and *S. platensis* were determined in the rats of subgroup Ib (7), IIb (7) and IIIb (7) by formalin induced paw edema model (Ali *et al.*, 2012). Here the indicator of inflammation severity was assessed by the amount of paw edema resulted from subcutaneous injection of 50 μ l of 2.5% formalin in the planter aspects of rats' right hind paw.

- a) Edema thickness (John and Shobana, 2012): Before the administration of subcutaneous formalin in the right hind paw, each rat was placed in a large glass desiccator and 3 to 4 ml of di-ethyl ether (99%) was poured into it. For the following 5 to 10 minutes the rat was observed closely and the ventilation was maintained by intermittent opening and closing of the desiccator's lid. Then anesthetized state was assessed by observing regular slow and deep breathing pattern and its well-being was assured by apex beat palpation. Then the paw thickness of both hind paws of the anesthetized rat was measured by a simple measuring tape and the basal paw thickness difference was determined by subtracting the left paw thickness from the right paw one. Similar maneuvers was done 3 hours after subcutaneous administration of dilute formalin (50 μ l; 2.5%) in the right hind paw and test paw thickness difference was calculated. Then the edema thickness was determined by subtracting the baseline value from the test one. Basal paw thickness difference = before formalin, paw thickness (right – left). Test paw thickness difference = after formalin, paw thickness (right – left). Edema thickness = paw thickness difference (test – basal)
- b) Edema volume (Ferridoni *et al.*, 2000): After completion of the test paw thickness measurement, each rat was again placed in the large glass desiccator and about 10 ml of di-ethyl ether (99%) was poured to anaesthetize it deeply. Death of this deeply anesthetized rat was ensured by decapitation. Then both the hind paws of the sacrificed rat were cut just above the ankle joints (4 cm from tip toe) by a sharp scissor. A water plethysmo meter was used to measure the volumes of animal's paws and the edema volume was determined by subtracting the left paw volume from right one. Left paw volume = height of water with left paw (after immersion – before immersion). Right paw volume = height of water with right paw (after immersion – before immersion). Edema volume = paw volume (right – left).

Data presentation and statistical analysis

All the data were expressed as mean \pm SEM. Analysis of variance (ANOVA), followed by Bonferroni post hoc test, was used to analyze the data statistically, by the help of analytical software Graphpad Prism (Version 6). In the interpretation of results, P 0.05 was considered as the level of significance.

Results

Tail immersion test

As shown in Figure 1, *S. platensis* increased the tail flick latency significantly ($P \leq 0.01$) in comparison to that of negative control, however, this result was not significant when compared to positive control.

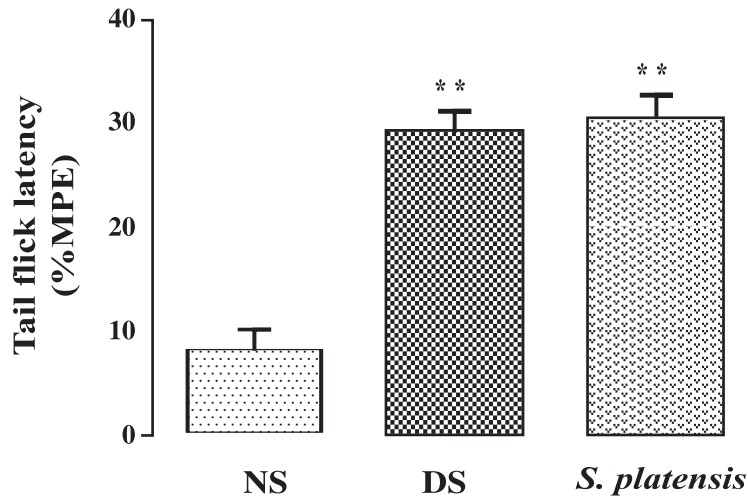


Fig. 1. Analgesic effect of *S. platensis* (*Spirulina platensis*, 400 mg/kg body weight) and positive control, DS (diclofenac sodium, 10 mg/kg body weight) in comparison to negative control, NS (normal saline, 5 ml/kg body weight) in tail flick latency of tail immersion test. Comparison was done on percentage of maximum possible effect (%MPE). Each bar symbolizes mean \pm SE of 7 rats in each group. **Significant ($P \leq 0.01$) in comparison to negative control.

Groups	Phases of Formalin test	Frequency of jerking in frequencies / 5 minutes	Duration of flexing in seconds / 5 minutes	Duration of licking in seconds / 5 minutes
Ib (with NS, n=7)	Early phase (1 st to 5 th minutes)	102.7 \pm 1.49 (97 to 109)	107 \pm 4.562 (97 to 125)	50.86 \pm 2.54 (42 to 62)
IIb (with DS, n=7)		42.71 \pm 3 *** (34 to 54)	50.14 \pm 2.44 *** (43 to 58)	9.14 \pm 2.98 *** (0 to 22)
IIIb (with <i>S. platensis</i> , n=7)		42.57 \pm 2.58 *** (35 to 55)	46.72 \pm 2.33 *** (39 to 57)	7.57 \pm 2.04 *** (0 to 18)
Ib (with NS, n=7)	Interphase (6 th to 15 th minutes)	65.29 \pm 7.8 (45 to 100)	23.14 \pm 3.93 (12 to 43)	9.86 \pm 2.75 (0 to 21)
IIb (with DS, n=7)		42.86 \pm 1.96 (37 to 50)	13.14 \pm 2.57 (6 to 27)	7.57 \pm 1.79 (0 to 14)

Formalin test

As shown in Table 1, in early and late phases of formalin test, *S. platensis* showed significant ($P \leq 0.001$) analgesia of all 3 variables in comparison to those of negative controls, however, these results are not significant when compared to positive control. In addition, this medicinal herb also showed significant ($P \leq 0.05$) decrease of jerking in interphase in comparison to negative control as showed in Table 1.

Table 1. Pain Variables in different phases of formalin test in different groups of rats (n=21)

Groups	Phases of Formalin test	Frequency of jerking in frequencies / 5 minutes	Duration of flexing in seconds / 5 minutes	Duration of licking in seconds / 5 minutes
IIIb (with <i>S. platensis</i> n=7)		34.29±4.71* (12 to 47)	12.43±3.37 (0 to 24)	5.86±1.9 (0 to 14)
Ib (with NS, n=7)	Late phase (16 th to 60 th minutes)	572.9±13.02 (532 to 633)	1172±37.47 (1036 to 1303)	295.9±12.74 (255 to 343)
IIb (with DS, n=7)		398±9.06*** (369 to 434)	716.1±32.34*** (607 to 870)	75.86±9.94*** (51 to 114)
IIIb (with <i>S. platensis</i> , n=7)		407.72±4.29*** (387 to 423)	744.9±33.19*** (627 to 918)	73.57±5.79*** (58 to 103)

Analgesic effect of *S. platensis* (*Spirulina platensis*, 400 mg/kg body weight) and positive control, DS (diclofenac sodium, 10 mg/kg body weight) in comparison to negative control, NS (normal saline, 5 ml/kg body weight) in different phases of formalin test. Data showing mean±SE of 7 rats in each group. */***Significant ($P \leq 0.05/0.001$) in comparison to negative control (NS).

Formalin induced paw edema test

As illustrated in Figure 3, *S. platensis* showed significant lowering of paw thickness ($P \leq 0.01$), paw volume ($P \leq 0.05$) in the paw edema model in comparison to those of negative controls. However, this lowering of inflammatory variables was not significant when compared to positive control.

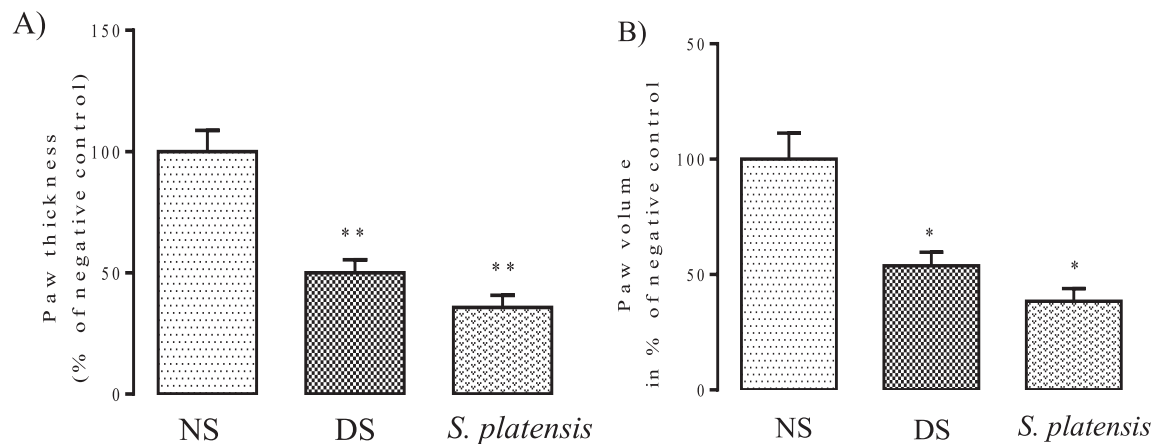


Fig. 2. Anti-inflammatory effects of *S. platensis* (*Spirulina platensis*, 400 mg/kg body weight) in comparison to positive control, DS (diclofenac sodium, 10 mg/kg body weight) and negative control, NS (normal saline, 5 ml/kg body weight) in paw thickness (A) and paw volume (B). Each bar symbolized for mean±SE of 7 rats in each group. ***/**Significant ($P \leq 0.05$ / $P \leq 0.01$) in comparison to negative control.

Conclusion

Our data demonstrated that *S. platensis* could elicit strong analgesia in rats subjected to the acute thermal (nociceptive) as well as persistent chemical (nociceptive and inflammatory) pain stimuli and strong anti-inflammation in chemical induced paw edema model. Therefore, from the present study it may be concluded that, *S. platensis* reduce pain (nociceptive, inflammatory) and inflammation and its analgesic and anti-inflammatory effects after 21 days administration is as effective as 7 days diclofenac sodium administration. Although, further studies are required in order to determine the exact component and molecular mechanism responsible for these beneficial effects of *Spirulina platensis*.

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Production of Craft Paper from Agricultural Residues

Md Nazrul Islam and Md Iftekhar Shams

Location: Forestry and Wood Technology Discipline, Khulna University, Khulna

Duration: One year (2016-2017)

Expenditure of the project: Tk. 1592000.00

Introduction

Paper is a communication and storage medium, a passport to knowledge that is documenting the world (Brännvall, 2009). Craft paper, a collection of art forms, is the most widely used material in arts and crafts. Generally, wood is chosen as a raw material for pulp and paper production due to appropriate chemical composition (Rowell *et al.*, 1997). Since, dependency on forest leads to deforestation, possible sources must be looked for from alternative sources. Some environment advocates have proposed the use of non-wood fibers in paper making (Kamoga *et al.*, 2013) though pulping operation is hampered due to high content of silica and fine. In this case, potassium hydroxide (KOH) instead of sodium hydroxide (NaOH) pulping is suggested (Huang *et al.*, 2007; Rodríguez *et al.*, 2008), suitable for small scale pulping and the black liquor can be used as fertilizer in agriculture (Huang *et al.*, 2007; Jahan *et al.*, 2016a), however, may not always suitable for efficient pulping. Banana pseudo stem, a non-wood lignocellulosic material (contains 92% water and rest have higher amount of cellulose) has the potentiality of paper making (Joedodibroto *et al.*, 1983; Ghosh *et al.*, 1984; Majumdar *et al.*, 1984). Hence, this study was conducted to evaluate the craft paper making potentiality of this plant by using common NaOH pulping process.

Objectives

In most of the cases, banana pseudo stem is kept in its own condition and it does not have any productive use. Therefore, this study was undertaken-

- To assess the potentiality of banana pseudo stem for pulping by NaOH process; and
- To use the produced pulp for production of craft paper alone and in combination with secondary pulp in order to compare the properties.

Methodologies

Banana pseudo stem were collected from the local area around Khulna city. The green stems were washed, air dried for 2-3 days to attain 40% MC and then, cut to 3 cm in length (Figure 1). Besides, discarded unbleachedkraft paper as secondary pulp (SP) were used to blend with banana pseudo stem pulp (BP) after pulping (Goswami and Saikia, 1994) which were collected from our wood products laboratory of Forestry and Wood Technology Discipline of Khulna University. Pulping was carried out by NaOH in a 15 liter, electrically heated, rotary, stainless-steel digester with alkali charges 8-12% (liquor:chips – 6:1, temp. 125° C for 120 min). After cooking, pulp was filtered and black liquor was drained off. Pulp was washed and yield was determined gravimetrically on oven-dry basis.



Fig. 1. Preparation of raw material (a) banana pseudo stem and (b) chips of banana pseudo stem

Half of the disintegrated pulp was bleached following single stage hydrogen peroxide (H_2O_2) bleaching (p^H 10 at 20% consistency, temp. $80^\circ C$ for 90 min). Handsheet was made from both bleached and unbleached pulp with expected 80GSM. Pulp were mixed at different ratios to produce hand sheet - BN (100), BN:SP (75:25), BN:SP (50:50) and BN:SP (25:75). After formation, sheets were dried in paper drier (temp. $90^\circ C$ for 7-8 min). Brightness, tensile and tear index were measured following TAPPI T-452, T-494 and T-414 standard, respectively.

Results

Yield

Banana pseudo stem were pulped by NaOH having different alkali concentrations 8, 9, 10, 11 and 12% and the yields were 25.6, 30.3, 32.3, 28.3 and 23.3%, respectively (Figure 2). The highest yield was 32.3% at 10% alkali charge and it meant that up to 10%, yield increased with the increase of chemical charge but decreased gradually after this limit. At higher alkali concentration carbohydrate degradation was higher, hence, resulted in the dropping of yield.

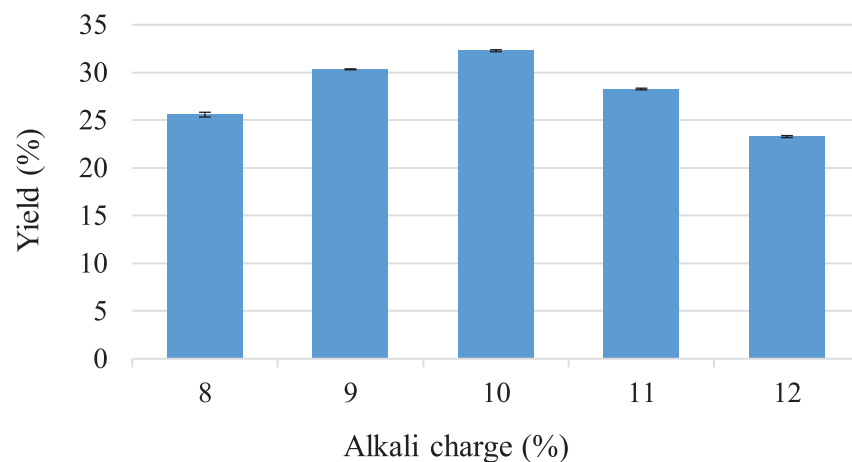


Fig. 2. Pulp yield (%) after cooking with different alkali charges

Brightness test

Brightness of unbleached handsheets of BN, BN:SP (75:25), BN:SP (50:50) and BN:SP (25:75) were 10.90, 11.07, 15.21 and 17.14%, respectively. After bleaching, brightness of BN, BN:SP (75:25), BN:SP (50:50) and BN:SP (25:75) were 37.19, 36.34, 38.12 and 39.18%, respectively (Figure 3). Among these, both unbleached and bleached handsheet of BN:SP (25:75) showed the highest brightness. The reason behind the difference in brightness was bleaching where bleaching chemicals acted as oxidants to break down residual lignin and increase its solubility.

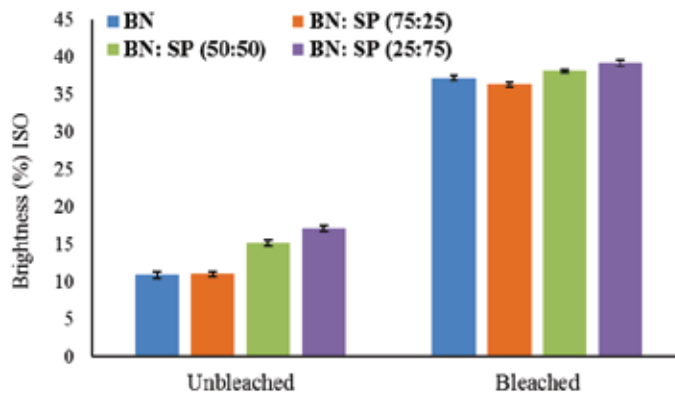


Fig. 3. Brightness (%) of different types of unbleached and bleached handsheets

Tensile index

Tensile index of unbleached handsheets of BN, BN:SP (75:25), BN:SP (50:50) and BN:SP (25:75) were 44.43, 44.34, 42.46 and 38.44 N m/g, respectively. After bleaching, tensile index of BN, BN:SP (75:25), BN:SP (50:50) and BN:SP (25:75) were 52.23, 51.78, 51.12 and 49.24 N m/g, respectively (Figure 4). Due to the hydrophobic nature, presence of lignin in the bonded area constituted a barrier to the formation of hydrogen bonds between the cellulose molecules

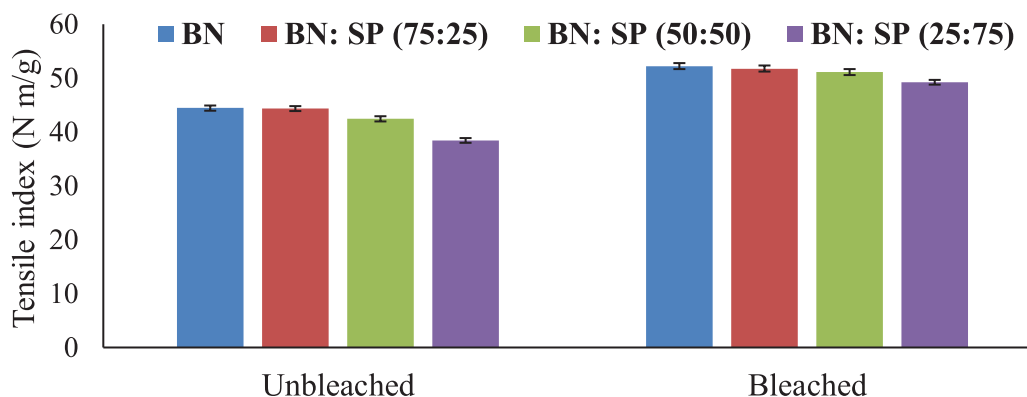


Fig. 4. Tensile index of different types of unbleached and bleached handsheets

After bleaching, the removal of lignin and exposure of cellulose resulted in more hydrogen bonds between adjacent fibers, hence, tensile index increased.

Tear index

Tear index of unbleached handsheets of BN, BN:SP (75:25), BN:SP (50:50) and BN:SP (25:75) were 3.35, 3.36, 3.38 and 3.37 mN m²/g, respectively. After bleaching, tear index of BN, BN:SP (75:25), BN:SP (50:50) and BN:SP (25:75) were 6.79, 6.85, 6.79 and 6.81 mN m²/g, respectively (Figure 5). Cellulose was exposed after bleaching due to the removal of lignin resulted in more hydrogen bonds and thus, tear index increased.

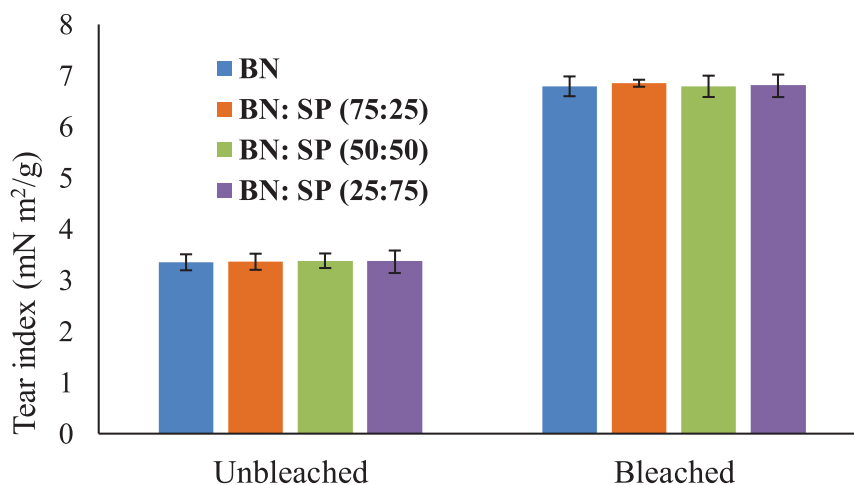


Fig. 5. Tear index of different types of unbleached and bleached hand sheets



Fig. 6. Unbleached and bleached hand sheets were used to make crafts and for painting

Conclusion

After harvesting, banana pseudo stem has always been a big problem in tropical countries, including Bangladesh. The ever growing amount of this plant has polluted and blocked the flow of water. Hence, the issue of banana pseudo stem should be looked from a different view where the real challenge is not how to get rid of this plant but how to benefit from it and turn it into a value added material. Besides, the pulp and paper industry provides employment opportunities for a vast number of people and plays a vital role in the overall economy of the country. In this study, banana pseudo stem was pulped by sodium hydroxide (NaOH). Addition of secondary pulp in the banana pseudo stem pulp had no/less impact on the properties of the handsheet. Therefore, it can be used as a source of raw material for manufacturing craft paper.

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Evaluation of Lead Induced Neurotoxicity in Mouse Brain and Other Tissues

Mahmud Hossain and Sohidul Islam

Location: Dept. of Biochemistry and Molecular Biology, University of Dhaka

Duration: One year (2016-2017)

Expenditure of the project: Tk. 2400000.00

Introduction

Lead (Pb) is a naturally occurring element that has been mined for several millennia and used to create products that meet a broad range of human needs. Its value as a gasoline additive, as a pigment for paints and glazes and its usefulness in many other products has led to widespread distribution of lead in the environment. Along with the widespread use of lead has come substantial human exposure (Canfield *et al.* 2005). As a result of industrialization, lead remains one of the most prevalent toxic metals in the environment as it remains in the human body for a long time, with a half-life of approximately 36 days in blood and it is also known to be sequestered in bone tissue with an estimated half-life of 27 years (Landrigan and Todd, 1994). Infants and young children are at particularly high risk of exposure because they engage in frequent hand-to-mouth behavior and spend a great deal of time where lead particles from deteriorating paint, gasoline emissions, and smelting operations are deposited (e.g. household floors, exposed soil) (Koller *et al.* 2004). There are several notes that the air pollution of Dhaka city became the severest when lead in the air was reported higher than in the atmosphere of any other place in the world. Other prominent sources of exposure include inhalation of emissions from vehicles using leaded fuel, ingestion of water conveyed through lead plumbing, and consumption of food that has been stored in lead-soldered cans or lead-glazed ceramics. Dozens of other sources of lead pose a threat to children, depending on their geographical location and their family's cultural practices, livelihood, and hobbies. Also, because on a kilogram per kilogram basis children drink more fluids, breathe more air, and eat more food than adults, they will accumulate more lead than an adult who is exposed at a similar level (Pocock *et al.* 1994).

Objectives

As lead can cause severe effect on children, especially on I.Q., in the present study we have used adolescent swiss albino mouse as an experimental model, and specifically hippocampal and prefrontal cortex regions were focused to understand the molecular mechanisms underpinning the behavioral alterations observed in children chronically exposed to lead at an early stage. The aims and objectives were:

- Measurement of catalase as a marker for lead induced oxidative damage of the cell;
- Measurement of one of the major neurotransmitter, dopamine to understand the neuronal activity of the brain;
- Analysis of different intermediates of the neurotransmitters to understand the level of active neurotransmitter and its consequences;
- Expression levels of apoptotic and oxidative stress associated genes after chronic lead exposure;
- Expression levels of circadian rhythm associated genes after chronic lead exposure;
- Analysis of DNA damage to understand the lethality of chronic lead exposure;
- Measurement creatinine to understand the adverse effect of lead on the kidney; and
- Measurement and comparison of ALT (Alanine aminotransferase) activity of the healthy control and different doses of lead treated mice to understand the effect of lead on hepatocellular tissues.

Methodologies

Swiss Albino mice were bought from Animal Resource Branch of ICDDR,B (International Centre for Diarrheal Disease Research, Bangladesh). Animals were acclimated for 2 weeks before use. After the acclimation, the mice were divided into several groups. In each subgroup there were 5-6 mice. Different doses (20mg/kg and 50mg/kg) of lead solution were prepared and treated the mice intraperitoneally for 28 days. Completion of the treatment, blood samples were collected by cardiac puncture for different parameter analyses. In case of neurotransmitter analysis by HPLC, and RNA isolation followed by cDNA synthesis for gene expression analysis fresh brain tissues from the targeted area (prefrontal cortex for circadian gene and hippocampus for apoptosis) were isolated. For the histochemistry analysis mice were deeply anesthetized with diethyl ether and 4% para-formaldehyde (PFA) heart perfusion was performed followed by decapitation. Mouse brain was further processed by different reagents followed by sectioning and hematoxyline-eosin staining. DNA damage was performed by ELISA method.

Results

Dopamine Assay

Dopamine is an organic molecule that functions as one of the brain's neurotransmitters—a chemical that ferries information between neurons. Dopamine helps regulate movement, attention, learning, and emotional responses. It also enables us not only to see rewards, but to take action to move toward them. Dopamine is heavily involved in the motor system. When the brain fails to produce enough dopamine, it can result in Parkinson's disease. Dopamine content in the mid brain was measured using high performance liquid chromatography (HPLC). Mice of the treatment groups showed a decline in dopamine content in a dose dependent manner (Fig. 1a).

Analysis of DOPAC and HVA level

As the dopamine level is going to decline, there are two possibilities-1. Dopamine synthesis is either decreasing, and/or, 2. Dopamine synthesis is normal, but it goes rapid degradation. 3,4-Dihydroxyphenylacetic acid (DOPAC) is a metabolite of the neurotransmitter dopamine. Dopamine can be metabolized into one of the three substances (Fig 2). One such substance is DOPAC. Another is 3-methoxytyramine (3-MT). Both of these substances are degraded to form homovanillic acid (HVA). In the present study, we have analyzed DOPAC (Fig. 1B) and HVA (Fig. 1C). We have observed that the level of HVA is significantly high which indicates that the degradation level of dopamine is relatively high compared to that of control.

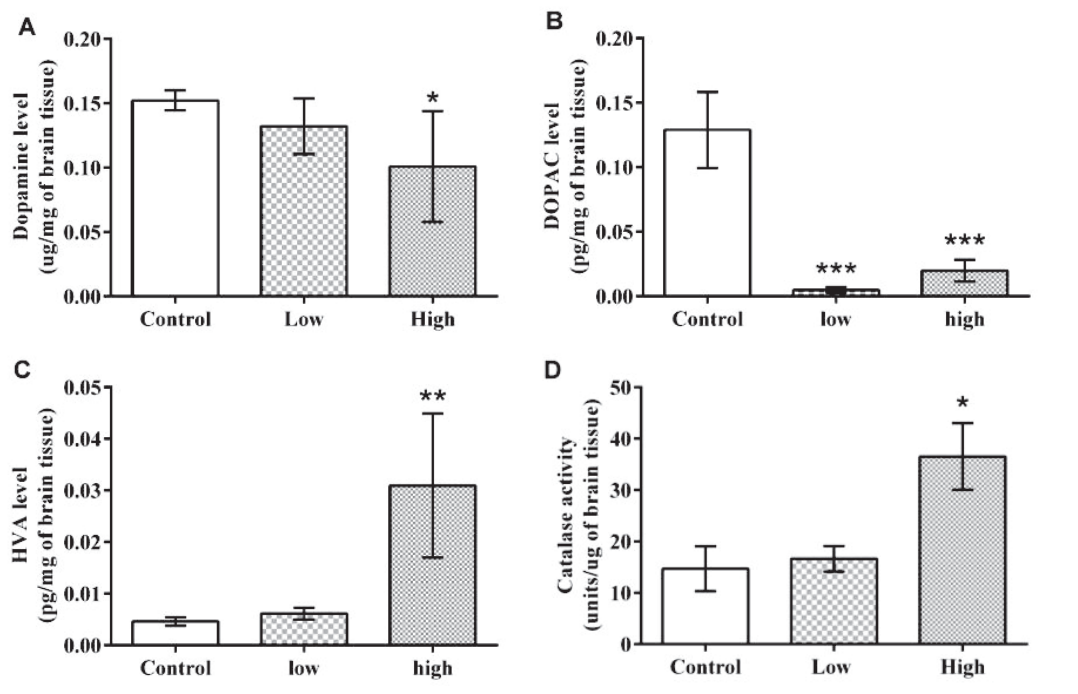


Fig. 1. Effect of chronic lead exposure on mid brain (A) Dopamine, (B) DOPAC (3,4-Dihydroxyphenylacetic acid), and (C) HVA (Homovanillic acid) levels in adolescent mice. (D) Alteration in hind brain catalase activity in adolescent mice from chronic lead exposure. (* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$)

Brain catalase assay

Catalase is an important enzyme that protects the cells from oxidative damage by reactive oxygen species (ROS). In the present study, the brain catalase assay was performed using hind brain. Mice of the treatment groups showed a dose dependent increase in catalase activity (Fig. 1D) indicates that the cells are in oxidative stress.

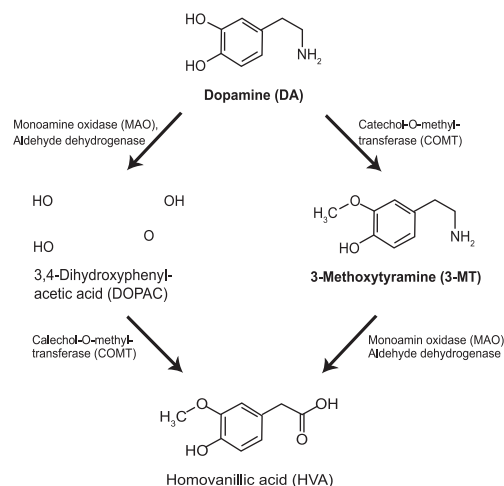


Fig. 2. Biodegradation of dopamine

Histochemical analysis

As we found that the level of catalase activity was high due to oxidative stress, there is a possibility to see the cell damage in the brain. Apoptosis is a form of programmed cell death that occurs in multicellular organisms. Biochemical events lead to characteristic cell changes

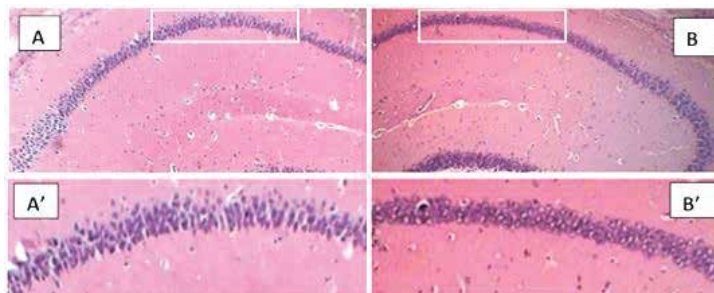


Fig. 3. Representative photomicrograph of hematoxyline-eosin staining in the CA1 area of the mouse hippocampus. White boxed area is the CA1 cell location in the hippocampus. A. Control group; B. Lead treated group. A' and B' is the white boxed magnified area.

(morphology) and death. The later stages of apoptosis are characterized by changes in nuclear morphology, including chromatin condensation, degradation of the nuclear envelope, and DNA strand breaks. The hippocampus is one of the main areas of the brain for memory and learning. We prepared the brain slices and hematoxyline-eosin stained was performed and found that the cell number is reduced as well as the morphology was altered, especially in the CA1 area in lead (II) acetate treated group compared to that of the control group (Fig. 3).

Gene Analysis for cell apoptosis

As we observed the cell damage and altered morphology in the histochemistry, to confirm our histological data in the present study, we further checked different apoptotic genes - Cas9, Cas12, SOD1, Catalase expression and found elevated levels of expression (Fig 4).

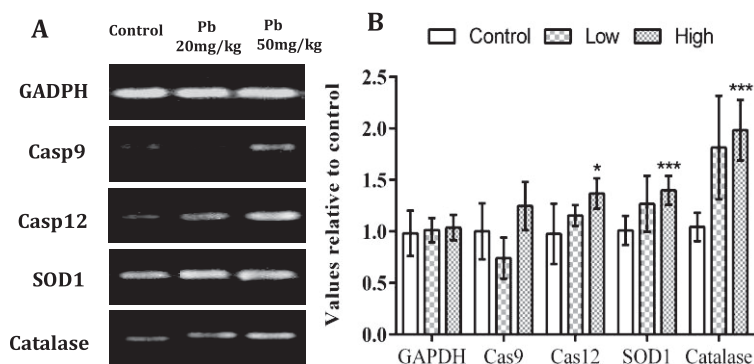


Fig. 4. Expression levels of apoptotic and oxidative stress associated genes after chronic lead exposure. (A) Representative PCR product gel electrophoresis image of different genes. Here, GAPDH was used as the housekeeping gene. (B) ImageJ software analyzed quantitative data of figure A. (* $P < 0.05$; *** $P < 0.001$)

DNA damage analysis

For further confirmation as a biomarker of oxidative DNA damage, 8-hydroxy-2'-deoxy-guanosine (8-OHdG) was measured using plasma sample. The value was assayed by 8-OHdG

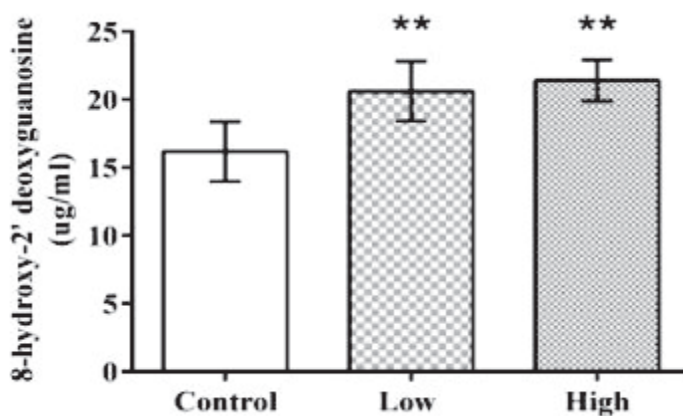


Fig. 5. DNA strand breakage analysis

EIA kit (Cayman, USA).

This assay was based on the competition between 8-OHdG and an 8-OHdG acetylcholinesterase (AChE) conjugate (8- OHdG tracer) for a limited amount of 8-OHdG monoclonal antibody. 8-OHdG Tracer and 8- OHdG bound monoclonal antibodies bound to goat polyclonal anti-mouse IgG that were previously attached to the plate well. The plate was washed to remove unbound reagents and then Ellman's reagent (which contained the substrate to AChE) was added into the well. The product of this enzymatic reaction had a distinct yellow color and the absorbance was measured at 412 nm by an ELISA reader. The amount of free 8-OHdG was inversely proportional to the color. In the present study, we have found increased DNA breakage value which supports our previous data (Fig. 5).

Circadian gene expression analysis

As we found lower levels of dopamine there is a high chance of suffering from depression. There is a link between the depression and an alteration in the body's Clock gene, which plays

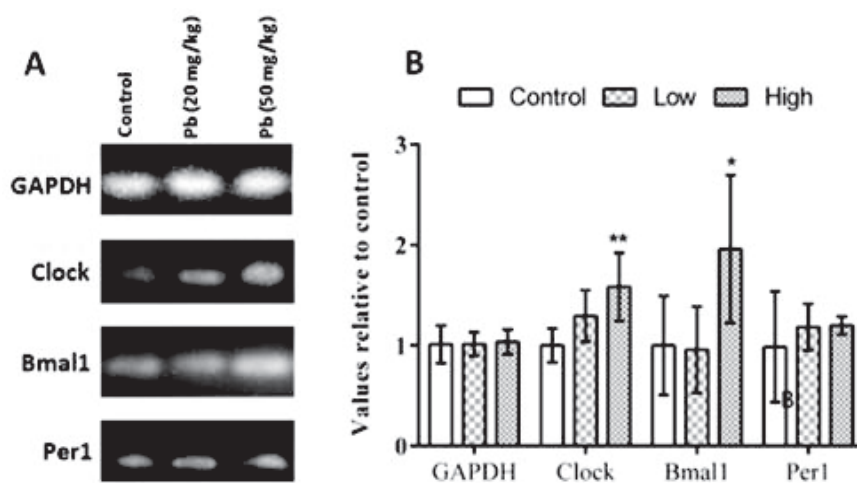


Fig. 6. Expression levels of circadian rhythm associated genes after chronic lead exposure. (A) Representative PCR product gel electrophoresis image of different genes. (B) ImageJ software analyzed quantitative data of figure A.

a role in regulating circadian rhythm. Here we have analyzed Clock, Bmal1 and Per1 gene expression was analyzed and found altered level of expression (Fig. 6).

Analysis of ALT and creatinine

The liver is one of the vital organs which play important roles in heavy metal metabolism. To address the issue of liver function ALT and to check the kidney

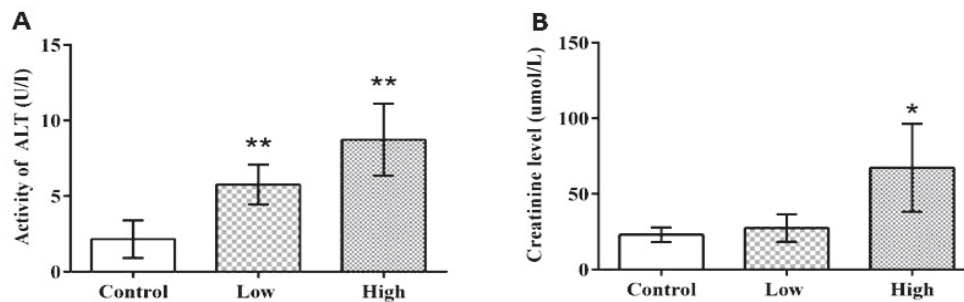


Fig. 7. Comparison of plasma ALT and creatinine of control and different doses of lead treated mouse. function creatinine was measured. We have found the increased value (Fig. 7) of both cases which indicates that both organs becomes affected due to lead toxicity.

Conclusion

We have tried our best to finish our experiments within the stipulated time and found some very interesting data which will lead us to continue some experiments in different dimensions in the future. We are preparing a manuscript to submit these interesting data in a good journal. Finally, I would like to express my gratefulness to the Ministry of Education, Government of Bangladesh; honorable reviewers; the teachers and my research fellows of my department for supporting me to conduct this project using the mouse as an experimental model.

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Enhancement of Poor Indigenous People through Aquaculture of Nutrient Rich Fish and Non-conventional Fisheries items in Homestead Ponds under Barind Tract, Northern Bangladesh

Md Mostafizur Rahman Mondol and Md Akhtar Hossain

Location: Department of Fisheries, University of Rajshahi

Duration: One year (2016-2017)

Expenditure of the project: Tk. 1000000.00

Introduction

Aquaculture contributes more than 50% of the total fish production of Bangladesh (DoF, 2015). Advancement of technologies leads aquaculture as a more profitable approach day by day. In spite of tremendous potentials, very insignificant benefits are found among the poor people in terms of nutrition, as they are only giving emphasis on making profit instead of consumption required nutrients from their homestead ponds. Carp-SIS polyculture is a proven technique in mitigating the malnutrition problem specially of the disadvantaged groups (Roos *et al.*, 1999; Roos *et al.*, 2007a,b; Kunda *et al.*, 2009). Cuchia (*Monopterus cuchia*) and freshwater bivalve (*Lamellidens marginalis*) are also important source of nutrition for the indigenous people of Bangladesh. Apart from the technology, recent climate change aspect makes some region more vulnerable than other parts of the country. Barind Tract is one of the climatically vulnerable zones, potential for aquaculture development in the homestead ponds by the poor indigenous people. Unfortunately no comprehensive research on homestead aquaculture is taken to work with the indigenous people of this area. Therefore, the present research is aimed at evaluating the nutritional enhancement of the poor indigenous people through aquaculture of nutrient rich fish and non-conventional fisheries items in the homestead ponds.

Objectives

The objectives of the present study were:

- to monitor the water quality parameters of the study ponds;
- to monitor the growth performance of fish and other non-conventional fisheries items;
- to evaluate the economics of the farming practices;
- to study the change in nutrient consumption of the households; and
- finally, to recommend suitable aquaculture strategy for nutritional enhancement of the ethnic people in the Barind Tract area.

Methodologies

The experiment was carried out in farmers' ponds at Tanoreu pazila under Rajshahi district and Nacholu pazila under Chapainawabganj district during July, 2016 and June, 2017. Pond size was ranged from 0.04 to 0.08 ha with 1.3 to 2.4 m water depth. All ponds were rain-fed, well exposed to prevailing sunlight and without an inlet or outlet.

Design of the experiment

The experiment was conducted with 4 treatments (T1-Traditional carp polyculture, T2-Carp+mola polyculture, T3-Carp+cuchia polyculture and T4- Carp+bivalve polyculture), each with 5 replicates. Replicates of each of four treatment groups were assigned by stratified random selection of ponds. In the experimental ponds different fish and bivalve species were stocked but same stocking density were maintained for carps for all of the treatments. For cuchia culture iron made cages (2.6mX 2.0mX1.67m) were developed in ponds with safety shelter.

Pond preparation and stocking

All predatory and unwanted fishes were removed from the experimental ponds by repeated netting. Ponds were prepared properly with lime (494kg/ha) and initial basal fertilization with urea (123.5kg/ha) and TSP (123kg/ha). Fingerlings were collected from a reputed fish fry trader of Amnura, Chapainawabganj. Initial length and weight of fingerlings was measured and stocking was done at early morning after 7 days of basal fertilization (Table 1).

Table 1. Species composition, initial weight and stocking density in each treatment

<i>Species</i>	Common name	Initial weight (g) (Mean \pm SD)	Stocking density (individual/ha)			
			T ₁	T ₂	T ₃	T ₄
<i>Labeo rohita</i>	Rui	95.95 \pm 14.05	1235	1235	1235	1235
<i>Gibelion catla</i>	Catla	171.64 \pm 48.72	741	741	741	741
<i>Cirrhinus mrigala</i>	Mrigel	111.29 \pm 2.97	988	988	988	988
<i>Hypophthalmichthyes molitrix</i>	Silver carp	98.75 \pm 8.95	1235	1235	1235	1235
<i>Ctenopharyngo donidella</i>	Grass carp	120.90 \pm 11.55	247	247	247	247
<i>Cyprinus carpio</i>	Carpio	97.54 \pm 5.5	494	494	494	494
<i>Barbonymus gonionotus</i>	Sarpunti	25.89 \pm 5.65	1235	5	1235	1235
<i>Amblypharyngodon mola</i>	Mola	0.85 \pm 0.13	-	49400	-	-
<i>Monopterus cuchia</i>	Kuchia	83.73 \pm 5.36	-	-	48/ cage	-
<i>Lamellidens marginalis</i>	Bivalve	14.25 \pm 1.72	-	-	-	49400

Post stocking management

Commonly available commercial fish feed was used daily at the rate of 3-4% of fish body weight. After stocking of fish urea (61.75 kg/ha) and TSP (61.75 kg/ha) were used at 7 days interval. In case of Treatment 3 *cuchia* was fed with dead fish, dry fish and meat of snails.

Water quality monitoring

Water temperature, transparency, dissolved oxygen (DO), p^H, alkalinity and free carbon dioxide (CO₂) were monitored fortnightly using the standard protocol.

Fish growth monitoring

Fishes were sampled monthly using a seine net and length and weight of 20 individuals were recorded to determine the fish growth and to adjust the feed ration. Final weight (g), Weight gain (g), Specific growth rate (SGR, %bwd-1), yield (kg/ha) and cost benefit ratio (CBR) of the fishes were calculated.

Data analysis

The data obtained in the experiment were analyzed statistically by one way ANOVA (Analysis of Variance) with Duncan Multiple Range Test (DMRT) at P<0.05 level of significance on SPSS (version-20.0).

Results

Water quality parameters

The result (mean±SD) of water quality parameters such as temperature, transparency, dissolved oxygen, p^H, CO₂ and alkalinity in different treatments are shown in Table 2. During this experiment the monthly water temperature, transparency, DO, p^H, CO₂ and alkalinity were ranged from 18.7 to 28.6°C, 22.5 to 31.5cm, 5.1 to 7.0 mg/l, 6.3 to 7.7, 5.1 to 8.7 mg/l and 46.5 to 70.5mg/l, respectively. The water quality parameters measured during the experiment were within the suitable range for fish culture and did not differ significantly among the treatments (P<0.05).

Fish growth, production performance and economics

In the present experiment all the fish and bivalve species showed a significant monthly growth performance (P<0.05). After 9 months culture period the mean final weight of *L. rohita*, *G. catla*, *C. mrigala*, *H. molitrix*, *C. idella*, *C. carpio* and *B. goniontus* was ranged from 648.2 (T₂) to 680.2 g (T₄), 702.52 (T₂) to 784.69 g (T₄), 517.43 (T₂) to 557.62 g (T₁), 781.50 (T₃) to 796.42 g (T₄), 603.22 (T₃) to 675.15 g (T₄), 623.15 (T₃) to 657.32 g (T₄), and 150.45 (T₂) to 165.23 g (T₄), respectively (Table 2). The mean final weight 2.80g, 265.75g and 25.5g was recorded for *A. mola*, *M. cuchia* and *L. marginalis*, respectively (Table 2). Among all species silver carp attained the maximum weight at harvest. Among all the treatments mean weight gain of the carps was higher in treatment T₄ and lower in T₂ (Figure 1). The highest specific growth rate (SGR, %bwd-1) was observed for silver carp (0.77-0.78) and lowest for catla (0.53-0.57). The survivality (%) of *L. rohita*, *G. catla*, *C. mrigala*, *H. molitrix*, *C. idella*, *C. carpio*, *B. goniontus*, *A. mola*, *M. cuchia* and *L. marginalis* was ranged from 89-92, 89-91, 88-90, 81-84, 83-88, 76-86, 75-78, 55, 51 and 87, respectively. During this experiment the yield of carps was estimated as 3605.05 kg/ha, 3449.94 kg/ha, 3540.37 kg/ha and 3625.66 kg/ha in treatment T₁, T₂, T₃ and T₄, respectively.

The yield of *A. mola*, *M. cuchia* and *L. marginalis* was 138.32kg/ha, 444.6kg/ha and 1259.6 kg/ha, respectively. Cost benefit ratio were 1:0.37, 1:0.38, 1:0.41 and 1:0.50 was calculated for T₁, T₂, T₃ and T₄, respectively (Fig. 2).

Table 2. Mean values of water quality parameters of experimental ponds under four different treatments

Parameters	Treatments			
	T ₁	T ₂	T ₃	T ₄
Temperature (°C)	25.5±3.7	25.2±2.5	24.8±2.4	24.8±4.1
Transparency (cm)	25.9±2.7	26.9±3.1	26.3±2.0	26.1±2.9
DO (mg/l)	6.3±0.6	5.9±0.5	6.5±0.7	6.6±0.8
pH	7.3±0.4	7.5±0.6	7.1±0.3	7.2±0.7
CO ₂ (mg/l)	7.2±1.8	7.5±1.3	7.1±1.1	6.8±1.4
Alkalinity (mg/l)	61.8±7.9	68.3±5.6	65.8±5.2	70.1±5.3

Table 3. Growth performance of fish and bivalve as obtained from different treatments during the experiment (9 months culture period)

Fish/bivalve species	Final weight (g)			
	T1	T2	T3	T4
Rui (<i>L. rohita</i>)	678.2±53.25	648.2±33.25	650.48±63.25	680.2±75.92
Catla (<i>G. catla</i>)	758.67±148.25	702.52±104.25	778.61±108.22	784.69±133.28
Mrigel (<i>C. mrigala</i>)	557.62±65.41	517.43±55.48	535.53±50.12	542.62±65.40
Silver carp (<i>H. molitrix</i>)	781.50±127.52	784.50±152.45	795.50±127.15	796.42±175.25
Grass Carp (<i>C. idella</i>)	673.78±163.91	623.52±138.36	603.22±85.21	675.15±76.52
Mirror carp (<i>C. carpio</i>)	645.40±105.25	625.35±65.44	623.15±65.05	657.32±135.47
Sarpunti (<i>B. goniontus</i>)	165.23±54.52	150.45±44.65	155.23±62.63	156.27±42.62
Mola (<i>A. mola</i>)	-	2.80±1.59		
Kuchia (<i>M. cuchia</i>)	-		265.75±76.35	
Bivalve (<i>L. marginalis</i>)	14.25±1.72	-		25.5±9.25

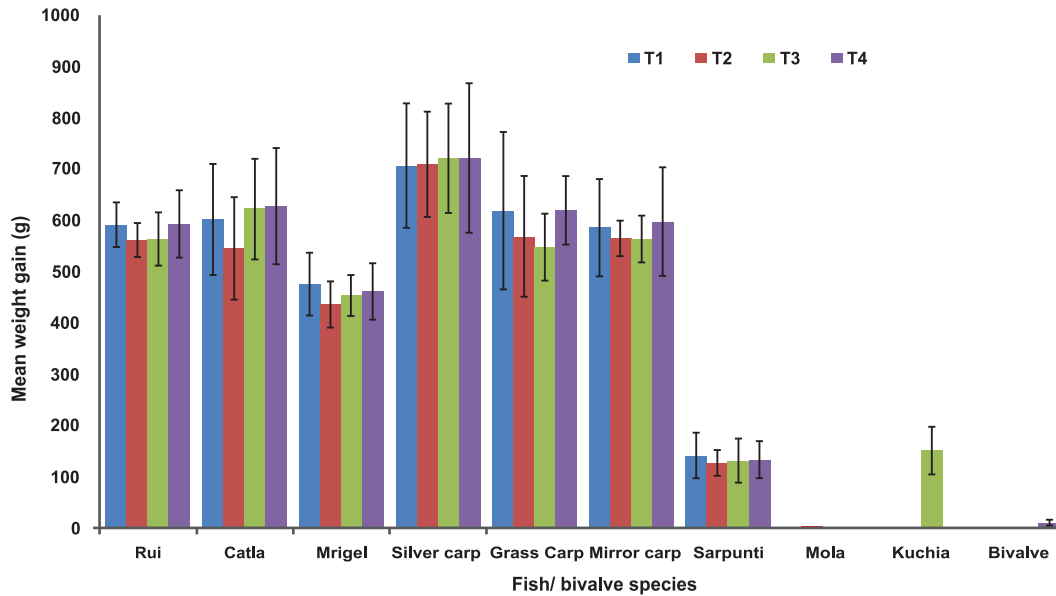


Fig. 1. Mean (\pm SD) weight gain (g) of fish and bivalve during the experiment

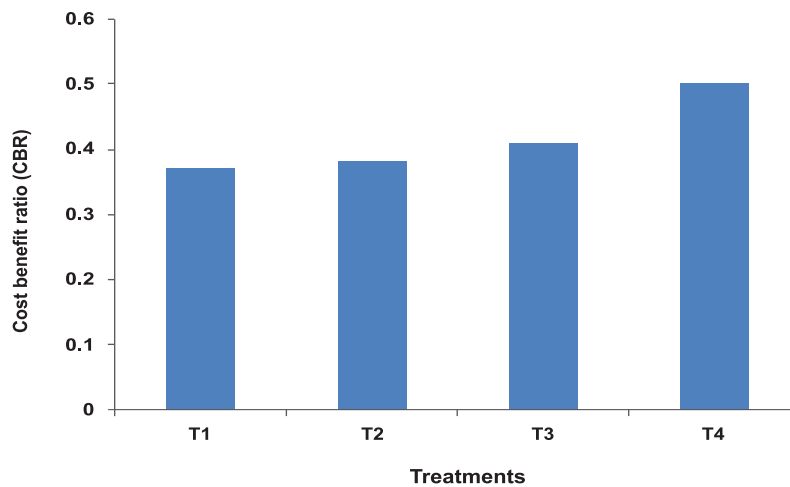


Fig. 2. Cost benefit ratio (CBR) in different treatments

Conclusion

Most of the indigenous people (Swantal) in the Barind Tract region are poor and facing nutritional deficiency. Fish is the major animal protein contributor and cheapest nutritional item in Bangladesh. The poor indigenous people (Swantal) in the Barind Tract region do not practice scientific fish culture, they usually stock some fish in their household ponds and then harvest and consume. That's why their aquaculture production is very low, which is unable to supplement their nutritional demand properly. From this research project the selected pond owner groups came to know about scientific fish culture through different fish culture training.

The fish production of the selected household ponds increased many folds from their earlier production, which enhanced per capita fish consumption of the selected farmer's family that ultimately enhanced their nutritional status. Among the four different treatments higher growth performance, production and CBR of the fishes in the treatment four (carp-bivalve aquaculture) explored a new dimension for the indigenous community as they preferably eat bivalve for their nutrition and it could be a better aquaculture option for the indigenous people in the Barind Tract region to meet up their nutritional demand. Further extensive research work is needed for the development of sustainable carp-bivalve aquaculture technology in the Barind Tract region of northern Bangladesh.

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Antinociceptive and Anti-Inflammatory Effect of *Nigella sativa* in Rats

Noorzahan Begum and Ismoth Ara Jerin

Location: Department of Physiology, Bangabandhu Sheikh Mujib Medical University, Dhaka

Duration: One year (2016-2017)

Expenditure of the project: Tk. 618000.00

Introduction

Pain is a subjective experience that destroys the quality of life. Renowned German Physician Albert Schweitzer described pain as “a more terrible lord of mankind than even death itself”. Pain is generated by the extensive and parallel neural networks in the brain on the basis of multiple inputs from sensory systems and from different brain areas (Melzack 1990). Pain has been defined by the International Association for the Study of Pain (IASP) as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage” (Loeser and Treede 2008). Nociceptive pain is caused by activation of nociceptors (Loeser and Treede 2008) by intense stimuli (Woolf 2010). Nociceptors have characteristic thresholds or sensitivities (Julius ad Basbaum 2001) which act as a key early warning system against tissue damage (Woolf 2004).

However, if tissue damage is inevitable and occurs despite the nociceptive withdrawal response, the focus shifts from protection of tissue to promotion of healing of the damaged tissue through inflammation (Woolf 2004).

For thousands of years, *Nigella sativa* has been used in many Asian, Middle Eastern and Far Eastern countries as a spice and food preservative as well as a protective and health remedy for the treatment of numerous disorders (Chopra *et al.* 1956; Nadkarni 1976, cited in Gali-Muhtasib, El-Najjar, Schneider-Stock 2006).

The seed of this plant is commonly known as black seed and is referred by prophet Mohammed (PBUH) as having healing powers and remedy of every illness except death (Sahih Al-Bukhari 71:591,592; Sahih Muslim 26:5489).

Analgesic and anti-inflammatory drugs are causing a lot of unwanted effects like gastritis, gastric ulcers and renal damage (Bashir and Qureshi 2010). In recent years, many studies have been conducted throughout the world to find alternatives to the traditional analgesic drugs to replace them so that their adverse effect can be minimized. The *Nigella sativa*, have shown both antinociceptive (Abdel-Fattah *et al.* 2000; Al-Ghamdi 2001; Hajhashemi, Ghannadi and Jafarabadi 2004) and anti-inflammatory effects (Houghton *et al.* 1995; Mutabagani and El-Mahdy 1997; Al-Ghamdi 2001).

However, to the best of our knowledge, no published data are available in assessing the analgesic and anti-inflammatory effects of single supplementations of *Nigella sativa* oil in increasing doses like 0.5 ml/kg, 1 ml/kg and 1.5 ml/kg of body weight in rats.

On the basis of this background, this study has been designed to evaluate the effects of single supplementations of *Nigella sativa* oil in increasing doses like 0.5 ml/kg, 1 ml/kg and 1.5 ml/kg body weight in rats.

Objectives

General Objective

To assess the effects of *Nigella sativa* oil against nociceptive and inflammatory pain as well as inflammation after single dose administration with increasing doses in rats.

Specific Objectives

- To assess the effects of single dose administration of *Nigella sativa* oil in 3 different doses (0.5, 1, 1.5 ml/kg body weight) on pain by the tail immersion, formalin and writhing test in different groups of rats;
- To assess the effects of the *Nigella sativa* oil on inflammation by the paw edema test in the aforementioned groups of rats;
- To assess all the study variables in weight and strain matched control rats for comparison; and
- To compare all the study variables among all the groups in order to evaluate the consistent pain reducing efficacy of *Nigella sativa* oil with the increment of doses.

Methodologies

This study was carried out in the department of Physiology at Bangabandhu Sheikh Mujib Medical University (BSMMU) under continuous supervision and monitoring by the faculty members from 1st January, 2016 to 31st December, 2016.

Ethical Clearance

The protocol of this study involving animal subjects was submitted to the Institutional Review Board (IRB) of Bangabandhu Sheikh Mujib Medical University (BSMMU) for approval before commencing the actual study. It received a certificate of approval from IRB after proper review by the members of IRB.

Study design

This study was a experimental interventional study. Intervention was given (*Nigella sativa* oil) to animal subject before performing pain evaluation test.

Sample size

Using the following statistical formula –

$$n = \frac{(Z_{\alpha} + Z_{\beta})^2 \times (\sigma_1^2 + \sigma_2^2)}{(\mu_1 - \mu_2)^2} \quad (\text{Kirkwood, 1998})$$

Z_{α} (Type I Error)	= 1.96	Z_{β} (Type II Error)	=0.85
μ_1 (Mean of one group)	=0.68	μ_2 (Mean of another group)	=3.2
σ_1 (SD of one group)	=0.31	σ_2 (SD of another group)	=4.26

(Ainan, 2015)

Therefore,

$$n = 4 \text{ (in each subgroup)}$$

Considering 10% discretion of study population

So the targeted sample size was 5 in each subgroup

Grouping

On the basis of doses of drug administration, the rats were divided as follows:

Group A (**Control**) : Consisted of 15 rats and received 1% solution of Tween 20 (10ml/kg body weight.)

Experimental Group

Group B1 : Consisted of 15 rats and received Nigella sativa oil 0.5ml/kg body weight in equal volume to that of 1% solution of Tween 20.

Group B2 : Consisted of 15 rats and received Nigella sativa oil 1ml/kg body weight in equal volume to that of 1% solution of Tween 20.

Group B3 : Consisted of 15 rats and received Nigella sativa oil 1.5ml/kg body weight in equal volume to that of 1% solution of Tween 20.

According to pain evaluating test performed, each of the above groups (15 rats) were further divided into three (3) subgroups a, b and c, consisting of five (5) rats in each.

- Aa, B1a, B2a, B3a - Five (5) rats were undergone tail immersion test.
- Ab, B1b, B2b, B3b - Five (5) rats were undergone formalin test and paw edema test.
- Ac, B1c, B2c, B3c - Five (5) rats were undergone writhing test.

Study Procedure

After collection, all the rats were acclimatized for initial 7 days in the laboratory environment. Then on the 7th day, on the basis of doses of supplementation, the rats were divided into Group A, B1, B2, and B3. Then after 1 hour, subgroups (Aa, B1a, B2a, B3a) undergone tail immersion test, (Ab, B1b, B2b, B3b) formalin test and (Ac, B1c, B2c, B3c) writhing test, respectively for measurement of pain variables. Immediately after these pain evaluation tests, all the rats were euthanized. Then inflammation was measured by formalin induced paw edema test in Group (Ab, B1b, B2b, B3b).

Test performed

Tail immersion test

(Le Bars, Gozariu and Cadden 2001; Vogel 2002; Lin *et al.* 2005; Steinmiller and Young 2007; Ahmadi *et al.* 2010; Ali *et al.* 2012)

For the acclimitization to the test environment, all the rats belonging to the subgroup Aa, B1a, B2a, B3a were marked for tail immersion test and were placed in the plexiglass mechanical restraining cage for five (5) minutes daily for 7 consecutive days, prior to the test. On the day of experiment, all the rats were placed individually in the plexiglass mechanical restraining cage with the tail hanging freely. Then, it was allowed for a period of five minutes to adjust the cage environment. Then, 400 ml of preheated water at $52\pm 0.1^{\circ}\text{C}$, was taken in a 500 ml beaker with a laboratory thermometer placed inside. Then the distal 5 cm of the tail of each rat was immersed into it and the latency of tail withdrawal was recorded. The mean of the measurements obtained from three (3) similar consecutive maneuvers, performed at five (5) minutes interval, was taken as baseline latency. Instantly thereafter, the rat was taken out side of the restrainer and intraperitoneally injected with 1% solution of Tween 20 or Nigella sativa oil 0.5 ml/kg or 1 ml/kg or 1.5 ml/kg body weight. Then 1 hour later, again three (3) successive tail withdrawal latency at 5 minute intervals were measured, and their mean was noted as the test latency. To minimize tissue damage, a maximum latency of fifteen (15) seconds was considered as cut-off time.

The antinociceptive effect was represented by percentage of maximum possible effect (% MPE) which was calculated as follows:

Peroxidase part is self-dependent whereas cyclooxygenase part depends on peroxidase. PCT, a better electron donor, reduces an iron cation in protophophyrin IX radical in the left part (POX) of the Fig. 5 that are liable to lower the amount of Tyr385* formation. Lower amount of Tyr385* will generate lower amount of COX enzymes, acting as COX inhibitor. However, COX inhibition by PCT is difficult in the presence of high peroxide levels although toxic hydrogen peroxide is converted into water in presence of peroxidase [Thomas]. The most negative (Mulliken) atomic charges on phenolic oxygen (Ar-O-H) and carbonyl oxygen ($=\text{C}=\text{O}$) are -0.225 and -0.350 respectively. Bond distances and bond angles of the optimized geometries and X-ray crystallographic structure of PCT [Beyer] are within the difference of <1.1% and <1% respectively (Fig.3).

Thermodynamic and electronic properties of PCT at the varied equilibrated geometries emerging from the computational chemistry approach are well interpretable. This might unveil a new avenue to further enhance the inner understanding of many unresolvable functions and metabolic activities in the Bio-, Medicinal and Pharmaceutical Chemistry. PCT displays an excellent safety profile within its usual therapeutic range. However, the major negative aspect of PCT is its ability induces serious, even fatal, hepatotoxicity above the usual therapeutic range. The mechanism of this toxicity is somewhat known and results from the depletion of endogenous glutathione and subsequent shunting of PCT metabolism from benign to toxic pathways [Dewar]. However, further analysis of the calculation is underway to address the issues in a more sophisticated way.

Conclusion

Despite having a moderately effective analgesic and antipyretic effect, paracetamol causes hepatotoxicity and nephrotoxicity if overdosed. The mechanism of paracetamol's adverse effects is fairly well understood. The drug is metabolized by different hepatic pathways to produce PCTS, PCTG, and NAPQI. Here, attempts were made to analyze critically the antioxidant behaviors of paracetamol and its metabolites by using advanced quantum chemical calculations. The geometrical and physicochemical characteristics have been determined to find out the factors affecting the antioxidant activity. Moreover, physicochemical properties such as total energy, binding energy, heat of formation, hydration energy, energy of HOMO, energy of LUMO, the Energy gap between LUMO-HOMO and dipole moment have been calculated. PCT is a kind of phenol which is a strong reducing agent. Our study reveals that two of the metabolites of PCT, PCTS and NAPQI might be considered as better antioxidant after degradation in human body (smaller EL-EH gap) which is supposed to inactivate COX enzymes by converting them to their inactive oxidized forms. Binding of PCT with selective protein is underway which is very case-sensitive and time consuming. But additional investigations based on experimental, clinical and theoretical aspects are required to resolve the unexplored phenomena of such kind of drug. On the basis of the information gained from the study, paracetamol with attaching other substituents could give viable alternative that can be screened and treated in more diverse ways in the field of medicinal chemistry. In addition, extensive works on kinetics, hydrolysis pathways and molecular docking of few antibiotics and antimicrobial drugs are underway to fulfill the remaining key objectives.

Publication from this Research

Uddin, M. N., Siddique, Z. A., Nobuyuki, M., Moniruzzaman, Wahhida, S. 2018. Oxotitanium (IV) complexes of some bis-unsymmetric Schiff bases: Synthesis, structural elucidation and biomedical applications. *Applied Organometallic Chemistry*.

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Removal of Toxic Metal Ions and Residual Dyes from the Effluent of Leather and Textile Industries- A Computational Investigation Using the First-Principle Approaches

Md Saiful Islam and Tapas Debanth

Location: Department of Theoretical and Computational Chemistry, Dhaka University

Duration: One year (2016-2017)

Expenditure of the project: Tk. 1890000.00

Introduction

There are several textile and leather industries in Bangladesh. Different types of dyes, (Ahmed *et. al.*, 1973) such as Alizarin, Congo red, Malachite green etc. and metal ions, such as aluminium, chromium, lead, manganese, titanium etc. are used in these industries. A certain portion of dyes applied in textile and leather industries are used and remaining unused portion of dyes is known as residual dyes. The residual dyestuffs from different sources especially tannery and textile industries are considered as organic pollutants which, when exposed into the natural resources contaminate soil and water systems. The unused dyes such as alizarin from the textile industries and heavy metal ions, such as chromium ion are going to the river through the drainage system. So, this dyes and heavy metal ions pollute rivers and ground water, damage human health and environment (Komiha *et. al.*, 2002). Alizarin is used in its complex form in the textile industries as a mordant dye. Presence of certain functional groups in the dye molecule causes its coordination to the metal ion (Vankar 2000). Chromium ion can bind with the alizarin molecule through ionic bond and/or dative covalent bond (Komiha *et. al.*, 2002). If the effluents from textile and leather industries are mixed together then it is expected that the chromium ion may bind the alizarin dye and thus unused dye and toxic metal ion can be removed.

Objectives

The present project aims to investigate the binding of toxic metal ions with dyes used in textile and leather industries through computational methods. The goals of the project are:

- Explore the binding site of dye molecule. There are various probable sites in the dye staffs and metal cations can bind with dye at their different oxidation states. Our main objective is to establish a model to find the most effective binding site of the organic dye and the relative binding strength of the cations with dye staffs;
- Study the thermodynamic stability of various oxidation and spin states of the metal cations bound to the dyestuffs. This will enable us to determine the stability of metal ion-dyes complexes;
- Design the catalytic oxidative removal processes of toxic metals and dyestuffs; and
- Study the effect of solvent on the metal ion-complex formation.

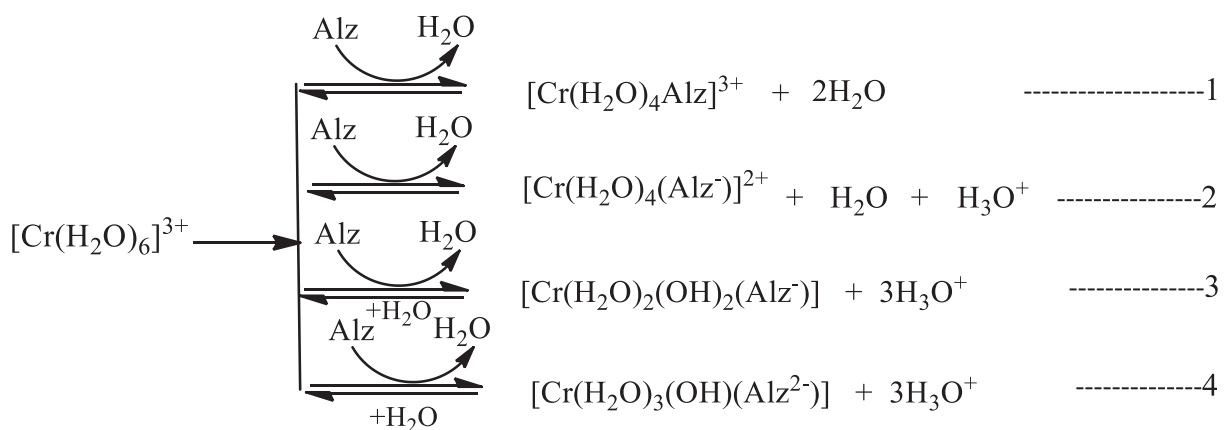
Methodologies

All calculations were performed with the Density Functional Theory (DFT) using Gaussian program. Density functional theory (DFT) is a quantum mechanical theory used in chemistry to investigate the electronic structure (principally the ground state) of many-body systems, in particular atoms, molecules, and the condensed phases. However, DFT can produce accurate results with relatively small basis sets. DFT has become the most popular and versatile method in computational chemistry, accounting for approximately 90% of all calculations today.

6-31G* [or 6-31G(d)] is 6-31G with added d polarization functions on non-hydrogen atoms. Polarization functions particularly important in achieving basis set convergence with correlated methods. The core orbitals are each represented by one basis function, each composed of six Gaussians (“6”). The polarization functions (*) are present on “heavy atoms”—those beyond helium. The geometries of all reactants and products were fully optimized in the gas phase at the B3LYP/6-31G(d) level of theory. We have used GaussView program to visualize optimized structures, HOMO, LUMO and ESP maps for all complexes.

Results

Since the textile dye (alizarin) and the metal ion (Cr^{3+}) both exist in aqueous medium, following reaction schemes have been considered and quantum chemical calculations were performed accordingly.



Quantum chemical calculations on Cr^{3+} - alizarin (alz) complexes for both doublet and quartet spin states of Cr^{3+} were done and the results are presented in the table 1.

Table 1. Energies of the optimized structure of the complexes of different spin state calculated at DFT/B3LYP/6-31G(d) level of theory.

Complex	Doublet/au	Quartet/au
$[\text{Cr}(\text{H}_2\text{O})_4\text{Alz}]^{3+}$	-2188.07818	-2188.11661
$[\text{Cr}(\text{H}_2\text{O})_4(\text{Alz}^-)]^{2+}$	-2187.98631	-
$[\text{Cr}(\text{H}_2\text{O})_2(\text{OH})_2(\text{Alz}^-)]$	-2187.35533	-2187.39208
$[\text{Cr}(\text{H}_2\text{O})_3(\text{OH})(\text{Alz}^{2-})]$	-2187.34119	-2187.37805

It is seen that, all of the complexes have lower energy in the quartet state than in the doublet state.

Reaction Energy

We calculated the reaction energy (ΔE_r) according to the following equation,

$$\Delta E_r = \{\Delta E([\text{Cr}(\text{H}_2\text{O})_4(\text{Alz})]^{3+}) + \Delta E(2\text{H}_2\text{O})\} - \{\Delta E([\text{Cr}(\text{H}_2\text{O})_6]^{3+}) + \Delta E(\text{Alz})\}$$

Calculations of the reaction energy, ΔE_r for the reaction 1 is shown below:

$$= [-2188.11661 + 2 \times (-76.38777)] - [-1501.77699 - 839.01881] \text{ au}$$

$$= -2188.11661 - 152.77554 + 2340.79580 \text{ au}$$

$$= -0.09635 \text{ au}$$

$$= -60.46 \text{ kcal/mol}$$

Reaction energies of all reaction scheme is presented in the table 2.

Table 2. Reaction energies of all complexation reactions

Reactions	Reaction energy / kcalmol ⁻¹
1	-60.46
2	-
3	-103.00
4	-94.20

Reaction 3 is more exothermic than the other reaction. So, the reaction 3 is more favorable than the other reactions.

Optimized structure of all complexes are shown in the figure 1.

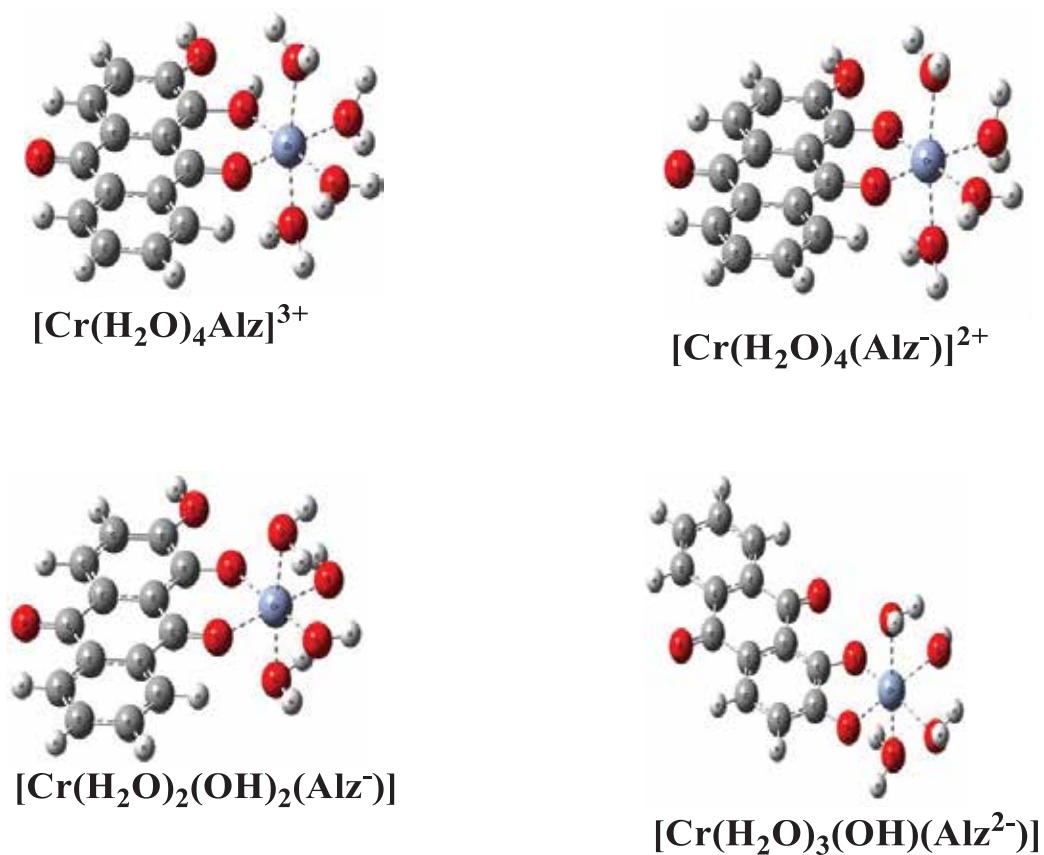


Fig. 1. Optimized structures of Cr(III) with alizarin complexes.

Binding energy

Binding energies of chromium ion-alizarin complexation gas phase have been evaluated and presented in the table 3. These energies are calculated as the difference between the energies of Cr^{3+} and deprotonated alizarin on one hand and the energies of the complexed on the other hand:

$$E_c = E_{\text{Cr-Aliz}} - (E_{\text{Aliz}^-} + E_{\text{Cr}^{3+}})$$

Where, Alz = Alizarin, Alz^- = deprotonated Alizarin

Table 3. Complexation energies for the Cr³⁺-alizarin complexes

Complex	Cr ³⁺	E(Cr ³⁺) (au)	E(Cr-Aliz) (au)	E(aliz) (au)	E _c (au)
[Cr(H ₂ O) ₄ Alz] ³⁺	Doublet	-1042.12956	-2188.07818	-839.22142	-306.72720
	Quartet	-1042.25599	-2188.11661		-307.50890
[Cr(H ₂ O) ₄ (Alz ⁻) ²⁺	Doublet	-1042.12956	-2188.98631	-838.56453	-307.29222
	Quartet	-1042.25599	-		-
[Cr(H ₂ O) ₂ (OH) ₂ (Alz ⁻)]	Doublet	-1042.12956	-2187.35533	-838.56453	-306.66124
	Quartet	-1042.25599	-2187.39208		-306.57156
[Cr(H ₂ O) ₃ (OH)(Alz ²⁻)]	Doublet	-1042.12956	-2187.34119	-837.81285	-307.39878
	Quartet	-1042.25599	-2187.37805		-307.30921

It is seen that, the highest complexation energy is for Cr(H₂O)₂(OH)₂(Alz⁻) complex. So, this complex is more favorable to form while effluents from textile and leather industries are mixed together.

Electronic properties

The chemical hardness is useful to rationalize the relative stability and reactivity of chemical compounds. For chemical hardness (η) is given by the equation (Pearson, 1987),

$$\eta = 1/2 (I - A)$$

Where, I and A are the vertical ionization energy and the vertical electron affinity respectively. According to the Koopman theorem (Koopmans, 1933), the ionization energy and electron affinity can be equalized through Highest Occupied Molecular Orbital (HOMO) and Lowest Unoccupied Molecular Orbital (LUMO) orbital energies ($EA = -E_{\text{HOMO}}$ and $IP = -E_{\text{LUMO}}$). $\eta = 1/2 (E_{\text{LUMO}} - E_{\text{HOMO}})$

Computed values of frontier molecular orbital (HOMO, LUMO) energies and chemical hardness is given in the table 4.

Table 4. The computed electronic properties of Cr(III) complexes.

Complexes	HOMO/ eV	LUMO/ eV	Gap energy/ eV	Hardness
[Cr(H ₂ O) ₄ Alz] ³⁺	-0.576	-0.508	0.068	0.034
[Cr(H ₂ O) ₂ (OH) ₂ (Alz ⁻)]	-0.203	-0.103	0.100	0.050
[Cr(H ₂ O) ₃ (OH)(Alz ²⁻)]	-0.185	-0.070	0.115	0.057

From the Table 3, the large HOMO-LUMO energy gaps for [Cr(H₂O)₃(OH)(Alz²⁻)] suggests higher stability and chemical hardness for the titled complex. Indeed the chemical hardness of the [Cr(H₂O)₄(Alz)]³⁺ complex is smallest, which indicates that these complexes is more unstable than the other studied chromium(III) complexes.

Electrostatic Potential (ESP) Map

An Electrostatic Potential (ESP) Map is a representation of electron density in the molecule. ESP maps allow an easy visualization of the distribution of charge in a molecule. Typically, the color scheme selected for ESP maps designates red corresponding to regions of high electron density and blue corresponding to regions of low electron density, with yellow and green intermediate levels.

Conclusion

Formation of all of the species of Cr(III)-alizarin is energetically favourable. Therefore, modelling by quantum chemical calculations clearly show that toxic heavy metal ion i.e., chromium ion easily bind with the textile dye i.e., alizarin. On the basis of this modelling, one can design experimental set-up with the aim of removing toxic metal ion and residual dye. Study of the gas phase binding energy, show that $[\text{Cr}(\text{H}_2\text{O})_2(\text{OH})_2(\text{Alz}^-)]$ is the most stable complex.

Publications from this Research

Islam, M. S., Debnath, T., Aziz M. A. and Islam M. S. 2018. Computational investigation of the Cr(III)-alizarin complex, 4th Conference of Bangladesh Crystallographic Association.

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Study on the Properties of Molecular Drugs and Compounds by Advanced Computational Chemistry Software

Zainul Abedin Siddique

Location: Department of Chemistry, Chittagong University

Duration: One year (2016-2017)

Expenditure of the project: Tk. 580000.00

Introduction

Paracetamol (PCT) is widely known as over-the-counter (OCT) drug due to its analgesic (pain relieving) and antipyretic (fever reducing) characteristics which are comparable to actions of other Non-steroidal anti-inflammatory drugs (NSAID). The multifaceted behaviours, mode of actions and application of the medicinal drugs and their metabolites/ degradants have been studied by advanced quantum chemical calculations, especially using GAUSSIAN 16. The search for a new drug replacing the present one (paracetamol) needs a mechanistic assay for the screening or thorough investigation of the compounds by molecular modeling, combinatorial chemistry or any other means. Without the pinpoint understanding and knowledge about the molecular target and mechanism, it is onerous to vie for a suitable alternative drug. So the present study is a quantum chemical approach with molecular modeling to search out and compare the possible mechanism of diversified actions of such kind of drugs. Considering the unexplored issues, the objective of this part of work is to find out the ways of preferable mechanism of action of paracetamol and its principal metabolites, temperature effect on the antipyretic activity, antioxidant behaviour, binding capability with selective protein and viability of the kind of quantum chemical calculation for having in-depth study of such drugs. This will add a unique milestone in drug discovery, health science, microbiology, chemical science and other branches of Physical Sciences as well.

Objectives

This work is aimed to understand, use and apply the novel concepts of molecular modeling and quantum chemical calculations, i.e. computational chemistry in diversified fields of basic science. So, the primary objectives are:

- Find out the ways of functions and mechanism of actions of drugs/ compounds;
- Characterize the binding capability of the drugs with selective protein in order to design new drugs as well as to elucidate fundamental physicochemical and biochemical processes; and
- Understand the anti-oxidant behavior.

Methodologies

The geometries of PCT and its principal metabolites [e.g., paracetamol sulphate (PCTS), paracetamol glucuronide (PCTG), N-acetyl-p-benzoquinone imine (NAPQI)] have been optimized by using semi-empirical, Hartree-Fock (HF) and finally density functional theory (DFT) employing Becke's exchange functional [Becke] combining Lee, Yang and Parr's (LYP) correlation functional [Lee, Yang, Parrs] with 6-311G(d,p) basis set. An RMS gradient of 0.001 was fixed as a terminating condition. Optimized geometries are compared with the experimental data that has amply been proven to give excellent ground state geometries [Beyer, Foresman]. Energies of HOMO and LUMO, the heat of formation, total energy, binding energy, hydration energy and dipole moment values were calculated from single point calculations (ab initio) at the global minimum. Monte Carlo Simulation in Hyperchem 8.0 was employed for temperature dependent study [Allen, Metropolis]. Monte Carlo simulations using all functions by repeated application of a computational algorithm that generates a new configuration from the current geometry which gave the equilibrium structures and average thermodynamic properties of the molecule at the varied temperatures.

Results

PCT is known to be metabolized through different pathways (non-toxic and toxic) but dominantly by conjugation with sulphate and glucuronic acid to form 4-acetamidophenol sulphate (PCTS) and 4-acetamidophenol glucuronide (PCTG) respectively (Fig. 1). The toxic pathway is accelerated due to the formation of increased amount of N-acetyl-p-benzoquinone imine (NAPQI) (Fig. 2) [Thomas].

The anti-oxidant mechanism and properties changed due to the structural modification of PCT and its metabolites at various temperatures are studied from a different dimension.

Monte Carlo calculation is a temperature dependent method that was used in this study. It is still uncertain whether PCT itself or any of their metabolites can work suitably at the appropriate temperature range. Total energy (kcal/mol), binding energy (kcal/mol), hydration energy (kcal/mol), heat of formation (kcal/mol), dipole moment (Debye), energies of HOMO-LUMO (eV) for paracetamol and its metabolites: PCTS, PCTG and NAPQI (N-acetyl-p-benzoquinone imine) are calculated at a certain temperature.

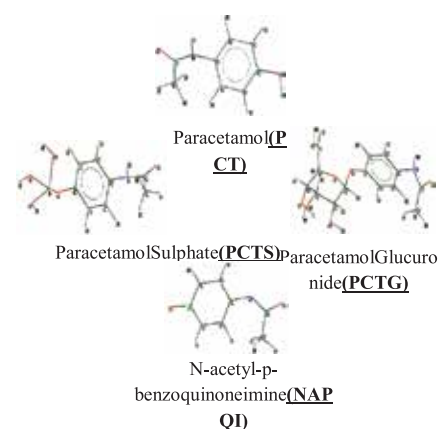


Fig.1. Paracetamol and its metabolites

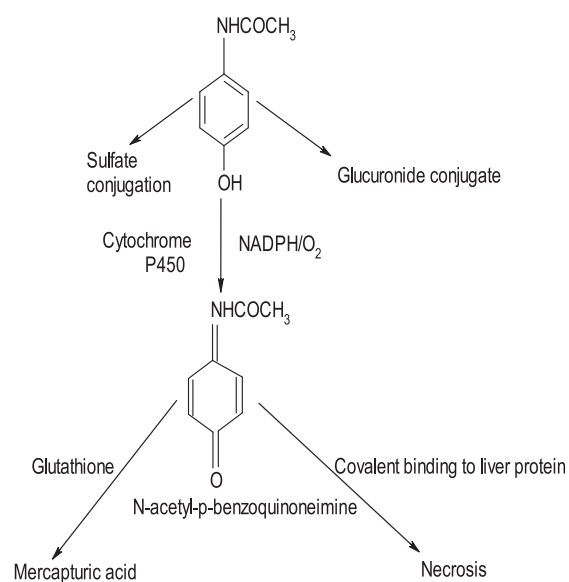


Fig. 2. Decay channels of PCT

From these physicochemical properties, energies of HOMO-LUMO signify additional importance [Dewar]. HOMO and LUMO are acronyms for highest occupied molecular orbital and lowest unoccupied molecular orbital, respectively [Woodward]. The energy difference between the HOMO and LUMO is termed the HOMO-LUMO gap. HOMO and LUMO are sometimes referred to as frontier orbitals. The difference in energy between these two frontier orbitals can be used to predict the strength and stability of the compound. Both the highest occupied molecular orbitals (HOMO) and lowest unoccupied molecular orbitals (LUMO) take part in the chemical reaction.

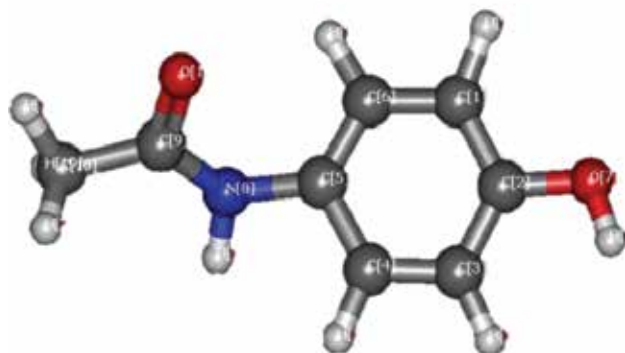


Fig. 3. Optimized structure of PCT

While comparing the energy levels of HOMO of PCT and their metabolites at normal body temperature (310 K or 98.50F) and feverish body temperature (314 K or 1050F), Energy level of HOMO of PCT is markedly lowered by about 42 kJ against other metabolites (such as 5 kJ higher for NAPQI) (Fig. 4). The same analogy is true in the case of LUMO of PCT, lowered by about 10 kJ, while increasing temperature from 98.50F to 1050F (Fig. 4) compared to other metabolites. Highest HOMO-LUMO energy gap (about 788 kJ) of PCT between the two temperatures is observed whereas the lower gaps (~727 kJ) are found for PCTS and NAPQI (Fig.4). This stimulates one to think in the way that PCT at elevated body temperature (i.e. feverish temperature) can act as better reducing agent than at the lower temperature (i.e. usual body temperature). At the elevated temperature, PCT can enhance the donating capability of electrons not to the LUMOs of its own but to the energetically favorable MOs of metabolites or any other compound in the body after degradation. All the HOMO and LUMO structures of PCT at the usual body temperature and at the elevated feverish body temperatures are shown separately in Figure 4. All the HOMOs and LUMOs of PCT and its metabolites are calculated separately and analyzed their structures on the basis of energy at each degree intervals. To avoid complexity all remaining structures of HOMOs/ LUMOs are not shown here.

This theoretical observation on PCT is of much supportive to the fact that PCT inhibits one or more isoenzymes of the cyclooxygenase (prostaglandin synthase, PGHS) enzymes or COX-1 (PGHS-1), COX-2(PGHS-2), and COX-3(PGHS-1b). COX enzyme catalyses the conversion of arachidonic acid (AA) to prostanoids and other chemical mediators responsible for inflammation, fever, pain, platelet-aggregation and mucous production in the gastrointestinal tract.

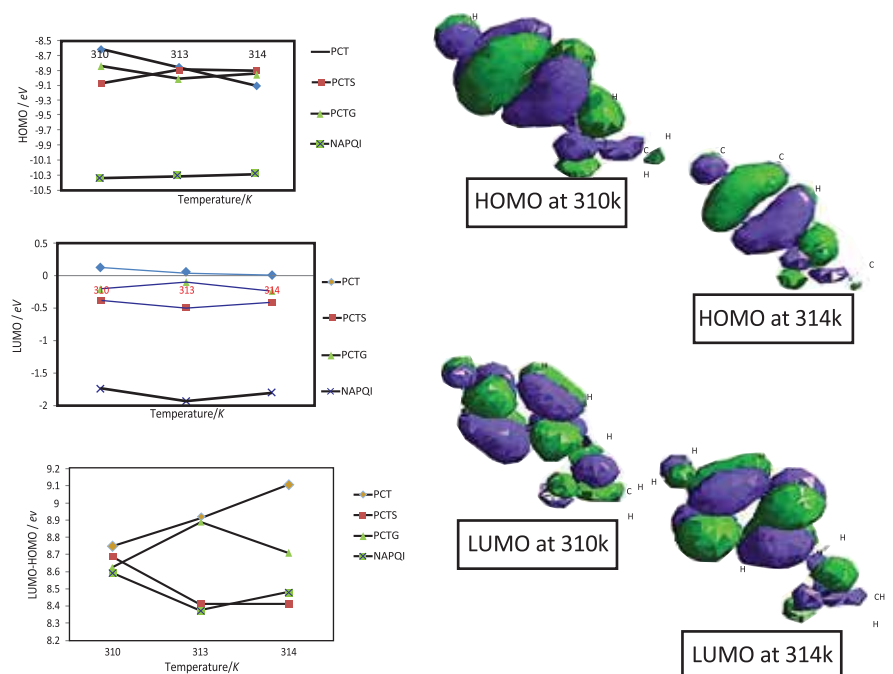


Fig. 4: HOMO-LUMO gap VS. Temp.

Since PCT at the elevated body temperature gains stability by lowering energy of HOMO through various mediator-based interactions can act as better antioxidant. It will get favourable condition to donate electrons to ferrylprotophyrin IX radical cation ($Fe^{4+}=OPP^{+*}$) within the periphery of peroxidase site of the PGHS enzyme. This ferryl radical cation generates tyrosine radicals (Tyr 385*) (Fig. 5)[Anderson, Ouellet, Alloui] in the cyclooxygenase site of PGHS. This is extremely needful for the catalyzation of arachidonic acid (AA) oxidation. That ascertains that Tyr385* reacting with AA takes part in oxidation to form prostaglandin G2 containing peroxide radical (PGG2*). PGG2 oxidizes porphyrin in the peroxidase site of the enzyme. These two sided reactions are going to be repeated or hindered or stopped owing to the efficiency of the paracetamol on the concerned surrounding of the site. Peroxidase part is self-dependent whereas cyclooxygenase part depends on peroxidase. PCT, a better electron donor, reduces an iron cation in protophyryn IX radical in the left part(POX) of the Fig. 5 that are liable to lower the amount of Tyr385* formation. Lower amount of Tyr385* will generate lower amount of COX enzymes, acting as COX inhibitor. However, COX inhibition by PCT is difficult in the presence of high peroxide levels although toxic hydrogen peroxide is converted into water in presence of peroxidase.

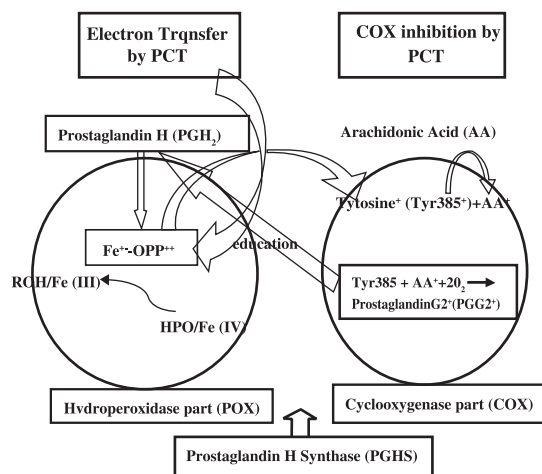


Fig. 5. Action of PCT through two components of PGHS: COX and POX sites.

The most negative (Mulliken) atomic charges on phenolic oxygen (Ar-O-H) and carbonyl oxygen ($=C=O$) are -0.225 and -0.350 respectively. Bond distances and bond angles of the optimized geometries and X-ray crystallographic structure of PCT [Beyer] are within the difference of <1.1% and <1% respectively (Fig.3). Thermodynamic and electronic properties of PCT at the varied equilibrated geometries emerging from the computational chemistry approach are well interpretable. This might unveil a new avenue to further enhance the inner understanding of many unresolvable functions and metabolic activities in the Bio-, Medicinal and Pharmaceutical Chemistry. PCT displays an excellent safety profile within its usual therapeutic range. However, the major negative aspect of PCT is its ability induces serious, even fatal, hepatotoxicity above the usual therapeutic range. The mechanism of this toxicity is somewhat known and results from the depletion of endogenous glutathione and subsequent shunting of PCT metabolism from benign to toxic pathways. However, further analysis of the calculation is underway to address the issues in a more sophisticated way.

Conclusion

Despite having a moderately effective analgesic and antipyretic effect, paracetamol causes hepatotoxicity and nephrotoxicity if overdosed. The mechanism of paracetamol's adverse effects is fairly well understood. The drug is metabolized by different hepatic pathways to produce PCTS, PCTG, and NAPQI. Here, attempts were made to analyze critically the antioxidant behaviors of paracetamol and its metabolites by using advanced quantum chemical calculations. The geometrical and physicochemical characteristics have been determined to find out the factors affecting the antioxidant activity. Moreover, physicochemical properties such as total energy, binding energy, heat of formation, hydration energy, energy of HOMO, energy of LUMO, the Energy gap between LUMO-HOMO and dipole moment have been calculated. PCT is a kind of phenol which is a strong reducing agent. Our study reveals that two of the metabolites of PCT, PCTS and NAPQI might be considered as better antioxidant after degradation in human body (smaller EL-EH gap) which is supposed to inactivate COX enzymes by converting them to their inactive oxidized forms. Binding of PCT with selective protein is underway which is very case-sensitive and time consuming. But additional investigations based on experimental, clinical and theoretical aspects are required to resolve the unexplored phenomena of such kind of drug. On the basis of the information gained from the study, paracetamol with attaching other substituents could give viable alternative that can be screened and treated in more diverse ways in the field of medicinal chemistry. In addition, extensive works on kinetics, hydrolysis pathways and molecular docking of few antibiotics and antimicrobial drugs are underway to fulfill the remaining key objectives.

Publication from this Research

Uddin, M. N., Siddique, Z. A., Nobuyuki, M., Moniruzzaman, Wahhida, S. 2018. Oxotitanium (IV) complexes of some bis-unsymmetric Schiff bases: Synthesis, structural elucidation and biomedical applications. *Applied Organometallic Chemistry* (press).

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