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Dedicated to the Father of the Nation Bangabandhu Sheikh Mujibur Rahman

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This volume of Barishal University Journal of Bio-Sciences is dedicated in honour of the Father of the Nation Bangabandhu

Sheikh Mujibur Rahman

on his birth centenary celebration

Editorial

It gives us immense pleasure to present Barishal University Journal of Bio-sciences, published by the faculty of Bio-sciences, University of Barishal. Barishal University Journal of Bio-sciences, is a double-blind peer reviewed journal devoted to publish original and review articles. The unbiased and un-opinionated peer review system of this journal is effective in filtering the authentic and significant articles that are associated with recent biological science research.

It is a great moment for us to declare the first volume of this journal as "Mujib Edition" in honor of the father of the nation of Bangladesh, Bangabandhu Sheikh Mujibur Rahman. Bangabandhu Sheikh Mujibur Rahman is an undisputable and charismatic leader in the global history with his inherent and extraordinary leadership. Bangabandhu's vision for our country was clear, challenging, and reality-based. He realized that we have resources but without scientific implementation and integrity, these resources are valueless. Hence, he focused on research in his co-operative ideas in the "first five-year plan" to make Bangladesh "Sonar Bangla". I hope this "Mujib Edition" of the journal will help us to expand our intellectual exploration and scholarly research with inspiration from the great leader Bangabandhu Sheikh Mujibur Rahman, whose motto was never to look back and fight with what you have.

Barishal University Journal of Bio-sciences is an interdisciplinary journal that aims to open a space for research in the field of Botany, Biochemistry & Biotechnology, Coastal Studies & Disaster management, and Soil Sciences. This volume comprises ten academic articles which cover various research areas including climate change challenges, crop improvement, food security, biodiversity, environmental pollution, and genetically inherited disease-related research.

Finally, we extend our sincere thanks to all contributors/ authors for sharing their findings and ideas with thousands of readers of the journal. We would also like to extend our thanks to article reviewers and readers. We believe with continued dedication and effort, Barishal University Journal of Bio-sciences will successfully endure its mission in offering a unique platform for high-quality research publication encompassing ongoing research in the field of Biological Sciences. We believe that the esteemed readers will find the present volume of the journal much informative, interesting, and useful. Your feedback will definitely help us in upgrading and improving the contents of our journal.

With thanks

Professor Dr. Md. Sadequl Arefin
Editor-in-Chief
Barishal University Journal of Bio-Sciences.

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BANGABANDHU SHEIKH MUJIBUR RAHMAN AND HIS DREAM SONAR BANGLA

Dr. Mihir Lal Saha

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Bangabandhu Sheikh Mujibur Rahman was born at Tungipara, a village of Gopalganj District. His Father's name is Sheikh Lutfur Rahman, and his mother's name is Sheikh Sayera Khatun. His parents used to adoringly call him "Khoka". From very early age, Sheikh Mujib showed a potential of leadership. He had to withdraw from school in 1934 to undergo eye surgery, and returned to school after four years, owing to the severity of the surgery and slow recovery. Later, he passed his Matriculation from Gopalganj Missionary School in 1942, IA from Islamia College (now Maulana Azad College) in 1944 and BA from the same college in 1947. After the partition of India, he was admitted into the Department of Law, University of Dhaka but could not complete because he was unfortunately expelled from the university in the early 1949 on the charge of 'inciting the fourth-class employees' in their agitation against the university authority's indifference towards their legitimate demands. After 61 years, in 2010, the expulsion was withdrawn by the university authority as it was found unjust and undemocratic.

He served as the first President of Bangladesh and later as the Prime Minister of Bangladesh from 17 April 1971 until his assassination on 15 August 1975. He is considered to be the driving force behind the independence of Bangladesh. He is popularly dubbed with the title of "Bangabandhu" by the people of Bangladesh. In plain Bengali, "Bangabandhu" means "Friend of Bengal". Sheikh Mujibur Rahman was, of course, incomparably more than that. He became a leading figure in and eventually the leader of the Awami League, founded in 1949 as an East Pakistan–based political party in Pakistan. Sheikh Mujib is credited as an important figure in efforts to gain political autonomy for East Pakistan and later as the central figure behind the Bangladesh Liberation Movement as well as the Bangladesh Liberation War in 1971. Thus, he is regarded as the Father of the Nation of Bangladesh. His daughter Sheikh Hasina, MP is the current leader of the Awami League and also the Prime Minister of Bangladesh.

Bangabandhu Sheikh Mujibur Rahman, the founder of Bangladesh and the greatest leader amongst Bengalee of all times, seemed to have an inherent passion for the promotion of the oppressed and distressed. This was evident at the early part of his life. Gradually he made

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it part of his life and philosophy to visualize a welfare state for all. He dreamt such a state in the womb of Pakistan for which he fought as a student activist. But while at maturity, he found that Pakistan was not appropriate for materializing of dreams of a democratic and equalitarian society, so he changed his idea of a free and sovereign state of Bangladesh. He pursued and ignited the 'First Revolution' which ultimately needed the war of independence to create Bangladesh. The achievement of independence brought him physically to power on 12th of January 1972 as the Prime Minister of Bangladesh. It may be recalled that cardinal part of the 7 March, 1971 speech of Bangabandhu Sheikh Mujibur Rahman, contained a call for 'struggle for emancipation', followed by a call for 'struggle for Independence' (Choudhury, The Daily Sun, 24 October, 2020).

Bangabandhu Sheikh Mujibur Rahman returned home from Pakistani captivity on 10 January 1972. He was received at Dhaka airport by a huge crowd which included a large number of his political co-travelers, colleagues and followers. From the airport he was driven to the Race Course Ground (now Suhrawardy Udyan) from where he had delivered his celebrated address to the nation on 7 March 1971. In his speech of 10 January 1972, Bangabandhu sounded thoughtful and composed, as he proceeded under the weight of the moment and the heavy burden of leadership of a free nation. Bangabandhu was quite candid about the future that awaited us and the problems that we faced. He stressed on the individual and collective responsibilities and the need to forge national unity to overcome the obstacles that lay on our way. He reminded his audience to be truthful to history and responsive to the needs of the people, he didn't provide any concrete plan or guideline for collective action. This came later, in a series of policy decisions and actions stretched over the years; culminating in his call for a 'Second Revolution' in a speech he gave at the National Parliament on 25 January 1975.

The aim of his Second Revolution was to materialize his dream of Sonar Bangla. He also provided specific plans for mobilizing the country's intellectual, cultural and economic resources to achieve the objectives of the revolution. Bangabandhu announced the Second Revolution roadmap in a speech delivered on 26 March 1975 at the Suhrawardy Udyan. In both the 25 January and 26 March speeches, he provided a list of actions that the Second Revolution would aim to undertake. In the three and half years of Bangabandhu's rule, a number of plans were put into action which helped checking the economic downslide and bring the economy back on its feet. He undertook the rebuilding of the agricultural infrastructure and putting in place a support system for farmers (which provided farm machineries, pumps and tube wells) and distributing crop seedlings free of cost or at a minimum price (Islam, The Financial Express, 17 March 2020).

Nobel laureate Norman Ernest Borlaug’s Green Revolution in the 1960s was indeed a great milestone for human civilization. After WWII Malthusian economists predicted serious consequences for humankind due to the burgeoning population throughout the world. The golden rays of the Green Revolution touched the soil of Bangladesh immediately after its liberation in 1971. Bangabandhu Sheikh Mujibur Rahman responded to the Green Revolution very quickly and appealed for an agricultural revolution in the new-born country. The government of Bangabandhu Sheikh Mujibur Rahman attached the highest priority to agricultural development. During Bangabandhu's rule, Bangladesh Agricultural Research Council, Bangladesh Rice Research Institute, Bangladesh Agricultural Research Institute, Cotton Development Board, Horticulture Board and other necessary infrastructure were established. Farmer-friendly agriculture policies were formulated. All out support was provided to farmers (Jewel, The Daily Star, 12 September 2019).

Bangabandhu Sheikh Mujibur Rahman is one of the notable charismatic leaders in the global history. Due to his inherent and extra-ordinary qualities, he gained trust, support and hope of the general peoples of Bangladesh. Bangabandhu Sheikh Mujibur Rahman is the architect of the independence of Bangladesh. Population of the country was 75 million in 1971 (UNFPA, 2020). Food shortage was about 25-30 lakh tons. Bangabandhu put special emphasis on agriculture after the liberation war. His dream was to achieve self-sufficiency in food production, thus he formulated long-term plan for the improvement of agriculture sector of Bangladesh (Shahnawaz, 2015). Food, in the hierarchy of all needs, is the most basic need for life. Since independence, Bangladesh has made significant progress in increasing domestic production of food grains. This, to a large extent, helped in overcoming the constraints of national food insufficiency. We are the proud citizens of the greatest Bengali of a thousand years, Bangabandhu Sheikh Mujibur Rahman. Bangabandhu wanted to make Bangladesh full of food grains which was achieved by supreme sacrifices made by three million lives. Therefore, he urged green revolution immediately after liberation war. Bangabandhu had a dream to establish Bangladesh which will be free from hunger and poverty. He wanted to see Bangladesh as 'Sonar Bangla' developing agriculture and farmers of the country (Rahman et al., 2014). Bangabandhu`s policy made Bangladesh a role model in agriculture and finally Bangladesh has become a role model in the world for increasing agricultural production significantly in the past few decades (Chowhan, 2020).

Meeting the food shortage, Bangladesh has now turned as an exporting country. Bangladesh is an example in the world in all human development index including reducing mother and child death, increase of average life expectancy, taking quality food. All these have been made possible due to the success in agriculture. This has been only possible because of the father of our nation Bangabandhu Sheikh Mujibur Rahman. But, after the killing of Bangabandhu, the achievement in agriculture was decreased. Through his epoch-making measures, we have achieved self-sufficiency in food under the visionary leadership of his daughter Jananetri Sheikh Hasina MP, the present Prime Minister of Bangladesh. Bangladesh will transform into upper-middle economy in 2031 and developed economy by 2041. For this, we must keep on the progress of the key factor agriculture development dreamt by Bangabandhu at any cost.

References

Choudhury Abdul Mannan. The Second Revolution. The Daily Sun, 24th October, 2020.

Chowhan Sushan. 2020. A review on Bangabandhu and agriculture: Future path for self-sufficiency in food production of Bangladesh. *Archives of Agriculture and Environmental Science* **5**(2): 200-204.

Islam Syed Manzurul. Bangabandhu's dream of Sonar Bangla anchored in 1972-1975. The Financial Express, 17 March 2020.

Jewel Md Roushon Jamal. The pioneer of the Green Revolution. The Daily Star, 12 September 2019.

Rahman S, Islam T, Reza A and Islam T. 2014. Evaluation of Charismatic Leader of Bangabandhu Sheikh Mujibur Rahman. *International Journal of Scientific and Research Publications*, **4**(5): 1–6.

Shahnawaz M. 2015. Sheikh Mujibur Rahman: Founder of Bangladesh. *African Journal of Political Science and International Relations*, **9**(5): 152–158.

UNFPA, United Nations Population Fund 2020. Bangladesh Population Pyramid Year: 1971. United Nations, Population Division, World Population Prospects: 2017 Revision.

Wikipedia. https://en.wikipedia.org/wiki/Sheikh_Mujibur_Rahman

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EFFECTS OF TEXTILE EFFLUENT ON HEAVY METAL ACCUMULATION BY JUTE LEAVES (*Corchorus capsularis)*

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Abstract
A pot experiment was conducted to assess the effects of textile effluent on heavy metal uptake by newly developed BJRI deshi pat shak-1 (*Corchorus capsularis*) in winter season. There were six treatments of different effluent levels. It was observed that heavy metal concentration in root, shoot and leaf of jute leaves increased with the increasing level of effluent irrigation both in non-contaminated and contaminated soils. The order of accumulation of heavy metal may be arranged as Fe>Mn>Zn>Cu>Cr>Pb>Ni>Cd for jute leaf in both non-contaminated and contaminated soils. The highest concentrations of heavy metals were found in T_6, where 100% textile effluent was applied. The concentration of heavy metals increased with different levels of textile effluent irrigation over control in both soils. But higher rate reduced the amount of total heavy metal uptake by jute leaves plants due to reduction of yield with higher concentration of effluent irrigation.

Keywords: Textile effluent, Heavy metal, Jute leaves.

Introduction

Pollution of heavy metals in aquatic environment is a growing problem worldwide and currently it has reached an alarming state (Ruqia *et al.,* 2015). The two main sources of heavy metals in wastewater are natural and anthropogenic. The natural factors include soil erosion, volcanic activities, urban runoffs and aerosols particulate matter while the human factors include metal finishing and electroplating processes, mining extraction operations, textile industries and nuclear power (Oghenerobor *et al.,* 2014). Textile industry is one of the most important and rapidly developing industrial sectors in Bangladesh. It is the most important sector of economy of Bangladesh (Begum *et al.,* 2018). Textile industry releases highly polluted and toxic wastewaters which are discharged into sewers and drains without any kind of treatment (Islam *et al.,* 2011). The use of polluted water in the immediate surroundings of big cities in most countries for growing of vegetable is a common practice. Although this water is considered to be a rich source of organic matter and plant nutrients, it also contains sufficient amounts of soluble salts and heavy metals such as Iron (Fe), Copper (Cu), Zinc (Zn), Lead (Pb), Nickel (Ni), Selenium (Se), Mercury (Hg), Chromium

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(Cr), Arsenic (As), and Aluminum (Al) (Mohammed and Folorunsho, 2015). Most of the studies show that the use of wastewater contaminated with heavy metals for irrigation over a long period of time increases the heavy metal contents of soils above the permissible limits. Ultimately, increasing the heavy metal content in soil also increases the uptake of heavy metals by plants depending upon the soil type, plant growth stages and plant species (Afzal *et al.,* 2013). In recent years, wastewater reuses has experienced very rapid growth. Volumes of wastewater reuse have increased 10-29% per year in Europe, the United States and China and by up to 41% in Australia (Aziz and Farissi, 2014). In areas where fresh water is scarce, wastewater allows low-income farmers to produce crops. They would otherwise not to be able to grow. On the other hand, wastewater production is continuous, making it a reliable and demand-based source of water that is available to farmers whenever they need it. Being sure of their water supply, even in the dry season, farmers can grow high-value crops. They can also grow crops that are more sensitive to water stress (e.g. Vegetables). The nutrients of that wastewater provide are an additional benefit, saving farmers money (in terms of the cost of chemical fertilizers) and increasing crop yield. So, wastewater irrigation can also significantly contribute to urban food security and nutrition. The objective of this experiment is to evaluate the concentration of some heavy metals in the leaves of jute leaves plant as influenced by textile wastewater irrigation.

Material and Methods

In the premises of Bangladesh Jute Research Institute, Dhaka, a pot experiment was carried out. Wastewater and soil samples were collected from Narayanganj districts. The collected soil samples (0-15 cm depth) were air dried, ground and sieved to pass through a 2.0 mm sieve and then mixed thoroughly to make it a composite sample. Dry roots, grasses and other vegetative residual parts were removed. One kg of each composite sample was taken in a plastic container for chemical analysis. One litter of textile wastewater was also taken in a plastic bottle. Physical and chemical characteristics of the soils and wastewater were determined using standard methods.

A pot experiment (7 kg soil per pot) was conducted in non-contaminated and contaminated soils with six treatments following randomized complete block design having three replications. Treatments of the experiment were: T_1 – Control , T_2- 100% RDF+ 0% TWW , T_3 – 50% RDF + 25% TWW, T_4 – 50% RDF + 50% TWW, T_5 – 50% RDF + 75% TWW, T_6 – 50% RDF + 100% TWW (TWW= Textile wastewater and RDF= Recommended dose of fertilizer). The jute leaves vegetable (BJRI deshi pat shak-1) was used as a test crop. Fifty healthy seeds were sown in each pot. Half dose of urea, full dose of TSP, MoP, fresh and wastewater were applied to soil one day before sowing according the treatments. Remaining half amount of urea was top dressed after 15 days of sowing. Intercultural operations were done accordingly. No infection of insecticides and pesticides were

Table 1. Some physical and chemical properties of the soil used

Parameters	Observation	
	Non- contaminated soil	Contaminated soil
Particle size analysis a		
Sand (%)	39	24
Silt (%)	63	63
Clay (%)	8	13
Textural class	Silt Loam	Silt Loam
pH b	6.8	6.9
EC (dS/m)	1.6	1.9
Organic matter (OM) % c	1.77	3.82
Total Nitrogen (N) % b	0.187	0.091
Potassium (K) meq/100g soil	0.18	0.10
Calcium (Ca) meq/100g soil	4.16	3.12
Magnesium (Mg) meq/100g soil	1.22	0.88
Available phosphorus (P) mg kg^{-1}	6.20	17.16
Available sulphur (S) mg kg^{-1}	16.73	11.22
Available copper (Cu) mg kg^{-1}	0.24	0.56
Available iron (Fe) mg kg^{-1}	52.07	234.00
Available manganese (Mn) mg kg^{-1}	12.52	12.79
Available zinc (Zn) mg kg^{-1}	1.46	5.67
Available lead (Pb) mg kg^{-1}	11.67	17.62
Available cadmium (Cd) mg kg^{-1}	0.098	0.123
Available nickel (Ni) mg kg^{-1}	29.67	27.84
Available chromium (Cr) mg kg^{-1}	34.80	33.37

a. Boyoucos(1962), b. Jackson(1973), c. Walkley and Black(1934)

Table 2. Chemical characteristics of textile wastewater of Natayangonj

Parameters	Values	Parameters	Values
pH	7.99	Phosphorus (mg kg^{-1})	58.72
EC (dS/m)	2.39	Sulphur (mg kg^{-1})	201.60
TDS (ppm)	1191	Copper (mg kg^{-1})	1.23
DO (ppm)	0.28	Iron (mg kg^{-1})	1.06
BOD (ppm)	2.85	Manganese (mg kg^{-1})	0.206
Colour	greenish- blue	Zinc (mg kg^{-1})	0.11
Total Nitrogen (%)	0.05	Lead (mg kg^{-1})	0.0001
Potassium (mg kg^{-1})	1.10	Cadmium (mg kg^{-1})	0.0063
Calcium (mg kg^{-1})	1.10	Nickel (mg kg^{-1})	0.274
Magnesium (mg kg^{-1})	0.33	Chromium (mg kg^{-1})	0.100

observed during jute leaves growth. The crop was allowed to grow for 45 days. Plant was harvested as root, shoot and leaf. Samples were air-dried and oven-dried at 65^0 C for 72 hours and after constant weight, plant samples were taken out of the oven and their dry weights were taken.

Results and Discussion

Effects of textile wastewater irrigation on heavy metal concentration in root, shoot and leaf of jute leaves plants in non-contaminated and contaminated soils of Narayanganj are presented in Figures 1 to 16. The results showed that heavy metal concentration in different parts of jute leaves plants increased with the increasing level of textile wastewater irrigation.

Zinc concentration in the leaf of jute leaves vegetable plants varied from 35.70 to 40.70 mg kg^{-1} and 43.70 to 65.70 mg kg^{-1} in non-contaminated and contaminated soil of Narayanganj respectively (Fig. 1 and 2). The highest concentrations 40.70 and 65.70 mg kg^{-1} of Zn in leaf were observed with T_6 (50% RDF + 100% TWW), respectively, in non-contaminated and contaminated soils. The lowest concentration of Zn in leaf 35.70 and 43.70 mg kg^{-1} were observed with T_1 (control) and T_2 (100% RDF + 0% TWW) consequently in non contaminated and contaminated soil.

In leaf of jute leaves plants Cu concentration ranged from 13.83 to 29.33 mg kg^{-1} and 20.84 to 34.45 mg kg^{-1} in non-contaminated and contaminated soil of Narayanganj (Figs. 3 and 4), respectively. The highest level of Cu in leaf 29.33 mg kg^{-1} in non-contaminated soil and 34.45 mg kg^{-1} in contaminated soils were observed with T_6 (50% RDF + 100% TWW). And the lowest level of Cu in leaves 13.83 and 20.84 mg kg^{-1} were observed with T_1 (control) and T2 (100% RDF + 0% TWW) in non-contaminated and contaminated soils, respectively.

In both soils Ni was not detected in T_1 (control) and T_3 (50% RDF + 25% TWW). Nickel concentration in leaf of jute leaves vegetable plants varied from 0.0 (zero) to 0.09 mg kg^{-1} and 0.0 (zero) to 0.07 mg kg^{-1} in non-contaminated and contaminated soils, respectively (Fig. 5 and 6). Maximum concentration of Ni in leaf of jute leaves 0.09 mg kg^{-1} in non-contaminated soil and 0.07 mg kg^{-1} in contaminated soil were observed with T_6 (50% RDF + 100% TWW). In both soils minimum concentration of Ni in leaves of jute leaves was 0.0 (zero) observed with T_1 (control) and T_3 (50% RDF + 25% TWW).

Iron concentration in the leaf of jute leaves plant ranged between 433.94 and 781.64 mg kg^{-1} and 355.32 to 909.65 mg kg^{-1}, respectively in non-contaminated and contaminated soil of Narayanganj (Figs. 7 and 8). Maximum values of Fe in leaves 781.64 and 909.65 mg kg^{-1} were found with the T_6 (50% RDF + 100% TWW), respectively, in non-contaminated

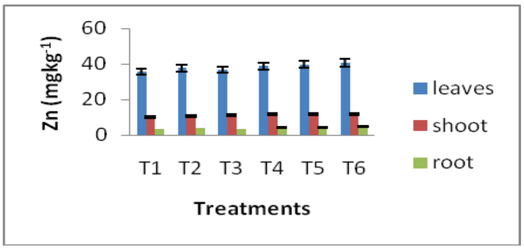

Fig. 1. Effect of textile effluent on concentration of Zn in different parts of jute leaves plants in non contaminated soil of Narayanganj

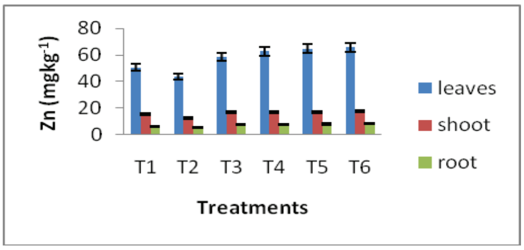

Fig. 2. Effect of textile effluent on concentration of Zn in different parts of jute leaves plants in contaminated soil of Narayanganj

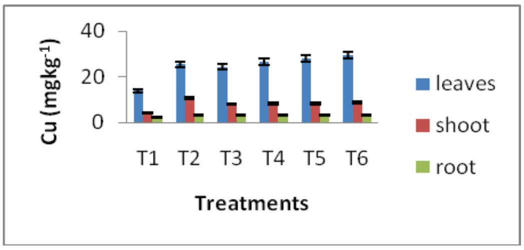

Fig. 3. Effect of textile effluent on concentration of Cu in different parts of jute leaves plants in non contaminated soil of Narayanganj

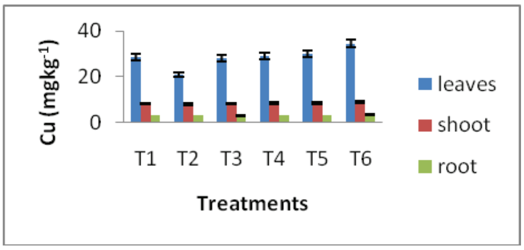

Fig. 4. Effect of textile effluent on concentration of Cu in different parts of jute leaves plants in contaminated soil of Narayanganj

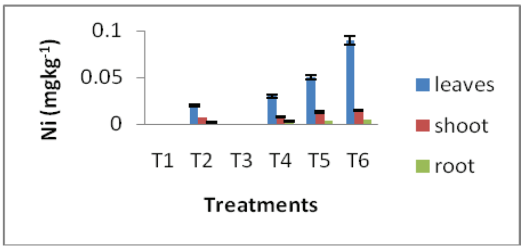

Fig. 5. Effect of textile effluent on concentration of Ni in different parts of jute leaves plants in non contaminated soil of Narayanganj

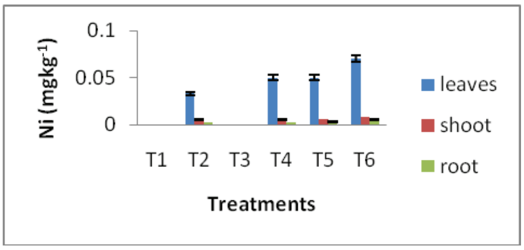

Fig. 6. Effect of textile effluent on concentration of Ni in different parts of jute leaves plants in contaminated soil of Narayanganj

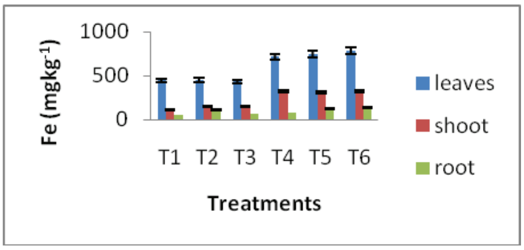

Fig. 7. Effect of textile effluent on concentration of Fe in different parts of jute leaves plants in non contaminated soil of Narayanganj

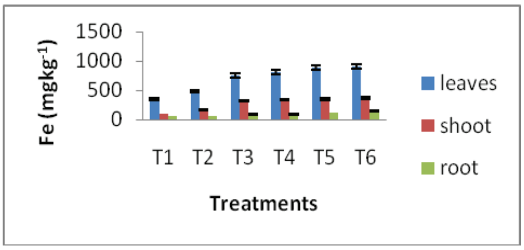

Fig. 8. Effect of textile effluent on concentration of Fe in different parts of jute leaves plants in contaminated soil of Narayanganj

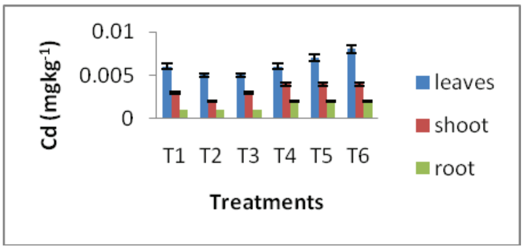

Fig. 9. Effect of textile effluent on concentration of Cd in different parts of jute leaves plants in non contaminated soil of Narayanganj

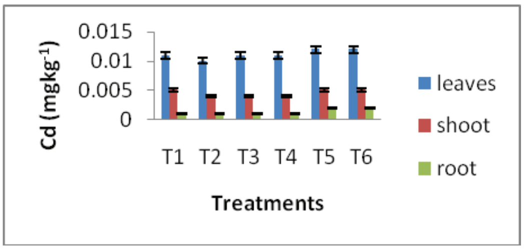

Fig. 10. Effect of textile effluent on concentration of Cd in different parts of jute leaves plants in contaminated soil of Narayanganj

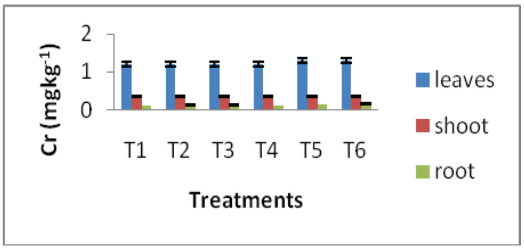

Fig. 11. Effect of textile effluent on concentration of Cr in different parts of jute leaves plants in non contaminated soil of Narayanganj

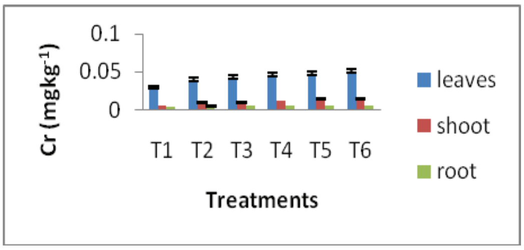

Fig. 12. Effect of textile effluent on concentration of Cr in different parts of jute leaves plants in contaminated soil of Narayanganj

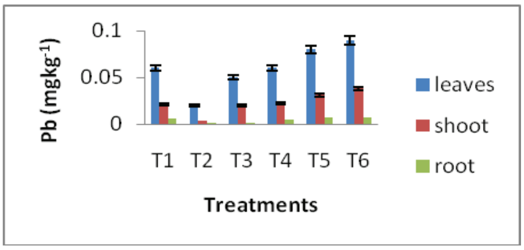

Fig. 13. Effect of textile effluent on concentration of Pb in different parts of jute leaves plants in non contaminated soil of Narayanganj

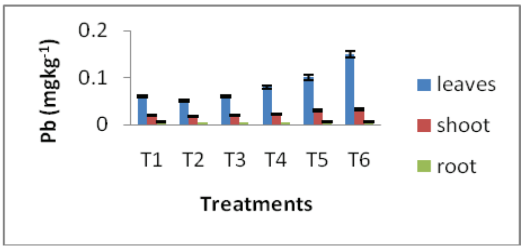

Fig. 14. Effect of textile effluent on concentration of Pb in different parts of jute leaves plants in contaminated soil of Narayanganj

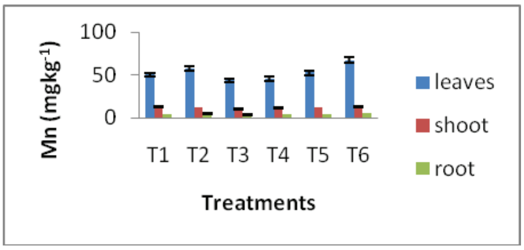

Fig. 15. Effect of textile effluent on concentration of Mn in different parts of jute leaves plants in non contaminated soil of Narayanganj

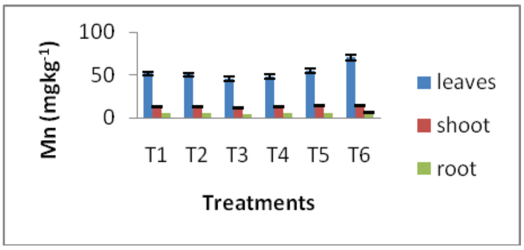

Fig. 16. Effect of textile effluent on concentration of Mn in different parts of jute leaves plants in contaminated soil of Narayanganj

and contaminated soil. And minimum values of Fe in leaves 433.94 and 355.32 mg kg^{-1} were observed with T_3 (50% RDF + 100% TWW) and T_1 (control) in non-contaminated and contaminated soils, respectively.

In non-contaminated and contaminated soil of Narayanganj Cd concentration in the leaf of jute leaves vegetable plant varied between 0.005 to 0.008 mg kg^{-1} and 0.010 to 0.012 mg kg^{-1}, respectively (Fig. 9 and 10). In both non contaminated and contaminated soils highest level of Cd in the leaf of jute leaves 0.008 and 0.012 mg kg^{-1} were found with the T_6 (50% RDF + 100% TWW), respectively. The lowest level of Cd in leaf of jute leaves 0.005 and 0.010 mg kg^{-1} were found with T_2 (50% RDF + 100% TWW) consequently in non-contaminated and contaminated soils.

Chromium concentration in the leaf of jute leaves vegetable plant ranged between 1.20 to 1.31 mg kg^{-1} and 0.030 to 0.051 mg kg^{-1} in non-contaminated and contaminated soil of Narayanganj, respectively (Figs. 11 and 12). Maximum concentration of Cr in the leaf 1.31 mg kg^{-1} in non-contaminated soil and 0.051 mg kg^{-1} in contaminated soil were observed with the T_6 (50% RDF + 100% TWW). Minimum concentration of Cr in the leaf of jute leaves 1.20 mg kg^{-1} in non-contaminated soil and 0.030 mg kg^{-1} in contaminated soil were observed with T_1 (control).

In the leaf of jute leaves vegetable plants Pb concentration varied from 0.020 to 0.090 mg kg^{-1} and 0.050 to 0.150 mg kg^{-1} in non-contaminated and contaminated soil of Narayanganj (Figs. 13 and 14), respectively. In non-contaminated soil the highest value of Pb in the leaf 0.090 mg kg^{-1} and in contaminated soil 0.150 mg kg^{-1} were found with the T_6 (50% RDF + 100% TWW). And lowest value of Pb in the leaf 0.020 and 0.050 mg kg^{-1} were observed with T_2 (100% RDF + 0% TWW) in in non-contaminated and contaminated soils of Narayanganj, respectively.

Level of Mn in the leaf of jute leaves vegetable plants varied from 43.60 to 67.30 mg kg^{-1} and 45.70 to 70.50 mg kg^{-1} in non-contaminated and contaminated soils of Narayanganj (Figs. 15 and 16), respectively. Highest level of Mn in the leaf 67.30 and 70.50 mg kg^{-1} were observed with T_6 (50% RDF + 100% TWW) in non-contaminated and contaminated soil, respectively. And lowest level of Mn in the leaf 43.60 and 45.70 mg kg^{-1} were observed with T_3 (50% RDF + 25% TWW) in non-contaminated and contaminated soils, respectively.

In non-contaminated soil of Narayanganj the concentration of Zn, Cu, Ni, Fe, Cd, Cr, Pb and Mn in the shoot of jute leaves ranged from 10.20 to 12.00, 4.20 to 8.75, 0.0 (zero) to 0.015, 111.20 to 322.30 , 0.002 to 0.004, 0.35 to 0.36, 0.004 to 0.038 and 10.72 to 13.10 mg kg^{-1}. In root it ranged from 3.50 to 4.95, 2.12 to 3.25, 0.0 (zero) to 0.005, 53.70 to

137.40, 0.001 to 0.002, 0.12 to 0.16, 0.001 to 0.007 and 3.51 to 5.30 $mgkg^{-1}$.

In contaminated soil of Narayanganj the concentration of Zn, Cu, Ni, Fe, Cd, Cr, Pb and Mn in the shoot of jute leaves ranged from 12.50 to 17.62, 8.10 to 8.90, 0.0(zero) to 0.008, 105.20 to 362.80, 0.004 to 0.005, 0.007 to 0.015, 0.017 to 0.032 and 11.80 to 14.20 $mgkg^{-1}$. In the root, it varied between 5.25 to 8.20, 3.10 to 3.45, 0.0 (zero) to 0.005, 51.10 to 151.20, 0.001 to 0.002, 0.004 to 0.007, 0.004 to 0.006 and 4.20 to 6.50 mg kg^{-1}.

The highest concentration of Zn, Cu, Ni, Fe, Cd, Cr, Pb and Mn in root, shoot and leaf of jute leaves plants were found with T_6, where 100% textile wastewater was irrigated. The order of accumulation of heavy metals might be arranged as Fe>Mn>Zn>Cu>Cr>Pb>Ni>Cd for jute leaf in both non-contaminated and contaminated soils. The findings are in consent with the following research workers:

Elhameh *et al .,* (2018) found that the trend of heavy metals concentration in vegetables was in the following order: Mn > Zn > Cu > Pb > Cr > Cd. Khan *et al*., (2005, 2003) and Khan *et al*., (2011) reported high concentration of heavy metal in vegetables grown in agricultural fields receiving textile wastewater. Carlos *et al*., (2018) found increases in concentrations of Mn, Na, Cu, and Zn in tissue of maize under irrigation with industrial wastewater. Hamdi *et al* ., (2017) found the high concentration of heavy metals in textile wastewater irrigated saplings, which indicate that the accumulation of heavy metals in apple saplings due to presents of higher Cr, Mn and Zn concentrations. Yaseen *et al*., (2017) found that concentration of heavy metals predominantly Cr, Cu, Cd and Pb was reduced in grains by application of 50% canal water and 50% textile wastewater.

Effects of textile wastewater on heavy metal uptake by jute leaves vegetable plants in non- contaminated and contaminated soils of Narayanganj are presented in Tables 3 and 4. The results showed that heavy metal uptake increased due to different concentration of textile wastewater irrigation over control. The result also revealed that higher rate of textile wastewater irrigation reduces the amount of total heavy metal uptake by jute leaves plants. It might be due to reduction of yield of jute leaves with higher concentration of textile wastewater.

Irrigation of textile wastewater significantly ($P \leq 0.05$) increased Zn uptake by jute leaves plants as compared with control in both non-contaminated and contaminated soils of Narayanganj. In non-contaminated soils the lowest uptake of Zn 15.44 g ha^{-1} and the highest uptake of Zn 36.58 g ha^{-1} were observed with T_1 (control) and T_2 (100% RDF + 0% TWW) respectively. And in contaminated soil of Narayanganj the lowest uptake of Zn 35.26 g ha^{-1} and the highest uptake of Zn 45.97 g ha^{-1} were observed consequently with the T_1 (control) and T_4 (50% RDF + 50% TWW).

Table 3. Effect of textile wastewater on heavy metal uptake by jute leaves vegetable plants in non-contaminated soil of Narayanganj

Treatments	Plant parts	Uptake of heavy metals (g ha^{-1})							
		Zn	Cu	Ni	Fe	Cd	Cr	Pb	Mn
T_1	Leaf	11.07	4.29	0	137.65	0.0019	0.37	0.0186	15.57
	Shoot	3.98	1.64	0	43.37	0.0012	0.14	0.0082	4.95
	Root	0.39	0.23	0	5.91	0.0001	0.01	0.0007	0.46
	Total	15.44 f	6.16 f	0 e	186.93 f	0.0032 d	0.52 d	0.0275 c	20.98 e
T_2	Leaf	26.01	17.58	0.0138	313.16	0.0035	0.83	0.0138	39.68
	Shoot	9.80	9.88	0.0065	137.92	0.0019	0.33	0.0037	11.35
	Root	0.77	0.60	0.0004	21.51	0.0002	0.02	0.0002	0.89
	Total	36.58 a	28.06a	0.021d	472.59 c	0.0056 b	1.18 a	0.0177 e	51.92 a
T_3	Leaf	11.01	7.25	0	130.18	0.0015	0.36	0.0150	13.08
	Shoot	4.57	3.24	0	62.61	0.0012	0.15	0.0082	4.40
	Root	0.42	0.37	0	8.32	0.0001	0.02	0.0001	0.42
	Total	16.00 e	10.86 e	0 e	201.11 e	0.0028 d	0.53 d	0.0233 d	17.90 f
T_4	Leaf	23.61	16.13	0.0183	434.04	0.0037	0.73	0.0366	27.66
	Shoot	9.05	6.24	0.0062	248.08	0.0031	0.27	0.0169	8.47
	Root	0.72	0.54	0.0005	13.35	0.0003	0.02	0.0009	0.73
	Total	33.38b	22.91b	0.025c	695.47a	0.0071a	1.02b	0.0544b	36.86 c
T_5	Leaf	22.23	15.66	0.0280	415.42	0.0039	0.73	0.0448	29.52
	Shoot	8.09	5.61	0.0088	211.62	0.0027	0.24	0.0211	8.30
	Root	0.68	0.48	0.0006	18.83	0.0003	0.02	0.0011	0.69
	Total	31.00 c	21.75 c	0.037 b	645.87 b	0.0069 a	0.99 b	0.0670 a	38.51b
T_6	Leaf	17.91	12.91	0.0396	343.92	0.0035	0.57	0.0396	29.61
	Shoot	3.96	2.89	0.0050	106.36	0.0013	0.12	0.0125	4.32
	Root	0.54	0.36	0.0006	15.11	0.0002	0.02	0.0008	0.58
	Total	22.41 d	16.16d	0.045 a	465.39 d	0.0050 c	0.711c	0.0529 b	34.51 d

Table 4. Effects of textile wastewater on heavy metal uptake by jute leaves vegetable plants in contaminated soil of Narayanganj

Treatments	Plant parts	Uptake of heavy metals (g ha^{-1})							
		Zn	Cu	Ni	Fe	Cd	Cr	Pb	Mn
T_1	Leaf	23.32	13.14	0	163.45	0.0051	0.0138	0.0276	23.69
	Shoot	10.87	5.98	0	75.74	0.0036	0.0050	0.0144	9.29
	Root	1.057	0.54	0	8.69	0.0002	0.0007	0.0010	0.88
	Total	35.26 e	19.66 d	0 c	247.88 e	0.0089 c	0.0195 f	0.0430 f	33.86 e
T_2	Leaf	31.03	14.80	0.0234	347.52	0.0071	0.0284	0.0355	35.64
	Shoot	11.88	7.70	0.0048	156.47	0.0038	0.0095	0.0162	12.45
	Root	1.05	0.64	0.0004	12.98	0.0002	0.0010	0.0008	1.12
	Total	43.96 b	23.14 a	0.0286 b	516.97 d	0.0111 a	0.0389 a	0.0525 d	49.21 a
T_3	Leaf	34.63	16.67	0	446.61	0.0065	0.0254	0.0354	26.96
	Shoot	7.39	3.65	0	141.46	0.0018	0.0044	0.0088	5.19
	Root	0.75	0.31	0	8.99	0.0001	0.0006	0.0004	0.42
	Total	42.77 c	20.63 c	0 c	597.06 c	0.0084 d	0.0304 e	0.0446 e	32.57 f
T_4	Leaf	33.23	15.45	0.0265	431.79	0.0058	0.0243	0.0424	25.60
	Shoot	11.66	5.76	0.0035	236.46	0.0028	0.0083	0.0152	8.63
	Root	1.08	0.45	0.0003	12.78	0.0001	0.0008	0.0007	0.78
	Total	45.97 a	21.66 b	0.0303 b	681.03 b	0.0087 c	0.0334 c	0.0583 c	35.01 d
T_5	Leaf	34.29	15.98	0.0265	471.91	0.0064	0.0254	0.0530	29.20
	Shoot	9.75	4.85	0.0034	202.46	0.0029	0.0080	0.0171	7.92
	Root	1.20	0.48	0.0005	17.61	0.0003	0.0009	0.0009	0.86
	Total	45.24 a	21.31 b	0.0304 b	691.98 a	0.0096 b	0.0343 b	0.071 b	37.98 c
T_6	Leaf	28.91	15.16	0.0308	400.25	0.0053	0.0224	0.0660	31.02
	Shoot	8.63	4.36	0.0039	177.77	0.0025	0.0074	0.0157	6.96
	Root	0.98	0.41	0.0006	18.14	0.0002	0.0008	0.0007	0.78
	Total	38.52 d	19.93 d	0.0353 a	596.16 c	0.0080 e	0.0306 d	0.0824 a	38.76 b

Textile wastewater irrigation significantly ($P \leq 0.05$) increased Cu uptake by jute leaves plants as compared with control in both non-contaminated and contaminated soils of Narayanganj. The minimum uptake of Cu 6.16 g ha^{-1} and the maximum uptake of Cu 28.06

g ha^{-1} were observed respectively with T_1 (control) and T_2 (100% RDF + 0% TWW) in non-contaminated soils. Similarly in contaminated soil of Narayanganj the minimum uptake of Cu 19.66 g ha^{-1} and the maximum uptake of Cu 23.14 g ha^{-1} were observed with the T_1 (control) and T_2 (100% RDF + 0% TWW), respectively.

The experiment revealed that textile wastewater irrigation significantly ($P \leq 0.05$) increased Ni uptake by jute leaves plants as compared with control in both non-contaminated and contaminated soils of Narayanganj. The lowest uptake of Ni found 0.00 (zero) g ha^{-1} in both non-contaminated and contaminated soils of Narayanganj with the T_1 (control) and T_3 (50% RDF + 25% TWW). And the highest uptake of Ni 0.0452 and 0.0353 g ha^{-1} were observed with T_6 (50% RDF + 100% TWW) consequently in non-contaminated and contaminated soils of Narayanganj.

Iron uptake by jute leaves plants significantly ($P \leq 0.05$) increased with the irrigation of textile wastewater as compared with control in both non-contaminated and contaminated soils of Narayanganj. In non-contaminated soil the lowest uptake of Fe 186.93 g ha^{-1} and the highest uptake of Fe 695.47 g ha^{-1} were observed with T_1 (control) and T_4 (50% RDF + 50% TWW), respectively. And in contaminated soil of Narayanganj the lowest uptake of Fe 247.88 g ha^{-1} and the highest uptake of Fe 691.98 g ha^{-1} were found, respectively with T_1 (control) and T_5 (50% RDF + 75% TWW).

Uptake of Cd by jute leaves plants significantly ($P \leq 0.05$) increased with the irrigation of textile wastewater as compared with control in both non-contaminated and contaminated soils of Narayanganj. In non-contaminated soil the lowest uptake of Cd 0.0028 g ha^{-1} and the highest uptake of Cd 0.0071 g ha^{-1} were observed with T_3 (50% RDF + 25% TWW) and T_4 (50% RDF + 50% TWW), respectively. But in contaminated soil of Narayanganj the lowest uptake of Cd 0.0080 g ha^{-1} and the highest uptake of Cd 0.0111 g ha^{-1} were found with T_6 (50% RDF + 75% TWW) and T_2(100% RDF + 0% TWW), respectively.

In both non-contaminated and contaminated soils the experiment showed that textile wastewater irrigation significantly ($P \leq 0.05$) increased Cr uptake by jute leaves plants as compared with control. Uptake of Cr ranged between 0.52 to 1.18 g ha^{-1} and 0.0195 to 0.0389 g ha^{-1} in non- contaminated and contaminated soils, respectively. The lowest uptake of Cr 0.52 g ha^{-1} and the highest uptake of Cr 1.18 g ha^{-1} were found in T_1 (control) and T_2 (100% RDF + 0% TWW), respectively in non-contaminated soil. Similarly in contaminated soil the lowest uptake of Cr 0.0195 g ha^{-1} and the highest uptake of Cr 0.0389 g ha^{-1} were found consequently in T_1 (control) and T_2 (100% RDF + 0% TWW).

The experiment revealed that textile wastewater irrigation significantly ($P \leq 0.05$) increased Pb uptake by jute leaves plants as compared with control in both non-contaminated and contaminated soils. The Pb uptake ranged between 0.0177 to 0.0670 g ha^{-1} and 0.0430 to 0.0824 g ha^{-1} in non-contaminated and contaminated soils, respectively. The lowest uptake of Pb 0.0177 g ha^{-1} and the highest uptake of Pb 0.0670 g ha^{-1} were found respectively in T_2 ((100% RDF + 0% TWW) and T_5 (50% RDF + 75% TWW) in non-contaminated soil. But the lowest uptake of Pb 0.0430 g ha^{-1} and the highest uptake of Pb 0.0824 g ha^{-1} were found respectively in T_1 (control) and T_6 (50% RDF + 100% TWW) in contaminated soil.

Textile wastewater irrigation significantly ($P \leq 0.05$) increased Mn uptake by jute leaves plants as compared with control in both non-contaminated and contaminated soils. Mn uptake ranged between 17.90 to 51.92 g ha^{-1} and 32.57 to 49.21 g ha^{-1} in non-contaminated and contaminated soils, respectively. The minimum uptake of Mn 17.90 g ha^{-1} and the maximum highest uptake of Mn 51.92 g ha^{-1} were observed in respectively T_3 (50% RDF + 25% TWW) and T_2 (100% RDF + 0% TWW) in non-contaminated soil. Similarly in contaminated soil the minimum uptake of Mn 32.57 g ha^{-1} and the maximum uptake of Mn 49.21 g ha^{-1} were found respectively in T_3 (50% RDF + 25% TWW) and T_2 (100% RDF + 0% TWW).

These observations are supported with the findings of the following workers:

Bieby *et al.,* (2011) reported that high concentrations of contaminants may inhibit plant growth and, thus, may limit total uptake of heavy metals by plants. Qing *et al.,* (2003) found that the abilities of various plant species to uptake and accumulate the metals from the soil are different. Marisa and John (2006) observed that individual plant types greatly differ in their metal uptake and bioavailability varied widely from element to element and according to different plant types.

Conclusion

As the concentration of most of the heavy metal in jute leaves plants were within the WHO permissible limits. So, it could be suggested from the experiments that where fresh water irrigation is scare, textile wastewater should be given priority to be used in jute leaves cultivation.

Author's contribution:

All authors are equally contributed, read and approved the final manuscript.

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References

Afzal S, Abdul N, Nazeef U, Rehman A, Akhlaq M, Zakir M and Khan MS. 2013.Comparative study of heavy metals in soil and selected medicinal plant. *Journal of Chemistry*. **2:** 1-5

Aziz F and Farissi M. 2014. Reuse of treated waste water in agriculture solving water deficit problems in arid areas (review). *Ann West Univ Timmisoara*. **17:** 95-110.

Bieby VT, Abdullah SRS, Basri H, Idris M, Anuar N and Mukhlisin M. 2011. A Review on Heavy Metals (As, Pb, and Hg) Uptake by Plants through Phytoremediation. *International Journal of Chemical Engineering*. vol. 2011, Article ID 939161, 31 pages. https://doi.org/10.1155/2011/939161

Begum M, Gani MN and Alam MD. 2018. Effect of textile effluent on yield of jute leaves (*Corchorus capsularis*) in winter season. *Journal of Biodiversity Conservation and Bioresource Management.* **4:** 53-59.

Bouyoucos GJ. 1962. Hydrometer method improved for making particle size analysis of soils. *Agronomy Journal.* **54:** 464-465.

Carlos FS, Schaffer N , Andreazza RA, Morris LA, Tedesco MJ and Boechat CL. 2018. Treated industrial wastewater effects on chemical constitution maize biomass, physicochemical soil properties, and economic balance. *Journal of Communications in Soil Science and Plant Analysis* . **49**(3)**:** 319-333

Elhameh C, Arfaeinia H, Karimyan K, Sharafi H and Hashemj SE. 2018. Dataset for effect comparison of irrigation by wastewater and ground water on amount of heavy metals in soil and vegetables: Accumulation, transfer factor and health risk assessment. *ELSEVIER*. **18:** 1702-1710.

Hamdi Z, Okcu GD and Yalcuk A. 2017. The impact of textile wastewater irrigation on the growth and development of apple plant. *International Journal of Phytoremediation* . **20**(2)**:**153-160.

Islam MM, Mahmud K, Faruk O and Billah MS. 2011. Textile dyeing industries in Bangladesh for sustainable development. *International Journal of Environmental Science and Development.* **2:**6-16.

Jackson ML. 1973. Soil Chemical Analysis, Prentice Hall, Inc. Engle wood cliffs, N. J., USA.

Khan MG, Daniel G, Konjit M, Thomas A, Eyasu SS and Awoke G. 2011. Impact of textile wastewater on seed germination and some physiological parameters in pea (*Pisum sativum* L.), Lentil (*Lens esculentum* L.) and Gram (*Cicer arietinum* L.). *Asian Journal of Plant Sciences.***10:** 269-273.

Khan TI, Marwari R and Kala M. 2005. Heavy metals analysis in *Raphanus sativus* and Environment. *Res. J. Chemistry and Environment*. **9**(4)**:** 46-51.

Khan TI, Marwari R and Singh N. 2003. Impact of textile waste water on Solanum melongena var F1- Hybrid Kanhaiya in pot experiments with special emphasis on analysis of heavy metals. *Dimensions of Pollution*. **2:**108-116.

Marisa I and John RD. 2006. Uptake of heavy metals by vegetable plants grown on contaminated soil and their bioavailability in the human gastrointestinal tract. *Food Additives & Contaminants* . **23:** 36-40.

Marshall CE. 1951. Proportion of sand, silt and clay in the basic soil textural classes. U.S. Department of agriculture. Hand book No. **18**, *Soil Survey Manual.* USA. pp.503.

Mohammed SA and Folorunsho JO. 2015. Heavy metals concentration in soil and *amaranthus retroflexus* grown on irrigated farmlands in the Makera area, Kaduna, Nigeria. *Journal of Geography and Regional Planning*. **8**(8)**:** 210-217.

Oghenerobor BA, Gladys OO and Tomilola DO. 2014. Heavy metal pollutants in wastewater effluents: Sources, effects and remediation. *Advances in Bioscience and Bioengineering.* **2**(4)**:** 37-43.

Qing RW, Yan SC , Xiu ML, Yi-Ting D and Peter C. 2003. Soil contamination and plant uptake of heavy metals at polluted sites in china. *Journal of Environmental Science and Health.* Part A. Toxic/Hazardous Substances and Environmental Engineering. **38:** 823-838.

Ruqia N, Khan M, Masab M, Rehman HU, Rauf NU, Shahab S, Ameer N, Sajed M, Ullah M, Rafeeq M and Shaheen Z. 2015. Accumulation of heavy metals (Ni, Cu, Cd, Cr, Pb, Zn, Fe) in the soil, water and plants and analysis of physico-chemical parameters of soil and water collected from Tanda Dam Kohat. *J. Pharm. Sci. Res*. **7**(3)**:** 89-97.

Walkley A and Black IA. 1934. An examination of Degtsareff method for determining soil organic matter and proposed modification for the chromic acid titration method. *Soil Sci*. **37:** 29-38.

Yaseen M, Aziz MZ, Komal A and Naveed M. 2017. Management of textile wastewater for improving growth and yield of field mustard (*Brassica campestris L.*). *in International Journal of Phytoremediation*. **19**(9)**:** 798-804.

KARYOLOGICAL INVESTIGATION OF *EUPHORBIA HIRTA* L. THROUGH CONVENTIONAL AND FLUORESCENT BANDING

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Abstract
The present investigation *Euphorbia hirta* L. was performed with three cytogenetical staining analysis *i.e.* orcein, CMA- and DAPI- stanining. In orcein staining, homogeneously stained interphase nuclei and prophase chromosomes were detected. Eighteen small metacentric chromosomes were found as it's diploid chromosomes number and its total length was 27.01 µm. The length of largest and smallest chromosomes was 2.38 µm and 0.94 µm, respectively. Both the interphase nuclei and prophase chromosomes possessed numerous CMA- and DAPI- positive bands in CMA- and DAPI- staining, respectively. In metaphase stage, two CMA- and 15 DAPI- positive bands were found. The total length of CMA- banded region and percentage of GC- repeats was 3.38 µm and 12.51%, respectively. On the other hand, total length of DAPI- banded region was 15.2 µm which occupied 56.27 % of total chromosome length. In case of CMA-and DAPI- banding, heteromorphicity was noticed in its karyotype. These may be due to small deletion, duplication or inversion of the corresponding banded region of the paired chromosomes.

Keywords**:** Orcein, CMA, DAPI, karyotype, *Euphorbia hirta*

Introduction

Euphorbia L. (spurges) belongs to Euphorbiaceae is a most diverse group of the plant kingdom having more than 2000 species (Santana et al., 2016). It is widely distributed throughout the temperate or tropical parts of India, Asia, Australia, and Africa. In Bangladesh, it is frequently observed all over the country (Ahmed et al., 2008 and Gosh et al., 2019). The species has great importance due to its medicinal and ornamental purposes although having some toxic properties (Shi et al., 2008 and Araújo et al., 2015).

Euphorbia hirta L. locally known as dudhiya is one of the most important and common species in Bangladesh with wide range of ethno-medicinal uses such as in Ayurveda, Unani and Siddha (Kumar et al., 2010). It also shows antibacterial, anti-inflammatory, antimalarial, galactogenic, antiasthmatic, antidiarrheal, anticancer, antioxidant, antiferlity, antiamoebic and antifungal activities along with its traditional uses (Kappor, 2001; Kumar et al., 2010; Kuta et al., 2014 and Ghosh et al., 2019).

Euphrobia represents such a vegetative and floral diversity that morphometric investigation of this group has always been controversial because the taxonomic data of

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these plants have not been made systematically (Webster, 1994). Therefore, karyological investigation with differential chromosome staining becomes a tool to know the authentic genomic information of plants (Levitsky, 1931; Stebbins, 1971 and Skornickova et al., 2007). In addition to classical karyotype analysis, fluorescent banding with DNA-base specific fluorochromes such as CMA (Chromomycine A_3) and DAPI (4′-6 Diamidino-2-Phenyl Indole) is a reliable method by which amount and location of GC- and AT-rich repetitive regions of each chromosome can be detected (Schweizer, 1976; Alam and Kondo 1995; Akhter and Alam 2005; Bonna et al., 2017).

E. hirta has been relatively little studied cytologically whereas most of the studies have been focused in taxonomical and pharmacological aspects. The chromosomal studies of these species are difficult because of having small sized and sticky chromosomes. Report on multiple basic chromosome numbers in this species also created a topic of interest to plant cytogeneticists.

Therefore, the objectives of present research were to study the nature of interphase nuclei and prophase chromosome, to find out the diploid chromosome number and to make conventional karyotype analysis as well as the detailed fluorescent banding pattern.

These objectives may contribute a better understanding of the cytomorphological diversity of *E. hirta* L. growing in Bangladesh and also may enrich the chromosomal database in country.

Materials and methods

The studied materials *Euphorbia hirta* L. were collected from adjacent of Barishal city and they were grown in the Department of Botany, University of Barishal. Healthy roots were pretreated with 0.002 M 8-hydroxyquinoline for 4 hrs at room temperature and then fixed in 45% acetic acid for 15 min at 4°C. The pre-treated roots were kept in 70% alcohol for future utilization. For hydrolysis, the pre-treated roots were kept in a mixture of two parts 1N HCl and one parts 45% acetic acid at 60°C depending on roots diameter for 30 secs to 1 min. For conventional study, the hydrolyzed root tips were squashed and stained in 1% aceto-orcein for 3 hours and observed under micros electric microscope. For fluorescent banding analysis, Alam and Kondo´s (1995) technique was used after some modification. Air dried slides were prepared 24 hrs before study after hydrolyzing, dissecting and squashing the materials with 45% acetic acid. After squashing, the cover glasses were separated from slide immediately. For CMA- staining, the prepared air-dried slides and coverslips were immersed in McIlvaine's buffer (pH 7.0) for 30 min and then for 15 min in that buffer complemented with MgSO4 (5 mM). The slides were kept in an air tight steamy box for 30 min after adding 5µl CMA on the materials. The materials were rinsed with above two buffer sequentially for 10 min in each wash.

Finally, the slides were mounted with 50% glycerol and kept at 4ºC for 24 hrs before observation. For DAPI-staining, the prepared air-dried slides and coverslips were immersed in McIlvaine's buffer (pH 7.0) for 30 min and then kept for 30 min in DAPI solution (0.01 mg/ml) for 30 min. Before mounting the materials with 50% glycerol, slides were immersed in McIlvaine's buffer (pH 7.0) for 10 min. Blue violet (BV) and UV filter cassette of Nikon (Eclipse 50i) fluorescent microscope were used for observing CMA- and DAPI- staining, respectively.

Results and Discussion

Conventional study

The interphase nuclei and prophase chromosomes according to Tanaka (1971) were "diffuse type" and "continuous type", respectively which shows homogenous distribution of heterochromatins within the nucleus (Figs. 1.a, 2.a). Generally, the "diffuse type" of interphase nuclei shows "continuous type" of staining in case of prophase chromosome and thus the present findings, followed the general rule regarding nature of interphase nuclei and prophase chromosome.

The species *Euphorbia hirta* L. was found to possess 2n = 18 small sized chromosomes with basic x=9 (Figs. 3.a, 4.a). Previously other scientists reported the similar diploid chromosome number (Krishnappa and Reshme, 1980; Kothari et al., 1981; Ono and Masuda, 1981; Podlech, 1986; Wang et al., 1999 and Santana et al., 2016). Different diploid chromosome number were also reported for this species, such as 2n=12 (x=6) (Chopde, 1965) and 2n = 20 (x=10) (Raghavan and Arora, 1958 and Alam, 1987) with variable basic chromosome number. This might be due to affinity towards eu- and aneuploidization of this plant species indicating the presence of cytotypes. The total length of 2n chromosome complements was 27.01 µm. The range was 0.03-0.09 in case of relative length of the individual chromosomes. Centromeric formula of this species was 18m. The individual chromosome length ranged from 0.94-2.38 µm which indicates regular decline of chromosomal length in karyotype having differences 1.44 µm between smallest and largest chromosomes (Table 1). Santana et al. (2016) reported similar result except they found sub-metacentric chromosomes along with metacentric chromosomes. The present findings revealed that *Euphorbia hirta* possess a proper symmetric karyotype. According to Stebbins (1971), the symmetric karyotype is a primitive character in course of evolutionary process. Therefore, the medicinally important plant *Euphorbia hirta* L. can be considered as primitive plant species from evolutionary point of view.

Table 1. Orcein, CMA- and DAPI- karyotype analysis of *Euphorbia hirta* L.

2n	Total chromatin length (μm)	Range of individual chromosomal length (μm)	Range of relative length	Centromeric formula	No. of CMA bands	CMA banded region (μm)	% of GC-rich repeats	No. of DAPI bands	DAPI banded region (μm)	% of AT-rich repeats
18	27.01	0.94-2.38	0.03-0.09	18m	2	3.38	12.51	15	15.2	56.27

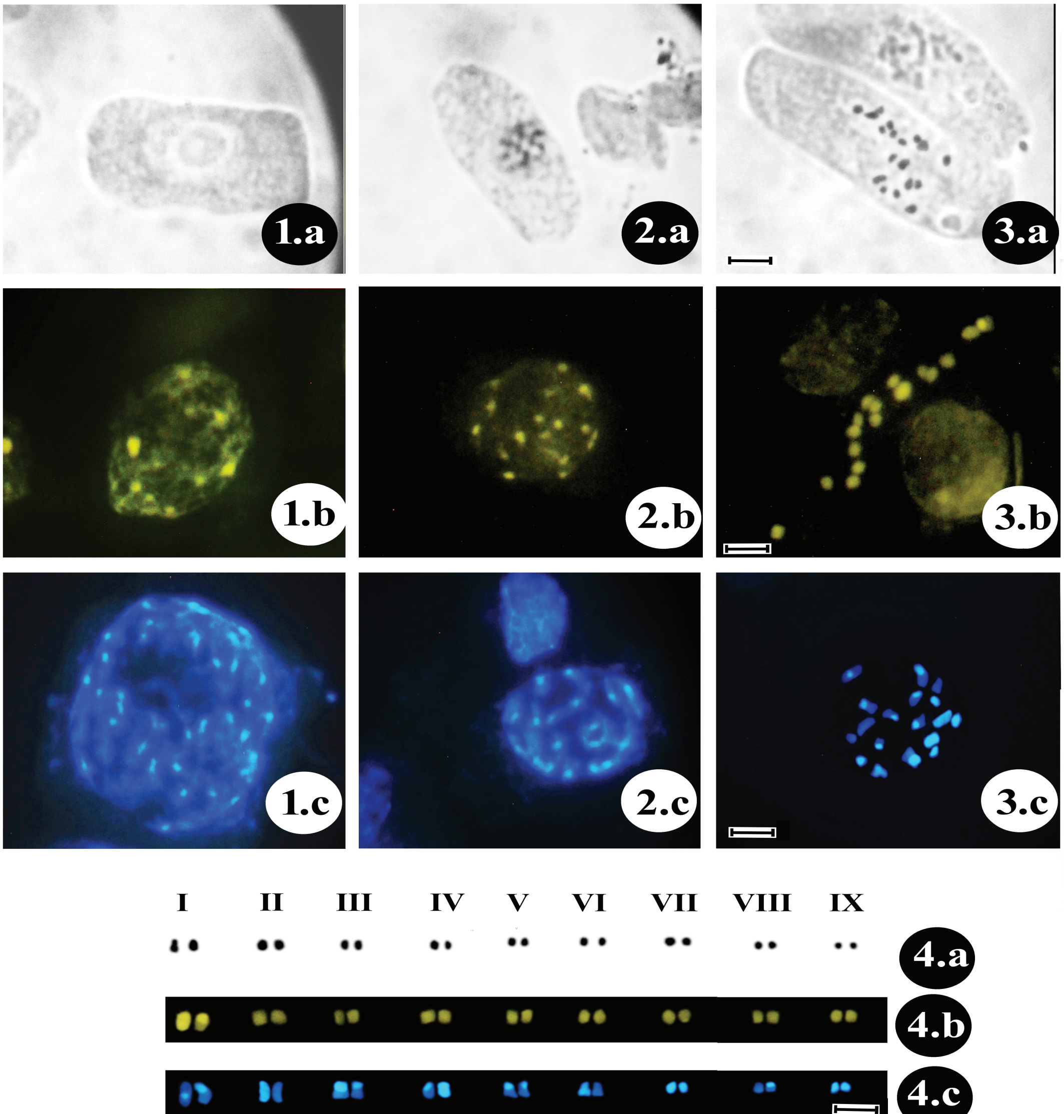
m= metacentric chromosome

Fluorescent banding

A big CMA band was found along with some small bands in the interphase nuclei of *Euphorbia hirta* (Fig. 1.b). In the prophase chromosomes, numerous small CMA-fluoresced region was found (Fig. 2.b). In metaphase, two CMA-positive bands were found in the first chromosome pair where one homologue member was entirely fluoresced and its homologue possess bands in short arm (Figs. 3.b, 4.b). The most probable reason for this heteromorphicity was the deletion of banded portion from the homologous locus of the respective chromosome or tandem duplication of GC-rich repeats (Hiron et al., 2006; Sultana and Alam, 2007; Khatunand Alam, 2010 and Afroz et al., 2013). Total CMA banded region was 3.38 μm which occupied about 12.51% of total chromosomal length (Table 1).

The interphase nuclei and prophase chromosomes possessed numerous DAPI- positive bands in this species (Figs. 1.c, 2.c). In metaphase, 15 DAPI positive bands were found. Both the member of chromosome pair VII, IX and a member of the pairs II, IV and VI were entirely fluoresced. Seven DAPI bands were found in short arm of both member of chromosome pairs III, V and a member of pairs I, IV and VIII. A centromeric band was observed in a member of chromosome pair I (Figs. 3.c, 4.c). Heteromorphocity were observed in chromosome pair I, II, IV, VI and VIII where homologue pair showed different banding pattern. These might be due to the result of small deletion, duplication or inversion of corresponding banded region of the paired chromosomes (Khatun and Alam, 2010, Afroz et al., 2013). The total length of DAPI-banded region was 15.2 μm that involved about 56.27 % of it (Table 1).

In conclusion, it may be said that this cytogenetical data of *Euphorbia hirta* L. obtained by conventional and fluorescent staining analysis of chromosomes indicates its primitiveness as well as heteromorphocity in a good number of chromosome pair due to chromosomal aberrations.



Figs. 1-4. Three stages of mitotic cell division of *E. hirta* L. after Orcein, CMA- and DAPI- staining. 1. mitotic interphase nuclei, (a) orcein- stained, (b) CMA-stained, (c) DAPI-stained, 2. mitotic prophase chromosomes, (a) orcein- stained, (b) CMA-stained, (c) DAPI-stained, 3. mitotic metaphase chromosomes, (a) orcein- stained, (b) CMA-stained, (c) DAPI-stained, 4. Karyotype assembled from mitotic metaphase stage, (a) orcein- stained, (b) CMA-stained, (c) DAPI-stained, Bar = 5 µm.

Author's contribution:

MA Collected the research materials, carried out orcein and CMA banding, prepare the manuscript. IJB Carried out DAPI banding, help in data analysis. All authors read and approved the final manuscript.

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References

Afroz M, Sultana SS and Alam SS. 2013. Karyotype and RAPD analysis of three morphological forms of *Alocasia fornicata* (Roxb.) Schott. *Cytologia*. **78**(3): 269-275.

Ahmed ZU, Hassan MA, Begum ZNT, Khondker M, Kabir SMH, Ahmad M, Ahmed ATA, Rahman AKA and Haque EU. 2008. Encyclopedia of Flora and Fauna of Bangladesh. Angiosperms: Dicotyledons (Balsaminaceae - Euphorbiaceae). *Asiatic Society of Bangladesh*. **7**: 423-424.

Akhter S and Alam SS. 2005. Differential fluorescent banding pattern in three varieties of *Cicer arietinum* L. (Fabaceae). *Cytologia*. **70**(4): 441- 445.

Alam SP. 1987. Cytological studies in a *Euphorbia hirta* Linn. population. *Cell Chromosome Research*. **10**: 13-20.

Alam SS and Kondo K. 1995. Differential staining with orecein, Giemsa, CMA and DAPI for comparative chromosome study of 12 species of Australian *Drosera* (Droseraceae). *American Journal of Botany*. **82**: 1278-1286.

Araújo SS, Almeida PM, Randau KP, Fernandes TCC, Marin-Morales MA, Benko-Iseppon AM, Cardona YT, Santos AV and Brasileiro-Vidal AC. 2015. Cytotoxic and genotoxic effects of ethanolic extract of *Euphorbia hyssopifolia* L. on HepG2 cells. *Journal of Ethnopharmacology*. **170:** 16–19.

Bonna IJ, Afroz M, Sultana SS and Alam SS. 2017. Comparative karyotype and RAPD analysis of four *Oxalis* L. Species. *Cytologia*. **82**(5): 527-533.

Chopde VP. 1965. Chromosome numbers in some flowering plants. *Science and Culture*. **31** (1): 30.

Ghosh P, Ghosh C, Das S, Das C, Mandal S and Chatterjee S. 2019. Botanical description, phytochemical constituents and pharmacological properties of *Euphorbia hirta* Linn. *International journal of Health Science and Research*. **9**(3): 274-286.

Hiron N, Alam N, Ahmed FA, Begum R and Alam SS. 2006. Differential fluorescent chromosome banding in *Hibiscus canabinnas* L. and *H. sabdarffa* L. *Cytologia*. **71**(2): 175-180.

Kappor LD. 2001. Handbook of ayurvedic medicinal plants. Washington, DC: CRC press. 182 pp.

Khatun M and Alam SS. 2010. Conformation of species status of *Corchorus trilocularis* by differential chromosome banding and isozyme assay. *Cytologia*. **75**(1): 83-88.

Kothari NM, Ninant CA and Kuriachan PI. 1981. In Chromosome number reports LXXI. *Taxon*. **30**: 511-512.

Krishnappa DG and Reshme RV. 1980. In Chromosome number reports LXVIII. *Taxon*. **29**: 536-537.

Kumar S, Malhotra R and Kumar D. 2010. *Euphorbia hirta:* Its chemistry, traditional and medicinal uses, and pharmacological activities. *Pharmcognosy Reviews*. **4**(7): 59-61.

Kuta FA, Damisa D, Adamu A, Nwoha E and Bello IM. 2014. Antibacterial activity of *Euphorbia hirta* against *Streptococcus pneumoniae*, *Klebsiella pneumoniae* and *Proteus vulgaris*. *Bayero Journal of Pure and Applied Sciences* **6:** 65–68.

Levitsky GA. 1931. The karyotype in systematics. *Bull. Appl. Bot., Genet. & Plant Breed*. **27:** 220-240.

Ono M and Masuda Y 1981. Chromosome numbers of some endemic species of the Bonin Islands II. *Ogasawara Research*. **4**: 1-24.

Podlech D. 1986. Chromosom en studien en Pflanzen des Saharo-Sindischen Trockengebietes. *Mitt. Bot. Staat. Mün*. **22**: 5–20.

Raghavan RS and Arora CM. 1958. Chromosome numbers in Indian medicinal plants. II.-proc. *Indian Acad. Sci. Sect. B* **47**(6): 352-358.

Santana KCB, Pinangé DSB, Vasconcelos, Oliveira AR, Brasileiro-Vidal AC, Alves MV and Benko-Iseppon AM. 2016. Unraveling the karyotype structure of the spurges *Euphorbia hirta* Linnaeus, 1753 and *E. hyssopifolia* Linnaeus, 1753 (Euphorbiaceae) using genome size estimation and heterochromatin differentiation. *Comparative Cytogenetics*. **10**(4): 657-696.

Schweizer D. 1976. Reverse fluorescent chromosome banding with Chromomycin and DAPI. *Chromosoma*. **58**: 307-324.

Shi QW, Su XH and Kiyota H. 2008. Chemical and pharmacological research of the plants in genus *Euphorbia*. *Chemical Reviews*. **108**: 4295–4327.

Skornickova JL, Sida O, Jarolimova V, Sabu M, Fer T, Travicek P and Suda J 2007. Chromosome numbers and genome size variation in Indian species of *Curcuma* (Zingiberaceae). *Annals of Botany*. **100**: 505-526.

Stebbins GL. 1971. Chromosomal evolution in higher plants. Addison-Wesley publishing company, California, USA. pp. 97.

Sultana SS and Alam SS. 2007. Differential fluorescent chromosome banding of *Solanum nigrum* L. and *Solanum villosum* L. from Bangladesh. *Cytologia*. **72**(2): 213-219.

Tanaka R. 1971. Type of resting nuclei in Orchidaceae. *Bot. Mag. Tokyo*. **84**: 118-122.

Wang YH, Ma JS and Liu QR. 1999. Karyotypes of eight species of *Euphorbia* L. (Euphorbiaceae) from China. *Acta Phytotax. Sin*. **37**(4): 394-402.

Webster GL. 1994. Classification of the Euphorbiaceae. *Annals of the Missouri Botanical Garden*. **81:** 3–32.

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PREVALENCE OF THALASSEMIA CARRIER AMONG STUDENTS OF UNIVERSITY OF BARISHAL, BANGLADESH

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Abstract
Thalassemia is rising as a major public health concern in South Asia, although childhood mortality has been reduced a lot. World's thalassemia belt includes Bangladesh, although knowledge regarding thalassemia is considerably poor here. Every year 7000 new babies are born with thalassemia in Bangladesh as 7% of our population are thalassemia carrier. A survey on Thalassemia awareness took place at the University of Barisal in April 2019 and it was found that only 10% of students had heard about thalassemia. This pilot study aimed to identify the β-Thalassemia carrier among students of the University of Barishal, Bangladesh to spread the knowledge and awareness among all the students and to their families. The present study was conducted in collaboration with BioTED. This study includes 115 individuals (53.04% male and 46.96% female) who are aged between 19 to 25 years. Among the 115 cases, 7.83% showed the presence of abnormal haemoglobin where 6.96% have HbE trait (ETT) and 0.87% have beta-thalassemia trait (BTT). The present study indicates that the frequency of the carrier is alarmingly high for HbE and β-thalassemia in Bangladesh.

***Keywords**:* Thalassemia, Hb-electrophoresis, β-globin, HbE trait.

Introduction

Inherited hemoglobin (Hb) disorders, also known as haemoglobinopathies are the highest common inherited blood disorders internationally. Approximately 3.4% of deaths of children under 5 years is caused by haemoglobinopathies (Modell and Darlison, 2008). Human globin genes mutations cause this disease that is classified into two groups-one groups of people to have abnormal globin structurally (Hb variants) whereas the other group of people have impaired globin synthesis (thalassemia). The most common form thalassemia are α-thalassemia (OMIM: #604131) and β-thalassemia (OMIM: #613985) which are categorised by the absence or decreased accumulation of α- and β-globin subunits (Shang and Xu, 2017).

In tropical and subtropical regions thalassemia is a predominant disease and malaria is endemic. Having a survival advantage in malarial endemic areas may cause a high frequency of hemoglobinopathies along with the carrier number (Galanello and Cao, 2011). The number of thalassemia variants carrier is very high in the Indian subcontinent along

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with Southeast Asia, Africa, the Middle East and the Mediterranean area (Weatherall, 2001; Piel and Weatherall, 2014). Moreover, thalassemia is not limited to conventional high-incidence regions anymore because of the recent massive population migrations. Currently, thalassemia has also become a common clinical problem in North America, Northern Europe and Australia (Galanello and Cao, 2011). To cope up with this disease the clinical management of thalassemia is also changes in the local health system of these areas such as, in California screening for Hb H disease has been added for newborns that can detect a common form of α-thalassemia (Lorey et al., 2001). The universal newborn screening was supported by Lal's group after they found 86 Hb H diseased patients (Lal et al., 2011). They also suggested that newborn screening should be extended to other populations for the clinical advantage against thalassemia (Lal et al., 2011).

Carriers of thalassemia mutations show no clinical abnormalities as the inheritance mode of thalassemia is autosomal recessive (AR). The chances of a child being a thalassemia patient are 25%, while 25% chance that the child will be normal and rest 50% child will be a thalassemia carrier, for every pregnancy when both parents are carriers (Shang and Xu, 2017). Prenatal diagnosis is the only way to check the birth risk of a child of thalassemia carrier parents or patients. Therefore, reduction the birth rate of thalassemia patients can be achieved by identifying high-risk couples before pregnancy by screening (or carrier testing) then perform a diagnostic procedure during pregnancy (Shang and Xu, 2017). Alternatively, both carrier (male and female) should not be getting married i.e. if one carrier male/female getting marriage with either one normal female/male, then the offspring will never become a diseased one.

Two sorts of globin genes mutations cause thalassemia: deletion and nondeletion. Nondeletion defects contain single nucleotide substitutions or oligonucleotide deletions/insertions whereas the deletion one generally involves a range of 1 kb (Shang and Xu, 2017). Interestingly, a special spectrum of α- and β-thalassemia mutations is frequently found in several populations worldwide which are characteristics as the reference data of the mutations. And that is why during a molecular diagnosis, the ethnic origin of a patient is considered. A major number of α-thalassemia is caused by deletion because of two α-globin genes present on the same chromosome. The haplotype is often written as αα/ which can easily describe the three classified groups of α-thalassemia mutations (Higgs, 2013; Piel and Weatherall, 2014). In case of α+-thalassemia deletion (-α/), just one α-globin gene is removed while α0-thalassemia deletion (--/) means the removal of both α-globin genes; and the third group is known as where either one of the α gene (α 2 or α1) is affected. On the other hand, a major number of β-thalassemia is caused by nondeletion defects. Altogether, 300 nondeletion β-thalassemia variants have been reported so far in several populations that include point mutation as well as small deletions within the exons of the β-globin gene, like βCD54–58 (−13 bp) and βCD89–93 (−14 bp) (Shang et al., 2011).

Beta-thalassemia became prevalent in Mediterranean, Italy, Greece, Turkey, West Asia, North Africa, South Asian, and Southeast Asia with 25000 death around the world in 2013 (Sharma et al., 2017). The absolute best carrier frequency is reported in Cyprus (14%), Sardinia (10.3%), Maldives (16.2%) and Southeast Asia (Flint et al., 1998; Mustafa et al., 2020). The high gene frequency of β-thalassemia in these regions is presumably associated with the selective pressure from *Plasmodium falciparum* malaria (Flint et al., 1998). Population migration and intermarriage between different ethnic groups have introduced thalassemia in almost every country of the planet, including Northern Europe where thalassemia was previously absent. About 1.5% of the worldwide population (80 to 90 million people) are reported as carriers of β-thalassemia (Bharti et al., 2020). Around 60,000 symptomatic individuals are born annually and the majority belongs to the developing world (Barua et al., 2020). Worldwide the total annual frequency of symptomatic individuals is reported 1 in 100,000 and 1 in 10,000 people within the European Union (Kadhim et al., 2017). Nevertheless, accurate data on carrier rates in many populations are still unknown as they study regarding this disease is still not spread out to all the region that are heavily affected (Vichinsky, 2005). Consistent with the Thalassemia International Federation (TIF), only about 200,000 patients with Cooley's anaemia (thalassemia major) are alive and registered as receiving regular treatment around the world (Eleftheriou, 2008; Soteriades and Weatherall, 2014; Farmakis et al., 2020). Abnormal Hb or structural Hb variant is the most common combination of β-thalassemia. Surprisingly, Southeast Asia has the highest prevalence in HbE/β-thalassemia with the carrier frequency is around 50-60% (Black et al., 2010; Fucharoen and Weatherall, 2012).

There are some prerequisites for thalassaemia prevention including raising awareness and education to health personnel, groups at risk, the population at large and also among policymaker (Co and Kan, 2012). Several intervention strategies werealso implemented in several countries for the prevention of thalassaemia. These include mandatory pre-marital screening and genetic counselling (MPSGC), prenatal diagnosis (PND) with an option for termination of an affected pregnancy. Countries like Cyprus, Italy, Greece, Turkey and Iran have successfully (80–100%) preventing the births of children with thalassaemia (Saffi and Howard, 2015). Genetic counselling proves to play the most important part of thalassaemia prevention (Tahura et al., 2016). A genetic counsellor should know about the molecular genetics of thalassaemia and have sufficient expertise to communicate with others and give detailed information about the disease to the patients and family members (Amin, 2011).

Bangladesh is a developing country where most of the people are Muslim and culturally sensitive. Although, health facilities have been improved a lot in Bangladesh, unfortunately there is no β-thalassaemia prevention program at the national level. There are very few hospitals that can provide facilities related to thalassemia and they are only based in the capital Dhaka that made it very insufficient and inconvenient for the whole population of the country (Tahura et al., 2016). Moreover, the majority of the population are unaware of thalassaemia due to lack of knowledge about this hereditary disease (Tahura et al., 2016).

The present study is the very first one that mainly aims for screening the thalassemia carrier among university students. Previous studies in different countries have shown that targeting college students (age 16 years and above) for thalassaemia screening and education are often effective in preventing the birth of affected children (Scriver et al., 1984; Mitchell et al., 1996). Unfortunately, a recent large scale study revealed that 67% of the college students of Bangladesh have not heard about thalassemia as a disease as there is no organized national program for raising awareness (Premawardhena et al., 2004; Firdous, 2005; Cao and Kan, 2013; Colah et al., 2017; Zaheer and Waheed, 2017; Hossain et al., 2020). Thus screening all the students in different types of institutions (e.g. High School, College, and University) can play a vital role in thalassemia prevention in Bangladesh (Hossain et al., 2020).

Methods

Study population

There were 115 participants (aged between 19–25 years) in this study that was conducted during December 2019 from 10 departments of the major disciplines (Arts, Science, Business and Social Sciences), of the University of Barishal. The study mainly aimed to find out the importance of raising awareness and screen young unmarried adults. After obtaining written informed consent, 5.0 ml of venous blood was collected from each participant via standard venepuncture in EDTA tube. This study was approved by the ethical review board of the University of Barishal, Bangladesh. Each participant received the report through email after completion of the screening tests.

Electrophoresis

For haemoglobin electrophoresis, Capillarys Hemoglobin (E) kit was used to measure HbA, HbA2, HbF and other abnormal Hb variants on Sebia CAPILLARYS-2 Flex Piercing (Sebia, Lisses, France) following manufacturer's instructions (Sebia, 2020). Haemoglobin electrophoresis was carried out in the laboratory of Thalassemia Samity Hospital (TSH) in Dhaka.

Statistical analysis

Statistical analysis was carried out using the SPSS statistical package (version 27.0).

Results

According to statistics, approximately 30,000 are affected by β-thalassemia major while 3500 with hydrops fetalis syndrome among 56,000 conceptions having major thalassemia disorder around the world (Cao and Kan, 2013). It has also been reported that globally 1.33

million pregnancies are at risk for a thalassemia major condition as 9 million carriers become pregnant per year (Modell and Darlison, 2008; Weatherall, 2010). Low-income countries along with the developing one have to carry a huge health burden as a major part of patients are there (Cao and Kan, 2013). Approximately 3% of the population are the carriers of β-thalassemia and 4% are the carriers of haemoglobin E (HbE) in Bangladesh according to the World Health Organization (WHO) (World Health Organization, 2008). According to the Bangladesh Thalassemia Foundation, 7% of the Bangladeshi population are thalassemia carriers and 7000 new babies are born with thalassemia every year (Bangladesh Thalassemia Foundation, 2020).

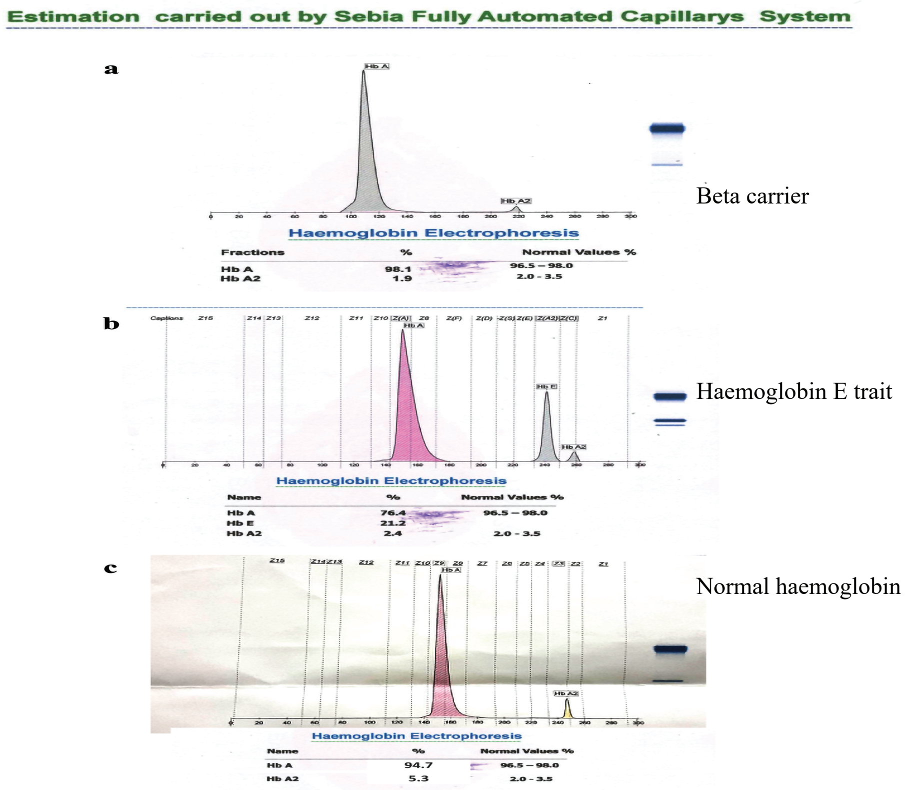

Fig. 1. Electrophorograms for Hb electrophoresis of normal haemoglobin, haemoglobin E trait and beta carrier. Capillary zone electrophoresis (CZE) is a widely used tool for analysis of haemoglobin variants. (a) Electropherogram of normal human hemoglobins where Hb A is in designated zone 9 and the percentage (98.1%) is well within the range (96.5-98 %). (b) In CZE, HbE moves behind HbA_2. Therefore, classical hemoglobin pattern of HbE trait is A_2EA. The percentage of these hemoglobins is as follows: HbA_2 -2.5%, HbE- 21.2% and HbA-76% which is much lower than the normal values of healthy adult. (c) In β-thalassemia carrier at adult life, the CZE pattern of hemoglobin typing result is A_2A or A_2FA with HbA_2 levels of more than 3.5% and HbF levels of less than 2% are always observed (Winichagoon et al., 2008).

Among 115 participants enrolled in our study, 106 (92.17%) were found normal and 9 (7.83%) cases were found to be the carrier of thalassemia. Of 7.83% carriers of β-globin gene mutations, 6.96% had HbE trait (ETT) and 0.87% had β-thalassemia trait (BTT). Out of 9 abnormal cases, 6 (66.67%) were females and 3 (33.33%) was male which indicated higher carrier probability in female compare to male.

Three different electrograms for Hb electrophoresis (normal, ETT and BTT) found in the present study are shown in figure 1. And table 1 and 2 represents the spectrum of haemoglobinopathies found among students (n=115) of the University of Barishal.

Table 1. Spectrum of haemoglobinopathies in University of Barishal (Gender wise).

Type of haemoglobinopathies	Incidence No. (%)		
	Male	Female	Total
Normal	58 (50.43)	48 (41.74)	106 (92.17)
Beta Carrier	0 (0)	1 (0.87)	1 (0.87)
E-Trait	3 (2.61)	5 (4.35)	8 (6.96)
Total	61 (53.04)	54 (46.96)	115 (100)

Table 2. Spectrum of haemoglobinopathies in University of Barishal (Age wise)

Type of haemoglobinopathies	Age Group (%)		Total
	11-20	**21-30**	
Normal	11 (9.57)	95 (82.61)	106 (92.17)
Beta Carrier	0 (0)	1 (0.87)	1 (0.87)
E-Trait	0 (0)	8 (6.96)	8 (6.96)
Total	11 (9.57)	104 (90.43)	115 (100)

Discussion

With 2,885 people living per square mile, Bangladesh is one of the most densely populated countries in the world (Chowdhury et al., 2015). A major part of the population lives in the rural area where the number of the tertiary hospitals are lower than the urban area. Here the public hospitals are overcrowded and lack of enough resources while the private clinics are out of reach for the general population (Islam and Biswas, 2014). As a result, the treatment drop-out rate is very common in Bangladesh. Being in the world's thalassemia belt, Bangladesh has the chance to face a major public health concern regarding thalassemia as it seems like the knowledge regarding this genetic disorder has not reached out to the mass population (Parvin et al., 2006; Hossain et al., 2020).

A study conducted by Khan et al. in 2005 reported an average frequency of 10.2% β-thalassemia carrier in Bangladeshi population with a 6.1% ETT and 4.1% BTT based on conventional haematological approaches (Khan et al., 2005). A recent study in 2020 by Noor et al. used a molecular approach to avoid false positive and false negative results and indicated the total carrier frequency of ETT and BTT as 10.92% (95% CI, 9.51–12.33), where ETT had the highest frequency 8.68% (95% CI, 7.41–9.95) followed by BTT, 2.24% (95% CI, 1.57–2.91) (Noor et al., 2020). Another study shows 28% of assessed rural women have β-thalassemia or HbE (Merrill et al., 2012).

The medical cost required for thalassemia patient per year can vary from BDT 127,000 (USD 1632; USD 1 = BDT 78) to BDT 309,000 (USD 3960) according to age, body weight and type of the disease (Hossain et al., 2017). The families with thalassemia patients in Bangladesh having no national insurance facility as well as any free treatment system from the government are carrying a severe economic and emotional burden. Several thalassemia endemic countries have set up comprehensive national prevention programs (Cao and Kan, 2013; De Sanctis et al., 2017). Effectiveness of such prevention programs like public awareness and education, carrier screening using molecular diagnostics, genetic counselling and prenatal diagnosis in Sardinia is evidenced by a reduction in the birth rate with thalassemia major from 1:250 live births to 1:4000. Such magical success has also been achieved by other countries (Bozkurt, 2007; Cao and Kan, 2013). These strategies may help the policymakers of Bangladesh to adopt an appropriate thalassemia prevention strategy.

Prevention of thalassemia is far cheaper and better than treatment. Immediate and concerted action on thalassemia prevention should be made mandatory in Bangladesh as currently as there is no affordable cure is available for thalassemia. Dissemination of information regarding thalassemia and its consequences should be accelerated by all kinds of digital media so that people can be made aware of it. Professionals like physicians can play a pivotal role in reducing the number of children with thalassemia. In parallel, a build-up of awareness by social bodies and organizations are also important to engage the wider population. A continuous and nationwide awareness program may remove the stigma of thalassemia as a “familial” disease and encourage more people to go for the screening before marriage.

The information of this study will be helpful in several ways, such as getting an insight of carrier frequency among university students and grasp the gravity of the situation, identifying the population at-risk and thus prioritizing them, and necessities and benefits of molecular-based carrier screening. Universities and other educational institutions should run such program continuously so that students can go through screening before they start their married life. It is particularly important for female students who usually get married earlier than their male counterparts. This can have additional benefits such as students can spread awareness among their families, relatives and society. Therefore, spreading awareness among the educated class of the society is likely to enhance the premarital thalassemia prevention strategy.

Conclusions

The present study depicts the preview of the carrier frequency in a small group of people, which highlights the implementation of a molecular screening method to overcome the shortcomings of the conventional methods. It also indicates HbE/β-thalassemia is looming as a threat for Bangladesh. Thus, necessary measures like awareness program for the mass population, genetic counselling and establishment of carrier screening facilities across the country are needed to implement here immediately. Critical knowledge gaps and misconceptions about thalassemia should be removed by an organized effort that can be facilitated by the dissemination of thalassemia related information and conducting screening programs in educational institutions.

Authors contribution

All authors are equally contributed, there is no conflict of interest.

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Refferences

Amin SK. 2011. Prevention of thalassaemia by genetic counseling. *Anwer Khan Modern Medical College Journal.* **2**(2): 26-28.

Bangladesh Thalassemia Foundation. 2020. From https://www.thals.org/.

Barua T, Das AK, Sultana R, Das D and Arju MAC. 2020. Socio-demographic Profile of Patients Admitted in Thalassemia Care Center of Chattogram Maa Shishu-O-General Hospital. *Chattagram Maa-O-Shishu Hospital Medical College Journal.* **19**(1): 33-37.

Bharti OK, Sood RK, Sharma HR, Kaur H, Minhas V, Chauhan R, Nigam N and Phull A. 2020. Mean corpuscular volume/mean corpuscular hemoglobin values are not reliable predictors of the β-thalassemia carrier status among healthy diverse populations of Himachal Pradesh, India. *Asian Journal of Transfusion Science.* **14**(2): 172.

Black M, Sinha S, Agarwal S, Colah R, Das R, Bellgard M and Bittles A. 2010. A descriptive profile of β-thalassaemia mutations in India, Pakistan and Sri Lanka. *Journal of community genetics.* **1**(3): 149-157.

Bozkurt G. 2007. Results from the north cyprus thalassemia prevention program. *Hemoglobin.* **31**(2): 257-264.

Cao A and Kan YW. 2013. The prevention of thalassemia. *Cold Spring Harbor perspectives in medicine.* **3**(2): a011775.

Chowdhury MAI, Kabir MM, Sayed AF and Sultana N. 2015. Pressurized Population Growth with Progressive Health facility, Life Expectancy and Declining Death in Bangladesh. *Int. Res. J. of Soc. Sci.* **4**: 1-10.

Co A and Kan Y. 2012. The Prevention of Thalassaemia. *Cold Spring Harb Perspect Med.*

Colah R, Italia K and Gorakshakar A. 2017. Burden of thalassemia in India: The road map for control. *Pediatric Hematology Oncology Journal.* **2**(4): 79-84.

De Sanctis V, Kattamis C, Canatan D, Soliman AT, Elsedfy H, Karimi M, Daar S, Wali Y, Yassin M and Soliman N. 2017. β-Thalassemia distribution in the old world: an ancient disease seen from a historical standpoint. *Mediterranean journal of hematology and infectious diseases.* **9**(1).

Eleftheriou A. 2008. Thalassemia International Federation: Guidelines for the clinical management of thalassemia. *Thalassemia International Federation Nicosia Cyprus.*

Farmakis D, Giakoumis A, Angastiniotis M and Eleftheriou A. 2020. The changing epidemiology of the ageing thalassaemia populations: A position statement of the Thalassaemia International Federation. *European Journal of Haematology.*

Firdous N. 2005. Prevention of thalassaemia and haemoglobinopathies in remote and isolated communities—the Maldives experience. *Annals of human biology.* **32**(2): 131-137.

Flint J, Harding RM, Boyce AJ and Clegg JB. 1998. The population genetics of the haemoglobinopathies. *Baillieres Clin Haematol.* **11**(1): 1-51.

Fucharoen S and Weatherall DJ. 2012. The hemoglobin E thalassemias. *Cold Spring Harb Perspect Med.***2**(8).

Galanello R and Cao A. 2011. Gene test review. Alpha-thalassemia. *Genet Med.* **13**(2): 83-88.

Higgs DR. 2013. The molecular basis of alpha-thalassemia. *Cold Spring Harb Perspect Med.***3**(1): a011718.

Hossain MS, Hasan MM, Raheem E, Islam MS, Al Mosabbir A, Petrou M, Telfer P and Siddiqee MH. 2020. Lack of knowledge and misperceptions about thalassaemia among college students in Bangladesh: a cross-sectional baseline study. *Orphanet journal of rare diseases.* **15**(1): 1-10.

Hossain MS, Raheem E, Sultana TA, Ferdous S, Nahar N, Islam S, Arifuzzaman M, Razzaque MA, Alam R and Aziz S. 2017. Thalassemias in South Asia: clinical lessons learnt from Bangladesh. *Orphanet journal of rare diseases.* **12**(1): 93.

Islam A and Biswas T. 2014. Chronic non-communicable diseases and the healthcare system in Bangladesh: current status and way forward. *Chronic Dis Int.* **1**(2): 6.

Kadhim KA, Baldawi KH and Lami FH. 2017. Prevalence, incidence, trend, and complications of thalassemia in Iraq. *Hemoglobin.* **41**(3): 164-168.

Khan W, Banu B, Amin S, Selimuzzaman M, Rahman M, Hossain B, Sarwardi G, Sadiya S, Iqbal A and Rahman Y. 2005. Prevalence of beta thalassemia trait and Hb E trait in Bangladeshi school children and health burden of thalassemia in our population. *DS (Child) HJ.***21**(1): 1-7.

Lal A, Goldrich ML, Haines DA, Azimi M, Singer ST and Vichinsky EP. 2011. Heterogeneity of hemoglobin H disease in childhood. *N Engl J Med.* **364**(8): 710-718.

Lorey F, Cunningham G, Vichinsky EP, Lubin BH, Witkowska HE, Matsunaga A, Azimi M, Sherwin J, Eastman J, Farina F, Waye JS and Chui DH. 2001. Universal newborn screening for Hb H disease in California. *Genet Test.* **5**(2): 93-100.

Merrill RD, Shamim AA, Ali H, Labrique AB, Schulze K, Christian P and West KP. 2012. High prevalence of anemia with lack of iron deficiency among women in rural Bangladesh: a role for thalassemia and iron in groundwater. *Asia Pacific journal of clinical nutrition.***21**(3): 416.

Mitchell JJ, Capua A, Clow C and Scriver CR. 1996. Twenty-year outcome analysis of genetic screening programs for Tay-Sachs and beta-thalassemia disease carriers in high schools. *American journal of human genetics.* **59**(4): 793.

Modell B and Darlison M. 2008. Global epidemiology of haemoglobin disorders and derived service indicators. *Bull World Health Organ.* **86**(6): 480-487.

Mustafa I, Firdous N, Shebl FM, Shi Z, Saeed M, Zahir Z and Zayed H. 2020. Genetic epidemiology of beta-thalassemia in the Maldives: 23 years of a beta-thalassemia screening program. *Gene.* 144544.

Noor FA, Sultana N, Bhuyan GS, Islam MT, Hossain M, Sarker SK, Islam K, Khan WA, Rahman M and Qadri SK. 2020. Nationwide carrier detection and molecular characterization of β-thalassemia and hemoglobin E variants in Bangladeshi population. *Orphanet journal of rare diseases.* **15**(1): 15.

Parvin R, Uddin M, Azam M and Akhteruzzaman S. 2006. “Prevalence and Spectrum of ß-Thalassemia and Other Haemoglobinopathies in a Selected Population of Bangladesh”.

12: 132-135.

Piel FB and Weatherall DJ. 2014. The alpha-thalassemias. *N Engl J Med.* **371**(20): 1908-1916.

Premawardhena A, de Silva S, Arambepola M, Olivieri N, Merson L, Muraco J, Allen A, Fisher C, Peto T and Vichinsky E. 2004. Thalassemia in Sri Lanka: a progress report. *Human molecular genetics.* **13**(suppl_2): R203-R206.

Saffi M and Howard N. 2015. Exploring the Effectiveness of Mandatory Premarital Screening and Genetic Counselling Programmes for beta-Thalassaemia in the Middle East: A Scoping

Review. *Public Health Genomics.* **18**(4): 193-203.

Scriver CR, Bardanis M, Cartier L, Clow C, Lancaster G and Ostrowsky J. 1984. Beta-thalassemia disease prevention: genetic medicine applied. *American journal of human genetics.* **36**(5): 1024.

sebia 2020. Capillarys 2 Flex Piercing. https://www.sebia.com/en-EN/produits/capillarys-2-flex-piercing.

Shang X, Rao Z, Lou J, Li W, Xiong F, Zhou HP and Xu X. 2011. Compound heterozygosity for a rare small deletion and a common point mutation in the beta-globin gene: report of two Chinese families. *Int J Lab Hematol.* **33**(1): 79-84.

Shang X and Xu X. 2017. Update in the genetics of thalassemia: What clinicians need to know. *Best Practice & Research Clinical Obstetrics & Gynaecology.* **39**: 3-15.

Sharma DC, Arya A, Kishor P, Woike P and Bindal J. 2017. Overview on thalassemias: a review article. *Medico Research Chronicles.* **4**(03): 325-337.

Soteriades ES and Weatherall D. 2014. The Thalassemia International Federation: a global public health paradigm. *Thalassemia Reports.*

Tahura S, Selimuzzaman M and Khan WA. 2016. Thalassaemia Prevention: Bangladesh Perspective-A Current Update. *Bangladesh Journal of Child Health.* **40**(1): 31-38.

Vichinsky EP. 2005. Changing patterns of thalassemia worldwide. *Ann N Y Acad Sci.* **1054**: 18-24.

Weatherall D. 2010. Thalassemia as a global health problem: recent progress toward its control in the developing countries. *Annals of the New York Academy of Sciences.* **1202**(1): 17-23.

Weatherall DJ. 2001. Phenotype-genotype relationships in monogenic disease: lessons from the thalassaemias. *Nat Rev Genet.* **2**(4): 245-255.

Winichagoon P, Svasti S, Munkongdee T, Chaiya W, Boonmongkol P, Chantrakul N and Fucharoen S. 2008. Rapid diagnosis of thalassemias and other hemoglobinopathies by capillary electrophoresis system. *Translational Research.* **152**(4): 178-184.

World Health Organization. 2008. Management of haemoglobin disorders: report of a joint WHO-TIF meeting, Nicosia, Cyprus, 16-18 November 2007.

Zaheer H and Waheed U. 2017. Development of a national thalassemia policy in Pakistan. *Global Journal of Transfusion Medicine.* **2**(1): 69-69.

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RIVER BANK EROSION PROBLEM IN BARISHAL, BANGLADESH: AN OVERVIEW FROM SOCIO-ECONOMIC CONTEXTS

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Abstract

River bank erosion is one of the most commonly faced disasters in Bangladesh. Socio-economic condition and population migration due to river bank erosion of Batamara union in muladi Upazilla of Barishal district in last 25 years was studied. A questionnaire survey was followed for the collection of information. Study says that people had lost their homestead and agricultural land ranges from 1 to 5 acres with high range of economic loss ranges from 0.85-4.0 million for homestead and 0.5-2.5 million for agricultural land. Land loss causes migration which is almost 50%. Almost 90% of growers have lost their agricultural land and are forced to change their way of livelihood. 19.5% of people who were resettled in nearby char and in same upazilla lead a poor health condition. 20-25% of the student dropped out from both primary and secondary school and the rate is on increase.

Keywords: River bank erosion, Socio economic impact, Migration, Quality of life

Introduction

River bank erosion is a common natural disaster for the riverine countries like Bangladesh (Baqee, 1997). More than 310 rivers and tributaries have made this country a land of rivers (Siddique *et al*., 2014). The origin of the major rivers of Bangladesh is the mighty Himalaya and are enters into the country from upstream with a tons of sediments to contribute in agricultural sector from the ancient era. In contrary, the country faces severe river bank erosion (Mollah and Ferdaush, 2015; Rabbi *et al*., 2013; Uddin and Rahman, 2011). River bank erosion is strongly influenced by the pore water pressures and the moisture content within the bank, which are influenced by hydrologic processes and riparian vegetation (Simon and Collison, 2002). When stress of water and sediments exceed the resistance of the bank, erosion occurs (Islam and Rashid, 2011). This phenomenon displaces human civilization and damages agricultural land. According to Das *et al*., (2014), a total number of 728,439 people has been displaced from their original homesteads by river bank erosion during 1981-1993 and it was also estimated that the annual number of displacement is to be 63,722 people. Density of population is also increasing over time as river bank erosion is progressively affecting more and more people (Indra, 2000).

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The study is conducted to the Batamara union under Muladi Upazilla, Barishal, situated on the bank of Arial Kha River and the union is surrounded by the river in three sides. According to the villagers, “joyonti river” (a branch of Meghna river) also flows through the south side of the union. The area of the union is 7640 acre with a population of around 21,940 (BBS, 2011). Both rivers are losing their depths and people face erosion in both northern and southern part of the union. The villagers of the union meet various socio-economic difficulties like losing their households, farms, social and educational organizations, agricultural lands and communication roads etc. Many people of the area have been forced to change their life style and are compelled to look for alternative sources of income due to this reason. Maximum affected people are being migrated to nearby char land and or urban to sub-urban areas. In view of the above conditions this study has been carried out the actual picture (Social and Economic) of the adversely affected population especially in the bank of the Arial Kha River.

Methodology

Batamara union is a very rural area of the Barishal district. The longitude and latitude of the area are 23°1'21.1584"N and 90°19'55.2576"E, respectively. The study was conducted from September 2018 to February 2019.

Information was collected through “Focus Group discussion and questionnaire survey

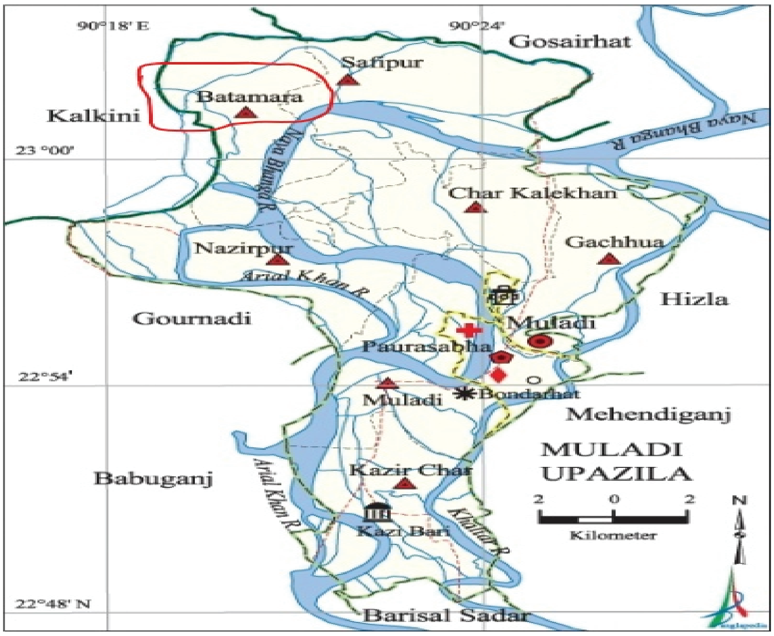

Fig. 1. Location map of the study area.

(Appendix-1)". Around 400 families from eight villages named Batamara and char Batamara, West Salimpur, South Salimpur, Alimabad, Toyka, Char Alimabad, and West char Salimpur. Within these 400 families, 120 vulnerable families were displaced one to two times and now living in the river site. About 20 key informant interviews were taken from the reference person in the societies like school teachers, Government organizations, NGO workers, Union Parishad members, current and previous chairman of the union, etc. In the group discussion each group consisted of 8-12 people. People who were interviewed were about 30-50 years old. The area marked with a polygon (Fig. 1) represents the location of the studied area. The graphical representations with data analyses were done in Microsoft Office Excel 2007.

Results and Discussion

Impact on Socio-economic condition

(a) Loss of Households

Due to river bank erosion people of the study area have lost their agricultural and homestead land and became rootless, ousted from their community, broken down their family ties and social bondage.

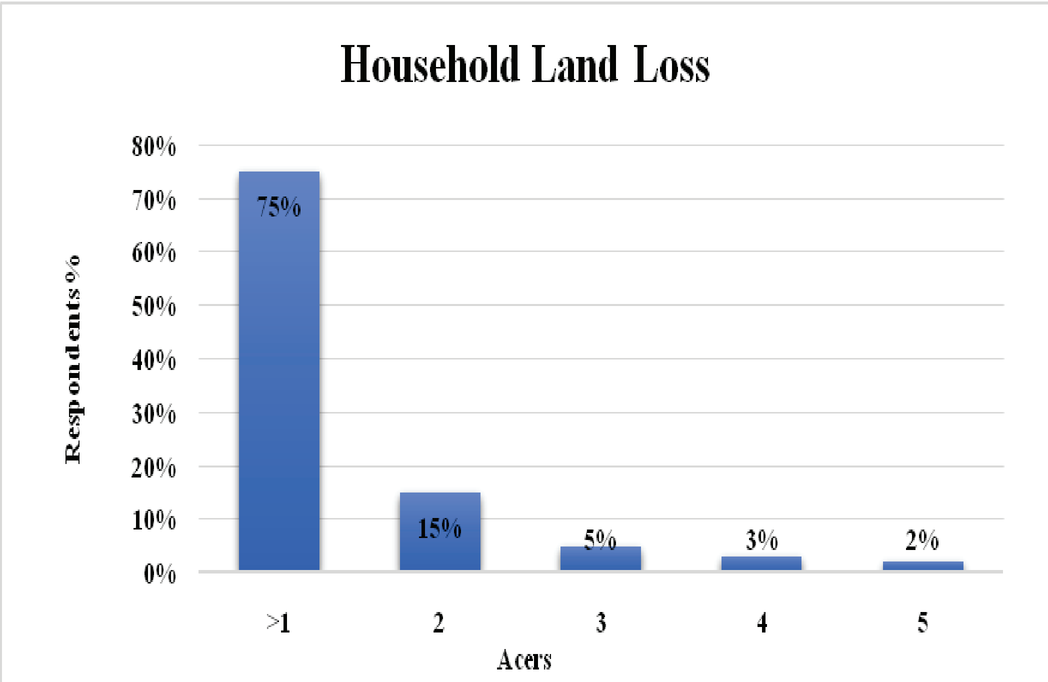

Fig. 2. Loss of household area

From the study it is found that about 75% people have lost greater than 1 acre of household lands. During this survey, 15% respondents said that they have lost 2 acres homestead area, 5% respondents for 3 acres and 3% responds for 4 acres homestead land due to river bank erosion. Only 2% people have lost homeland about 5 acres (Fig. 2). This result conforms well to those of Roy *et al.,* (2017).

(b) Loss of Agricultural Land

The effect of loss of agricultural land is enormous, and it is quite impossible to regain. Due to riverbank erosion many farmers become poor overnight. Maximum people of the studied area depend on agriculture. So, losing cultivable lands made them economically vulnerable.

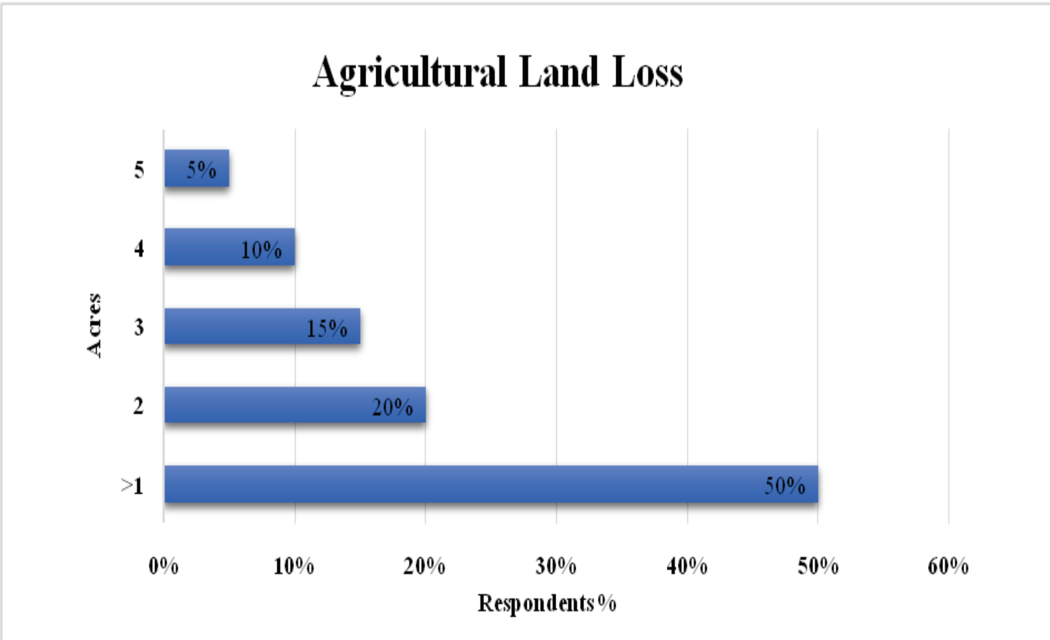

Fig. 3. Loss of Agricultural Land

From the study it is evident that, 50% respondents have lost greater than 1 acres of their agricultural land (Fig. 3). About 20% who have lost agricultural lands about 2 acres, 15% people of the study area have lost about 3 acres of land. Minimum 4 acres of agricultural land have lost about 10% of respondents. About 5% people of the affected area have lost 5 acres of land.

According to Roy *et al.,* (2017), it was recorded that almost 63% respondents have lost less than 5 acres agricultural land of Durgapasha union in Bakergonj Upazilla due to river bank erosion. Siddik *et al.,* (2017) found that out of 100 respondents 90 respondents have lost their cultivable lands in Nalua union of Bakerganj Upazilla. Uddin and Basak (2012) conducted a study in the riverbank erosion prone area in Sirajganj and Gaibandha district and found that 38.9 and 40.9 percent respondents of the area respectively lost 0.2 to 0.5 ha of their agricultural land.

Impact on economic loss

(a) Monetary Loss for Homestead

River bank erosion has been created unpredictable monetary problem. This monetary loss brings unwanted sufferings for sufferer to find a place to remake his/her house. River bank erosion largely affects poor and marginalized people who are not capable enough to overcome the loss. Wiped out of homesteads implies that the family or individual lost the total assets. Empirical data (Fig. 4) shows that respondents have lost above 4,000,000 BDT for per 5 acres land. Approximately 3,000,000 BDT for per 4 acres homestead land, more or less 2,000,000 BDT have lost for 3 acres of homestead land. Observed data showed that the monetary cost per 2 acres of land is above 1,000,000 BDT. The monetary loss of 1 acre's homestead land is <850,000 BDT.

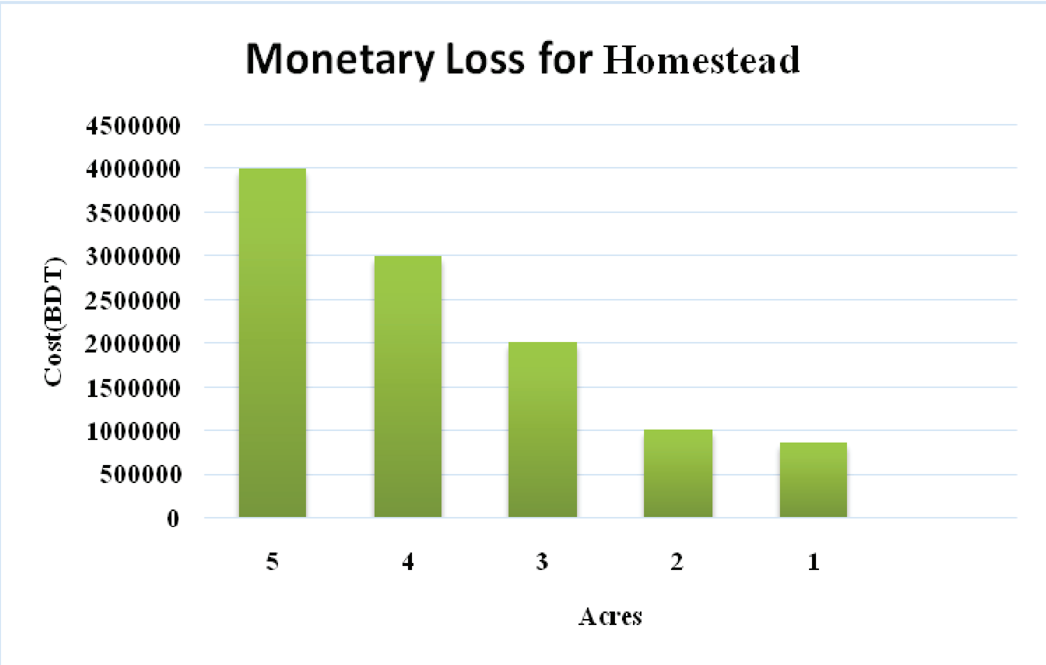

Fig. 4. Monetary Loss for Homestead due to river bank erosion

Baki (2014) reported that 25.6% of respondents have faced monetary loss below 2,000,000 BDT for homestead land. 21.6% of them have faced monetary loss in between 2,000,000 to 4,00,000 BDT; 16.9% in between 4,00,000 to 6,00,000 BDT; 22.7% in between 6,00,000 to 8,00,000 BDT and 13.2% displaces have faced monetary loss more than 8,00,000 BDT which is similar to our study. The money is calculated based on per acre price of homestead land. There price is approximately 500,000 TK/acre in the studied area. The price valuation is also cross verified from the Union Parishad and from the reference person. The price varies on the location of the land.

(b) Monetary Loss for Agricultural land

Agricultural land is the vital resource for the people living in Bangladesh as almost 84% percent of people depend on agriculture (Mirza, 2015).

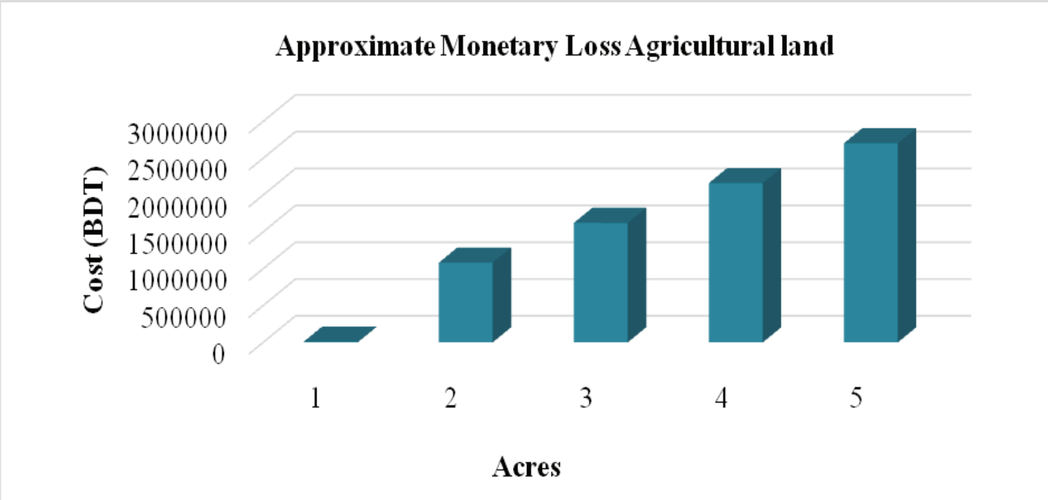

Fig. 5. Approximate Monetary Loss for Agricultural land due to river bank erosion

In the studied area, most of the respondents are heavily dependent on agriculture as their primary and secondary occupation. Little loss in cultivable lands put the marginalized people in more vulnerable situation. Monetary loss of agricultural land is more than 2.5 million BDT for loss of 5 acres or more of agricultural land due to river bank erosion (Fig. 5). Four (4) acres of cultivable land has a price of about 2.0 million BDT. Monetary loss for each acres of agricultural land is around 0.5 million of BDT. Our findings corroborates with (Siddik *et al.,* 2017). The sum of money is calculated based on per acre of agricultural land. The price is approximately 500,000 TK/acre in the studied area that is cross verified from the Union Parishad and the reference person. The price varies on the location and rate of crop production of the land.

Impact on quality of life

(a) Displacement due to river bank erosion

The immediate impact of river bank erosion is displacement. In erosion-prone areas, most of the families have witnessed a displacement in their lifetime. They were forced to be uprooted from their original homestead more than once in some cases which has negative impact in economy and in society. All of the respondents of study area had lost their land, either totally or partially.

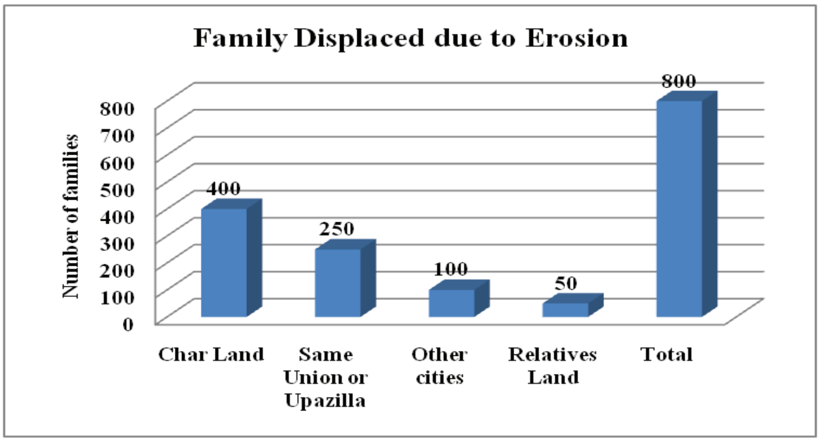

Fig. 6. Number of families displaced due to river erosion in different places of the area.

People took part in field survey gave an estimation of 800 family displacements. Among them 400 (50%) families are resettled in the same area and near char land within the study area (Fig. 6). Approximately 250 (31.25%) families have migrated to other union and upazilla. 100 (12.5%) families migrated to nearby cities like Madaripur, Barishal and somewhat far cities like Dhaka. This figure also showed that the people who were unable to manage a new shelter for them were moved to their relative's places that is approximately 50 (6.25%) numbers of families.

(b) Conversion of profession

Due to river bank erosion family displacement is a common phenomenon. As a result of displacement people are forced to change their previous profession in most of the cases. Most of these people become engaged to fisheries, daily labor like rickshaw pulling, etc. in their own villages or to the nearby cities.

Around 10% peoples got the chance to remain in their old profession like farming. 55% people have converted their profession into fisheries, 28% people converted their profession into day laborer and 7% people are in others professions (Fig. 7).

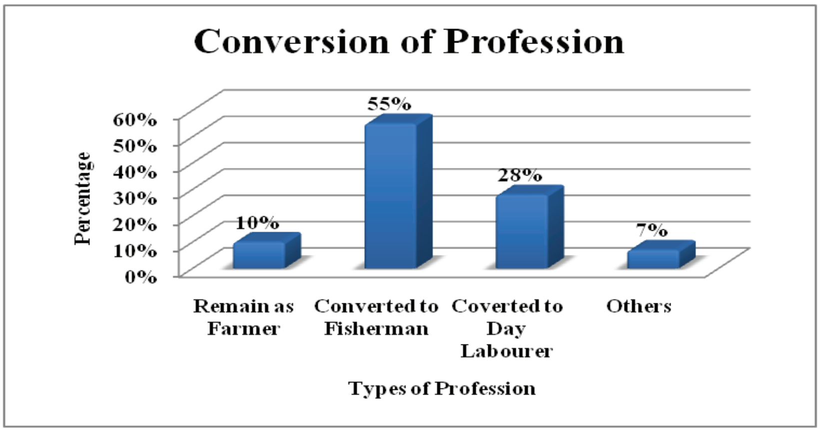

Fig. 7. Conversion of profession of migrated people in percentage (%).

(c) Health hazard due to bank erosion

People of the study area who have migrated to the char land area facing various kinds of diseases such as diarrhea diseases, typhoid fever, cholera, leptospirosis and hepatitis-A, malaria, dengue, asthma, different types of infection etc. The health care facilities of these areas are inadequate. The upazilla health complex is situated at a distance of about 20-25 km from study area. There are also a union health complex and a community health care center in the study area but are not in service properly. According to the health inspector of Batamara union, the rate of infection from different types of diseases has been increased in last 10 years. The reasons behind this poor health conditions are poverty, lack of education etc. caused by the river bank erosion.

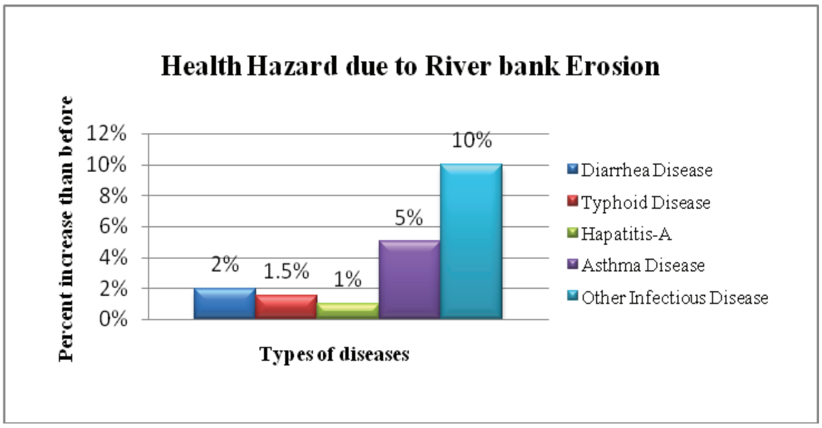

Fig. 8. Rate of (%) increase of infection from different diseases due to river bank erosion.

According to Fig. 8, in last 10 years the rate of infection from different diseases is increased by 19.5%. The increase rate of diarrhea infection is 2%, for typhoid it is 1.5% and, for hepatitis-A it is 1%. The rate of infection for asthma is 5% and for other infectious diseases it is 10%. The types of diseases are mainly water borne which indicates lack of education or social awareness in the studied area. The data is mainly collected from the union health office.

(d) Education of children

All kind of natural or anthropogenic disaster hampers children education. Household displacement, migration and socio economic loss vastly affect the primary and secondary education for both the resettled and migrated children. Dropout is a very common scenario in these areas. The educational infrastructure is not adequate enough. In the study area, there are two primary school and two high schools currently are facing threat to go under water due to bank erosion. In char area of Arial Kha and Joyonti river scenario is even worse. There are only two primary schools in the whole area and children of these areas have to use boat to go to the school for secondary education. For this reason during the rainy season or during the water inundation period the children of the char land areas cannot go to the school. According to education inspector of the union, approximately 20-25% of the students dropped out from both primary and secondary education level due to river bank erosion in the year 2000- 2018.

Government and organizational steps

Till the time of study; no governmental, organizational, NGOs and INGOs initiatives have taken to prevent the erosion and migration of the study area. Recently, the local parliament member has proposed a project to protect two high schools with primary school, bazaars, and some local area. Peoples of this area are thriving for betterment of the situation.

Conclusion

Bangladesh is a hazard prone country. Every year it faces a lot of natural disaster among them river bank erosion is a significant one. It has a disastrous impact on countries socio-economic conditions. The study found that river bank erosion is responsible for losses of homestead and agricultural land. The loss is about 1-5 acres of land in both cases. The percentage of people who lost 1 acre of homestead and agricultural land are 75% and 50% respectively. In case of monetary loss, the loss ranges from 0.85-4.0 million for homestead and 0.5-2.5 million for agricultural land. The people of the erosive area faces unemployment problem and forced to migrate from their origin which is almost 50%. Almost 90% of people convert their way of livelihood. River bank erosion also causes the degradation of their quality of life. There is an increase of health hazard which is almost 19.5% and the educational drop out has been increased about 20-25% in last 10 years. The study draws attention on this burning topic and suggests a more intensive study on a broader aspect. It also recommends governmental and related organizations to take steps to lessen the sufferings of the community and protect their natural way of living.

Author's Contribution:
MAR has conducted the questionnaire survey part mostly. AAR had the main idea. Both of the authors have contributed equally in writing and editing.

References

Baki ATM. 2014. Socio-economic impacts of Gorai riverbank erosion on people: A case study of Kumarkhali, Kushtia. (Doctoral dissertation, BRAC University).

Bangladesh Bureau of Statistics (BBS). 2011. Bangladesh Population Census 2011, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.

Baqee MA. 1997. Coping with floods and erosion in Bangladesh Charlands. *Asia Pacific Journal of Development*. **4**(2): 38-52.

Connecticut River Joint Commissions (CRJC). 1996. "River Dynamics and Erosion", Living with the River, Charlestown, NH. Online version (accessed 18 September 2014): http://crjc.org/erosion.htm.

Das TK, Haldar SK, Das Gupta I and Sen S. 2014. River Bank Erosion Induced Human Displacement and Its Consequences. *Living Rev. Landsc. Res.* **8**(3): 1-35.

Elahi KM. 1972. Urbanization in Bangladesh: A Geodemographic Study, *Oriental Geographer* **16**(1): 39-48.

Islam MF and Rashid AB. 2011. Riverbank erosion displacees in Bangladesh: need for institutional response and policy intervention. *Bangladesh J. Bioeth.* **2**: 4-19.

Indra D. 2000. Not just displaced and poor: How environmentally forced migrants in rural Bangladesh recreate space and place under trying conditions: (596722011-009). *Refugees and Immigrants.* **1**(8): 163-191.

Islam N. 1996. The Urban Poor in Bangladesh. *Centre for Urban Studies*, Momin Offset Press, Dhaka.

Khan AAM. 1982. Rural-Urban Migration and Urbanization in Bangladesh. *Geogr. Rev.***72**: 379-394. https://doi.org/10.2307/214592

Mollah TH and Ferdaush J. 2015. Riverbank Erosion, Population Migration and Rural Vulnerability References 105 in Bangladesh. *Environment and Ecology Research*. **3**(5): 125-131.

Mirza MMU. 2015. Causal Relationship between Agriculture, Industry and Services Sector for GDP Growth in Bangladesh: An Econometric Investigation. *Journal of Poverty, Investment and Development.* **8**: 124-129.

Roy DK, Goswami S, Ahmed T, Saha MK, Emon MH and Rahim A. 2017. Socio-economic impacts of river bank erosion on durgapasha union in bakerganj upazila, Bangladesh. *Barisal University Journal*. **4**(1): 165-183.

Rabbi H, Saifullah ASM, Sheikh MS, Sarker MMH and Bhowmic AC. 2013. Recent study on riverbank erosion and its impacts on land displaced people in Sirajgonj riverine area of Bangladesh. *World J Appl Environ Chem.* **2**(2): 36–43.

Rahman MR. 2013. Impact of riverbank erosion hazard in the jamuna floodplain areas in Bangladesh. *J. Sci. Foundation.* **8**(1-2): 55-65.

Siddik MA, Mostafa Zaman AKM, Islam MR, Hridoy SK and Akhtar MP. 2017. Socio-economic impacts of river bank erosion: a case study on coastal island of Bangladesh. *The Journal of NOAMI.* **34**(2): 73.

Siddique NEA, Islam MM, Sultana J and Halim A. 2014. Potential of soil sensor EM38 measurements for soil fertility mapping in the Terrace soil of Bangladesh. *J. Sci. Tech. Env. Info.* **1**: 1-15.

Simon A and Collison AJC. 2002. Quantifying the mechanical and hydrologic effects of riparian vegetation on streambank stability. *Earth Surf. Process. Landf.* **27**: 527–546.

Uddin AFMA and Basak JK. 2012. Effects of riverbank erosion on livelihood. UnnayanOnneshan-The Innovators: Dhaka, Bangladesh.

Uddin MN and Rahman M. 2011. Socio - Economic Impact of Erosion along the Right Bank of the Jamuna River in Bangladesh. *DUET Journal.* **1**(2): 35-42.

Appendix-1
Questionnaires

Sl no.	Questions	Answer
1	Have you ever faced river bank erosion problem?	
2	If yes, how much land did you lose due to bank erosion?	
3	The house you live, is it on your own land or someone else's land?	
4	How much money did you lose when your previous home collapsed?	
5	Apart from the previous house, did any of your agricultural land lost into the river?	
6	If yes, how much agricultural land you lost?	
7	How much financial loss have you suffered due to demolition of agricultural land?	
8	How many houses in your area have been destroyed by river bank erosion in the last 25 years?	
9	What do you do for living?	
10	What was your previous job?	
11	If there is any changes in your way of earning, do you think your changes in occupation has any effect on your family?	
12	What do you think is the reason for your displacement?	
13	How many families do you think are migrated to other cities or areas?	
14	What are the problems you are facing due to bank erosion?	
15	What are the steps that have been taken by the Bangladesh government to control the effect of river bank erosion?	

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PLANT DIVERSITY OF BARISHAL UNIVERSITY CAMPUS, BANGLADESH

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Abstract

Floristic composition of the Barishal University campus was studied during the period of December 2017 to November 2018. Plant diversity and species richness along with their medicinal values were investigated from the area of university campus where a total of 166 plant species had been recorded which is assigned to 69 families indicating high plant diversity. For each species local name, english name, scientific name, family, habit, presence of medicinal value and uses have been provided. Species presentation varies from 1 to 9. 41% species belongs to 68 families and 59% species belongs to others 98 families. Fabaceae, Euphorbiaceae and Solanaceae are the largest family in Dicotyledons having 9 species in each whereas Poaceae is the largest family in Monocotyledons having 6 species. The abundance of herbs is highest in amount (84) whereas the lianas are lowest. Though the number of tree species is comparatively higher (39), most of them are planted or introduced from outside. Besides these, about 29 types of shrubs, 12 types of climbers and 2 types of lianas are also present. The result showed that 66% plant species represented by native species whereas 34% plant species represented by exotics. The survey spotted the presence of a threatened species namely *Salvinia molesta.*

Keywords: Plant diversity, Barishal University, Dicotyledons, Monocotyledons.

Introduction

Biodiversity, abbreviated from the terms 'biological' and 'diversity', encompasses the variety of life forms found at all scales of biological organization. It is the totality of genes, species and ecosystem in a region (Hossain et al., 2014). It is essential for human survival and economic wellbeing and for the ecosystem function and stability (Singh, 2002). The total number of species available on the earth is not determined yet however, it is estimated that the total number of animal and plant species could be between 13 and 14 million (Heywood, 1995). Approximately, 25000-30000 plant species have been used by the people of tropical countries and up to 25000 species have been used in traditional medicines (Heywood, 1993).

But human activities have contributed tremendous amount of threats to plant diversity of the world such as urbanization, commercial agriculture, tree plantations, logging and wood extraction, mining and transportation, pollution, over harvesting, tourism, biological invasion, and exotic monoculture plantations. Some natural events and disasters also have an impact on the plant diversity in different habitats (Uddin and Hassan, 2016).

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Survey and documentation of plant resources of campus area of different Universities have already been done (Uddin and Hassan, 2016; Hossain et al., 2014; Alam and Pasha, 1999; Uddin and Pasha, 1999). Plant diversity survey is very important as it provides the knowledge of vegetation composition, diversity, habitats, and comparison with similar other habitats may become a tool to estimate the level of adaptation to the environment and their ecological significance (Hossain et al., 2014). This kind of survey gives potential information of natives, rare, threatened and other plant species having medicinal values.

Barishal University is comparatively a newer campus. It is landscaped around the Kirtonkhola River with field areas and plants making the campus a natural arboretum. The campus area is associated with abundant and unique plant growth dominated by herbs and high shrubs. In spite of its socio-economic and ecological significance, there has been limited information on the survey and documentation of vegetation structure and plant diversity of the university campus which is very essential for the students, faculty members and other enthusiastic persons having plant fascinations. Not only these, such information is relevant for the management and conservation of this kind of typical ecosystem. Therefore, the main objective of the present study is to take an attempt to make a list of the plant species growing and planted at BU campus area.

Materials and Methods

Barishal (historically known as Bakla-Chandradwip; also Gird-e-Bandar) district, with an area of 2790.51 km^2, is bounded by twelve districts and several rivers flow across Barishal including the Kirtonkhola, Arial Khan, Khoyrabad and Sandhya. Barishal is a rice producing center of Bangladesh. The area of the city is 24.91 km^2 located in between 22°38′ and 22°45′ north latitudes as well as 90°18′ and 90°23′ east longitudes (Chakraborty et al., 2020). University of Barishal is the only general public university in Barishal division and country's 33rd public university, located in between 22º 39′N and 90º 21′ E. The campus area is present on the eastern bank of the Kirtonkhola River beside Barishal-Patuakhali highway and is about 2 kilometers from the centre of Barisal City. The university campus covers an area of 50 acres (https://en.wikipedia.org/wiki/University_of_Barisal). The campus area is composed of both native and exotic plant species.

In order to collect data, the total campus area was divided into five zones as marked in Fig. 1 to minimize the risk of missing any plant species. Observations on the campus area was done in two seasons (summer and winter) during the period of December 2017 to November 2018, as in these two seasons, plants show different adaptations and physical growth. As a result, this survey was completed easily and properly. The images of each plant species were captured by camera (Canon 1300D) along with either flowers or fruits.

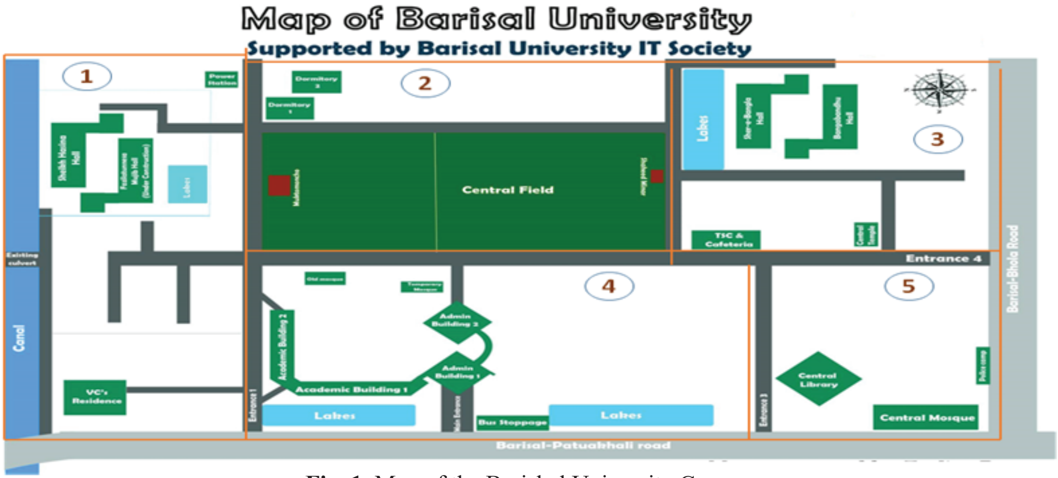

Fig. 1. Map of the Barishal University Campus

Most of the plants were identified at the observation site and in case of confusion in identity, fertile plant specimens have been collected (Hyland, 1972; Balick et al., 1982; and Alexiades, 1996). Plant species were identified consulting different Floras (Prain, 1903; Hooker, 1872-1897; Kirtikar and Basu, 1987; Huq, 1987; Uddin and Hassan, 2004; Siddiqui et al., 2007a and 2007b; Ahmed et al., 2008a, 2008b, 2008c, 2009a, 2009b and 2009c; Pasha and Uddin, 2013) and the scientific names, english names, habit, medicinal values (either present or not) and uses are described with the help of these literatures. Families have been determined according to Cronquist (1981).

Results and Discussion

A total of 166 plant species have been recorded in the present survey of Barishal University campus. All 166 plant species are under 69 families indicating a high biological diversity at family level taxa (Hossain et. al., 2016). In case of each species scientific name, local name, English name, family, habit and medicinal values have been provided. Among the species observed, 39 trees, 29 shrubs, 84 herbs, 12 climbers and 2 lianas were found. Species presentation varies from 1 to 9. According to calculation, it has been shown that 41% species belongs to 68 families and 59% species belongs to others 98 families. Here, the abundance of herbs is highest in amount and the lianas are lowest in amount (Fig. 2). As the study area is newly established, herbs are found in higher amount than the other types of plant species. Among the trees, most are introduced due to aesthetic desire of the campus view.

The most dominant families are Fabaceae, Euphorbiaceae and Solanaceae family in Dicotyledons having 9 species in each whereas Poaceae is the largest family in monocotyledons having 6 species. Relatively higher numbers of plant species were found in Amaranthaceae and Asteraceae; 8 species in each family. 7 species of Cucurbitaceae and 6 species each of Poaceae, Malvaceae and Caesalpiniaceae family are listed. In addition to these, 5 species of Mimosaceae family and 4 species each of Araceae, Moraceae and Verbanceae family each were also found. Rutaceae, Salviniaceae, Myrtaceae, Meliaceae and Acanthaceae had 3 species in each family. Besides these, about 15 families (Apocynaceae, Combretaceae, Chenopodiaceae, Convolvulaceae, etc.) were found having 2 plant species in each and about 36 families (Aloaceae, Anacardiaceae, Annonaceae, Apiaceae, Asclepiadaceae, Basellaceae, Boraginaceae, Brassicaceae, etc.) are represented by only one plant species in Barisal University campus area (Fig. 4).

In the present study, it was tried to explore the origin status of plants of the campus area and found that about 66% plant species are native species whereas 34% plant species are exotics (Fig. 3) showing a good rising tendency which may be a matter of challenge for the future native species (Uddin and Hassan, 2016). In the present study, presence of one of the threatened species of Bangladesh such as *Salvinia molesta* has been spotted in the campus area.

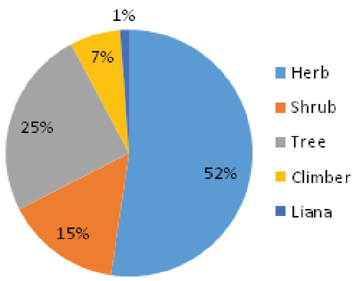

Fig. 2: Plant species of different habits

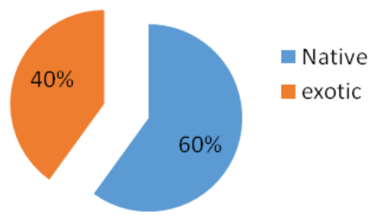

Fig 3: Origin status of the plant species recorded

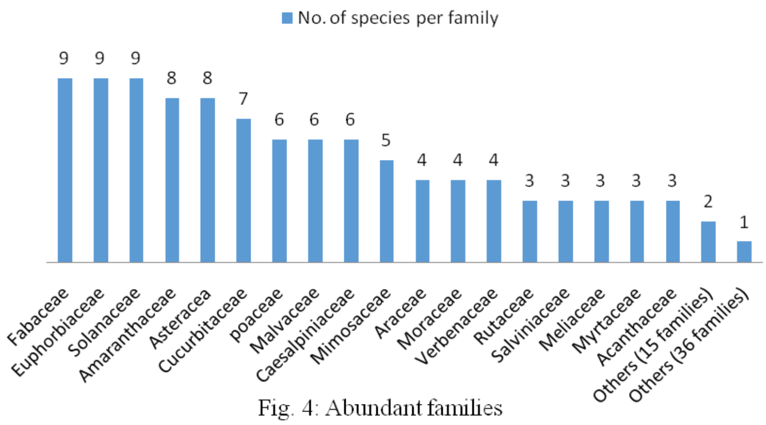

Fig. 4: Abundant families

Observation during survey revealed that the campus area dominated by a good number of herb and shrub species. These are *Centella asiatica* (Thankuni), *Amaranthus spinosus* (Kanta-nutia), *Pistia stratiotes* (Topapana), *Calotropis procera* (Akand), *Heliotropium indicum* (Hatisur), *Cassia sophera* (Kalkashunda), *Typha elephantine* (Hogla), *Cleodendrum viscosum* (Bhant), *Lantana camara* (Lantana), *Phyllanthus niruri* (Bhui amla), *Crotalaria pallida* (Jhun-jhuni), *Saccharum spontaneum* (Kash), *Echinochloa crusgalli* (Shama ghash), etc. Among the native species some trees such as *Polyalthia longifolia* (Debdaru), Mangifera indica (Aam), *Borassus flabellifer* (Tal), *Alstonia scholaris* (Chhatim), *Nerium oleander* (Karabi), *Azadirachta indica* (Neem), *Tamarindus indica* (Tentul), *Dillenia indica* (Chalta), *Cycas circinalis* (Cycas), etc are found (Table 1).

Table 1. A total list of the recorded plant species including their common name, scientific name, family name, english name, habit and their medicinal value.

Family Name	Scientific Name	English Name	Local Name	Habit	Medicinal Value	Uses (in/as)
Acanthaceae	*Justicia gendarussa* Burm. f.	Jendarussa	Jagatmadan	Shrub	P	Eczema, chronic rheumatism
Acanthaceae	*Hygrophila spinosa* T. Anderson	Starthorn	Kulekharha	Shrub	P	Jaundice, dropsy
Acanthaceae	*Justicia adhatoda* L.	Malabar nut	Bashak	Shrub	P	Diarrhoea, influenza
Aloaceae	*Aloe vera* (L.) Burm. f.	Barbados aloe/ Burn plant	Ghritaku-mari	Herb	P	Peptic ulcers, diabetes
Amaranthaceae	*Amaranthus spinosus* L.	Spiny amaranth	Kanta-nutia	Herb	P	Piles, leprosy
Amaranthaceae	*Amaranthus viridis* L.	Slender amaranth	Notay shak	Herb	P	Snakebite
Amaranthaceae	*Amaranthus tricolor* L.	Red amaranth	Lal shak	Herb	A	-
Amaranthaceae	*Amaranthus lividus* L.	Livid amaranth	Data shak	Herb	A	-
Amaranthaceae	*Alternanthera philoxeroides* Griseb.	Alligator weed	Helencha shak	Herb	P	-

Amaranthaceae	*Alternanthera sessilis* (L.) R.Br. ex DC.	Sessile joyweed	Chanchi/ Sachi shak	Herb	P	Intestinal cramps
Amaranthaceae	*Achyranthes aspera* L.	Prickly chaff-flower	Apang	Herb	P	Piles, gonorrhea
Amaranthaceae	*Alternanthera pungens* Kunth	Khaki weed	Not known	Herb	A	-
Anacardiaceae	*Mangifera indica* L.	Mango	Aam	Tree	P	Fever, diarrhea
Annonaceae	*Polyalthia longifolia* Sonn.	Mast tree	Debdaru	Tree	A	-
Apiaceae	*Centella asiatica* L.	Indian pennywort	Thankuni	Herb	P	Ulcers, eczema
Apocynaceae	*Nerium oleander* L.	Oleander	Karabi	Tree	A	Opthalmia, headache
Apocynaceae	*Alstonia scholaris* L.	Devil's tree	Chhatim/ Chaitan	Tree	P	Hypertensio n, cholera
Araceae	*Colocasia esculenta* L. Schott	Taro	Kachu	Herb	P	Alopecia
Araceae	*Alocasia macrorrhizos* L.	Giant taro	Man kachu	Herb	P	Tumors, jaundice
Araceae	*Pistia stratiotes* L.	Water lettuce	Topapana	Herb	P	Eczema, leprosy
Arecaceae	*Borassus flabellifer* L.	Palmyra palm	Tal	Tree	P	Ulcers, wound
Asclepiadaceae	*Calotropis procera* (Ait.) R. Br.	Rooster tree	Akand	Shrub	P	Leprosy, dysentery
Asteraceae	*Xanthium orientale* L.	Rough cocklebur	Ghagra	Herb	P	Hernia, ulcer
Asteraceae	*Blumea balsamifera* DC.	Borneo camphor	Kakronda	Herb	P	Scabies, leucorrhoea
Asteraceae	*Eclipta alba* L.	False daisy	Kalokeshi/ Kesaraj	Herb	P	Jaundice, asthma
Asteraceae	*Enhydra fluctuans* Lour.	Not Known	Helencha	Herb	P	Skin disease, gonorrhea
Asteraceae	*Mikania cordata* (Burm.f.) Robinson	Heartleaf hempvine	Assamlata / Tarulata	Herb	P	Snake bite scorpion sting
Asteraceae	*Tagetes erecta* L.	African marigold	Genda	Herb	P	Healing, stop bleeding

Asteraceae	*Tagetes patula* L.	French marigold	Lal genda	Herb	P	Cuts and wound
Asteraceae	*Helianthus annuus* L.	Sunflower	Surzamu-khi	Herb	A	-
Basellaceae	*Basella alba* L.	Indian spinach	Poi shak	Herb	P	Urticaria
Boraginaceae	*Heliotropium indicum* L.	Indian heliotrope	Hatisur	Herb	P	Ulcers, ringworm
Brassicaceae	*Eruca sativa* Mill.	Rocket salad	swetsarish a	Herb	P	Diuretic, stomachic
Bromeliaceae	*Ananus comosus* (L.) Merr.	Pineapple	Anarash	Herb	P	Abortifaci-ent
Caesalpiniaceae	*Cassia sophera* L.	Pepper-leaved senna	Kalkashun -da	Shrub	P	Ringworm, skin disease
Caesalpiniaceae	*Senna alata* (L) Roxs.	Ringworm bush	Dadmurda n	Shrub	P	Scabies, ringworm
Caesalpiniaceae	*Cassia fistula* L.	Golden shower tree	Sonalu	Tree	P	Tonsillitis, paralysis
Caesalpiniaceae	*Bauhinia acuminata* L.	White bauhinia	Sada-kanchon	Tree	A	-
Caesalpiniaceae	*Delonix regia* Raf.	Royal Poinciana	krishnach u-ra	Tree	A	-
Caesalpiniaceae	*Tamarindus indica* L.	Tamarind	Tentul	Tree	P	Paralysis, dysentery
Cannaceae	*Canna indica* L.	Indian shot	Kalaboti	Herb	P	Diaphore-tic,diuretic
Caricaceae	*Carica papaya* L.	Papaya	Pepe	Shrub	P	Laxative
Chenopodiaceae	*Spinacia oleracea* L.	Spinach	Palong shak	Herb	P	Fever
Chenopodiaceae	*Chenopodium album* L.	Pigweed	Batua shak	Herb	A	Piles, dysentery
Combretaceae	*Terminalia catappa* L.	Malabar almond	Kathbada m	Tree	P	Leprosy, scabies
Combretaceae	*Terminalia chebula* Retz.	Chebulic myrobalan	Haritoki	Tree	P	chronic ulcers, wound
Convolvulaceae	*Ipomoea aquatica* Forssk.	Water spinach	Kalmi shak	Herb	P	Strangury, diarrhea
Convolvulaceae	*Batatas crassicaulis* Benth.	Not known	Dhol kolmi	Herb	A	-
Cucurbitaceae	*Coccinia grandis* (L) Voigt	Ivy gourd	Telakucha	Clim-ber	P	Bronchitis diabetes

Cucurbitaceae	*Cucurbita maxima* Duch.	Pumpkin	Misti kumra	Liana	P	Inflammation
Cucurbitaceae	*Lagenaria siceraria* (Molina) Standl.	Bottle gourd	Lau	Climber	P	Headache
Cucurbitaceae	*Luffa aegyptiaca* Mill.	Sponge gourd	Dhundul	Climber	P	Diuretic, galactagogue
Cucurbitaceae	*Luffa acutangula* (L.) Roxb.	Ridged gourd	Jhinga	Climber	P	Ringworm, leprosy
Cucurbitaceae	*Momordica charantia* L.	Bitter melon	Karala	Climber	P	Asthma, diabetes
Cucurbitaceae	*Trichosanthes dioica* Roxb.	Pointed gourd	Patal	Climber	P	Snake bite, bronchitis
Cycadaceae	*Cycas circinalis* L.	Nepal cycas	Not known	Tree	P	Aphrodisiac
Cyperaceae	*Cyperus rotundus* L.	Nut-grass	Mutha	Herb	P	Piles, Syphilis
Dilleniaceae	*Dillenia indica* L.	Elephant apple	Chalta	Tree	P	Coughs
Dioscoreaceae	*Dioscorea oppositifolia* L.	Chinese yam	Not known	Climber	A	-
Dioscoreaceae	*Dioscorea esculenta* (Lour.) Burkill	Lesser yam	Maitta alu	Climber	P	Alimentary disorders
Dryopteridaceae	*Christella dentata* (Forssk.)	Fern	Bish dhekia	Herb	A	-
Euphorbiaceae	*Croton bonplandianus* Baill.	Bonplant's croton	Bondhone	Herb	P	Scabies, rickets
Euphorbiaceae	*Ricinus communis* L.	Castor-oil plant	Bherenda/ Reri	Shrub	P	Constipation, joint pains
Euphorbiaceae	*Jatropha curcas* L.	Barbados nut	Bagh verenda/ sadajeol	Shrub	P	Heart disease, asthma
Euphorbiaceae	*Acalypha indica* L.	Indian nettle	Muktajhuri	Herb	P	Arthritis, scabies
Euphorbiaceae	*Chrozophora rottleri* (Gejseler) A. Juss	Turnsole	Khudi okra	Herb	P	Blistering purposes
Euphorbiaceae	*Jatropha gossypifolia* L.	Bellyache nettle spurge	Lalbherenda / Laljeol	Shrub	P	Gonorrhea, fever

Euphorbiaceae	*Phyllanthus emblica* L.	Emblic myrobalan	Amloki	Tree	P	Piles, asthma
Euphorbiaceae	*Phyllanthus reticulatus* Poir.	Reticulated leaf-flaver	Chitki	Shrub	P	Small pox, syphilis
Euphorbiaceae	*Phyllanthus niruri* L.	Not Known	Bhui amla	Herb	P	Gonorrhea, jaundice
Fabaceae	*Crotalaria retusa* L.	Devil bean/ Rattleweed	Atashi	Herb	A	-
Fabaceae	*Crotalaria pallida* Aiton	Not known	Jhun-jhuni	Herb	A	-
Fabaceae	*Phaseolus vulgaris* L.	Common/ Kidney bean	Shim	Clim-ber	A	-
Fabaceae	*Lens culinaris* Medic.	Lentil	Masur	Herb	P	Coughs, small pox
Fabaceae	*Butea monosperma* (Lamk.) Taub.	Bengal kino tree	Palash	Tree	P	Night blindness, piles
Fabaceae	*Cajanus cajan* (L.) Millsp.	Pigeon pea	Arhar	Shrub	P	Snake bites, jaundice
Fabaceae	*Erythrina fusca* Lour.	Erythrina	Kanta-mother	Tree	A	-
Fabaceae	*Sesbania sesban* (L.) Merr.	Egyptian rattle pod	Jyonti	Shrub	P	Diabetes, cough
Fabaceae	*Sesbania bispinosa* (Jacq.) Wight	Not Known	Dhaincha	Shrub	P	Ringworm, eye disease
Lamiaceae	*Leucas indica* (L.) R.	Leucas	Shwetodr-on	Herb	P	Snakebite, headache
Lamiaceae	*Ocimum sanctum* L.	Sacred basil	Tulsi	Herb	P	Cough, fever
Liliaceae	*Allium cepa* L.	Onion	Piyaj	Herb	P	Diabetes
Liliaceae	*Zephyranthes rosea* Lindl.	Pink rain lily/fairy lily	Golapi ghashful	Herb	A	-
Lythraceae	*Lagerstoemia speciosa* (L.) Pers.	Crepe flower	Jarul	Tree	P	Apathae of mouth
Magnoliaceae	*Michelia champaca* L.	Champak	Champa	Tree	P	Intermittent fever
Malvaceae	*Hibiscus rosa-sinensis* L.	China rose	Joba	Shrub	P	Fever
Malvaceae	*Abelmoschus esculentus* (L.) Moench	Lady's finger/Okra	Dherosh	Herb	A	-

Malvaceae	*Corchorus capsularis* L.	Jute	Deshi-pat	Herb	P	Dysentery, skin disease
Malvaceae	*Abutilon indicum* (L.) Sweet	Indian mallow	Petari/Jhampi	Shrub	P	Fever, ulcers
Malvaceae	*Abutilon hirtum* (Lamk.) Sweet	Hispid abutilon	Gol-petari	Herb	P	Cough, toothache
Malvaceae	*Sida cordifolia* L.	Flannel weed	Berela	Shrub	P	Blood dysentery
Malvaceae	*Malvaviscus arboreus* Cav.	Nodding malva	Not known	Shrub	A	-
Marsileaceae	*Marsilea quadrifolia* L.	Waterclover	Susni shak	Herb	P	Cough, bronchitis
Marsileaceae	*Marsilea crenata* C. Persl	Water fern	Susni shak	Herb	P	Cough, bronchitis
Melastomaceae	*Melastoma malabathricum* L.	Indian rhododendron	Lutki/ Datranga	Shrub	P	Leucorrhoea, diarrhea
Meliaceae	*Azadirachta indica* A. Juss	Neem/Indian lilac	Neem	Tree	P	Malaria, ulcers
Meliaceae	*Swietenia mahagoni* Jacq.	Mahogoni	Mehogoni	Tree	A	-
Meliaceae	*Melia azedarach* L.	Barbados lilac	Gora neem	Tree	P	Rheumatism headache
Menispermaceae	*Tinospora cordifolia* (Willd.) Hook.	Tinospora gulancha	Ghora gulancha	Climber	P	Fever, chronic dysentery
Menyanthaceae	*Nymphoides indicum* (L.) O. Kuntze	Water snowflake	Chand malla	Herb	P	Fever, jaundice
Mimosaceae	*Samanea saman* (Jacq.) Merr.	Saman/Rain tree	Randi-koroi	Tree	A	-
Mimosaceae	*Acacia auriculiformis* A.Cunn. ex Benth	Ear-pod wattle	Akashmoni	Tree	A	-
Mimosaceae	*Acacia nilotica* (L.) Delile	Gum arabic tree	Babla	Tree	P	Coughs, piles
Mimosaceae	*Mimosa pudica* L.	Touch-me-not	Lajjabati	Herb	P	Fever
Mimosaceae	*Leucaena leucocephala* (Lamk.) de Wit	White babool	Ipil-ipil	Tree	A	-
Moraceae	*Ficus hispida* L. f.	Opposite-leaved Fig	Dumur	Tree	P	Diabetes
Moraceae	*Ficus benghalensis* L.	Banyan tree	Bot	Tree	P	Dysentery, diabetes

Moraceae	*Ficus religiosa* L.	Peepal tree	Ashwathwa	Tree	P	Scabies, gonorrhea
Moraceae	*Artocarpus heterophyllus* Lam.	Jackfruit	Kanthal	Tree	P	Ulcer, asthma
Myrtaceae	*Psidium guajava* L.	Guava	Piyara	Tree	P	Cholera, diarrhea
Myrtaceae	*Syzygium cumini* (L.) Skeels	Black plum	Kala jam	Tree	P	Bronchitis, ulcer
Myrtaceae	*Myrtus samarangensis* Blume	Java apple	Jamrul	Tree	A	-
Nyctaginaceae	*Boerhavia diffusa* L.	Spreading hog-weed	Punarnava	Herb	P	Epilepsy, anemia
Nymphaeaceae	*Nymphaea nouchali* Burm. f.	Water lily	Shapla	Herb	P	Piles, dysentery
Piperaceae	*Peperomia pellucida* (L.) H. B. & K.	Shiny bush	Luchi pata	Herb	P	Fever, eczema
Piperaceae	*Piper longum* L.	Indian long pepper	Pipul	Herb	P	Tumors, bronchitis
Poaceae	*Imperata cylindrica* (L.) P. Beauv	Cogongrass	Chau	Herb	A	-
Poaceae	*Cynodon dactylon* (L.) Pers.	Bermuda grass	Durba ghash	Herb	P	Chest pain, itching
Poaceae	*Chrysopogon aciculatus* (Retz.) Trin	Love grass	Prem kanta	Herb	P	Rat bite
Poaceae	*Triticum aestivum* L.	Bread wheat	Gom	Herb	P	Tuberculosis, strangury
Poaceae	*Saccharum spontaneum* L.	Wild sugarcane	Kash	Herb	A	-
Poaceae	*Echinochloa crusgalli* L.	Barnyard grass	Shama ghash	Herb	P	Spleen disorder
Polygonaceae	*Polygonum effusum* Meissn.	Knot weed	Chemtisag	Shrub	P	Pneumonia
Polygonaceae	*Persicaria hydropiper* L.	Water-pepper	Bishkatali	Herb	P	Dysentery, skin disease
Polypodiaceae	*Microsorum punctatum* (L.) Copel	Fern	Gucha patra	Herb	A	-
Polypodiaceae	*Drynaria quercifolia* (L.) J. Sm.	Bird-nest fern	Pankhiraj	Herb	A	-

Pontederiaceae	*Eichhornia crassipes* (Mart.) Solms	Water hyacinth	Kachori-pana	Herb	A	-
Pontederiaceae	*Monochoria hastata* (L.) Solms	Arrowleaf false pickereweed	Baranukha	Herb	A	-
Portulaceae	*Portulaca oleracea* L.	Common purslane	Lunia shak	Herb	P	Leprosy, piles, fever
Pteridaceae	*Pteris vittata* L.	Fern	Dhekia	Herb	A	-
Rhamnaceae	*Ziziphus mauritiana* Lamk.	Indian jujube	Boroi	Tree	P	Vomiting, ulcers
Rosaceae	*Rosa chinensis* Jacq.	Tea rose	Kanta golap	Shrub	P	Wound, stpains
Rubiaceae	*Anthocephalus cadamba* (Roxb.) Miq.	Not Known	Kadam	Tree	P	Apathaes, stomatitis
Rubiaceae	*Paederia foetida* L.	Not Known	Gandha bhaduli	Climber	P	Diarrhoea, rheumatism
Rutaceae	*Glycosmis pentaphylla* (Retz.) A. DC.	Tooth-brush plant	Ash-sheora	Shrub	P	Anemia, jaundice, scabies
Rutaceae	*Citrus limon* (L.) Burm. f.	Lemon	Gora lebu	Shrub	P	Arteriosclerosis, scurvy
Rutaceae	*Citrus maxima* (Burm.) Merr.	Pummelo	Batabi lebu	Tree	P	Influenza, catarrh
Salviniaceae	*Salvinia molesta* Mitch.	Water spangle	Pani dhekia	Herb	A	-
Salviniaceae	*Azolla pinnata* R. Br.	water fern	Lalkhudipana	Herb	P	Diuretic, antibacterial properties
Salviniaceae	*Azolla filiculoides* Lamarck.	Red duck weed	Lal khudi pana	Herb	A	-
Sapindaceae	*Litchi chinensis* Sonn.	Litchi	Lichu	Tree	P	Small pox, throat infection
Sapotaceae	*Mimusops elengi* L.	Bullet wood	Bokul	Tree	P	Chronic dysentery, piles
Scrophulariaceae	*Scoparia dulcis* L.	Goat weed	Bondhone	Herb	P	Diabetes, diphtheria, fever

Scrophulariaceae	*Bacopa monnieri* (L.) Pennell	Dwarf becopa	Brammi shak	Herb	P	Headache, anemia
Smilaceae	*Smilax macrophylla* Roxb.	Shot bush	Kumarilata	Climber	P	Syphilis, gonorrhea
Solanaceae	*Solanum xanthocarpum* L.	Solanum	Kanta kari	Herb	P	Fever,cough toothache
Solanaceae	*Solanum nigrum* L.	Black nightshade	Titbegun	Herb	P	Diabetes, menstrual disorders
Solanaceae	*Lycopersicon esculentum* Mill.	Tomato	Tomato	Herb	A	-
Solanaceae	*Solanum melongena* L.	Eggplant/ Brinjal	Begun	Herb	P	Diabetes, cholera, dysuria
Solanaceae	*Capsicum frutescens* L.	Spur pepper	Kacha morich	Herb	A	-
Solanaceae	*Nicotiana plumbaginifolia* Viv.	Not Known	Bon tamak	Herb	A	-
Solanaceae	*Physalis minima* L.	Insipid physalis	Fotka	Herb	P	Abdomen pain, diabetes
Solanaceae	*Solanum capsicoides* All.	Ciliate solanum	Not known	Shrub	P	Toothache, ulcerated nose
Solanaceae	*Solanum myriacanthum* Dunal,Hist.	Not Known	Rulpuk	Shrub	P	Tooth problems
Sterculiaceae	*Abroma augusta* L.	Devil's cotton	Ulat kambal	Tree	P	Dysentery, bronchitis
Tamariaceae	*Tamarix bengalensis* Baum.	Not Known	Jhau	Shrub	A	-
Thelypteridaceae	*Ampelopteris prolifera* (Retz) Copel	Walking fern	Dhekia shak	Herb	P	Antibacterial properties
Typhaceae	*Typha elephantina* Roxb..	Cat tail	Hogla	Herb	A	-
Urticaceae	*Laportea interrupta* (L.) Chew.	Not Known	Lal bichuti	Herb	P	Coughs, asthma
Verbenaceae	*Gmelina arborea* Roxb.	White teak	Gamari	Tree	P	Leprosy, constipation, anemia

Verbenaceae	*Cleodendrum viscosum* Vent.	Not Known	Bhant	Shrub	P	Tumor, asthma, cough
Verbenaceae	*Lippia alba* Mill.	Not Known	Pichas-lakri	Shrub	A	-
Verbenaceae	*Lantana camara* L.	Lilac lantana	Lantana	Shrub	P	Rheumatism
Vitaceae	*Cayratia trifolia* (L.) Domin	Not Known	Amal lata	Liana	P	Abdominal pains
Zingiberaceae	*Curcuma zedoaria* (Christm.) Rosc.	Zedoary	Shoti	Herb	P	Piles,asthma bronchitis
Zingiberaceae	*Curcuma longa* L.	Turmeric	Halud	Herb	P	Jaundice, ringworm, ulcers

Butea monosperma and *Ficus benghalensis* provide feeding sites to a good number of native birds (Hossain et al., 2014 and Uddin and Hassan, 2016). Some rare and common species which growing in Barishal University campus is presented in Fig. 5.

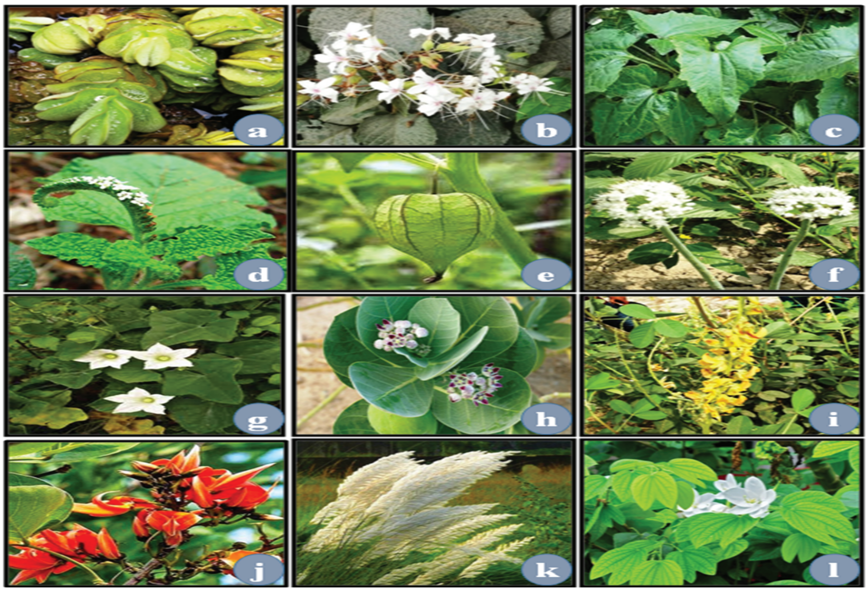

Fig. 5. Some rare and common species planted and growing in Barishal University campus; a) Pani dhekia (*Salvinia molesta*); b) Bhant (*Cleodendrum viscosum*); c) Assamlata (*Mikania cordata*); d) Hatisur (*Heliotropium indicum*); e) Fotka (*Physalis minima*); f) Piyaj (*Allium cepa*); g) Telakucha (*Coccinia grandis*); h) Akand (*Calotropis procera*); i) Jhun-jhuni (*Crotalaria pallida*); j) Palash (*Butea monosperma*); k) Kash (*Saccharum spontaneum*); and l) Sada-kanchon (*Bauhinia acuminate*).

During the present survey of floristic composition in a small land of BU campus, 166 species are found which indicates richness in one component of diversity. However, extensive and intensive survey may increase the total number of species in the campus area (Uddin and Hassan, 2016). There is an unequal presence of individual species as during different plantation programs, different species are planted on choice and priority basis. But priority should be given on the plantation of native species with multipurpose functions because the exotic and first growing plant species may cause threat to the natives. Not only those different flowering plants of different seasons should be planted to increase the aesthetic view of the campus. The present study is an initial step to uncover plant diversity in the Barishal University campus; further inventories are needed to assess the relationship between vegetation compositions with the soil properties.

Author's contribution:

All authors are equally contributed, read and approved the final manuscript.

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References

Ahmed ZU, Begum ZNT, Hassan MA, Khondker M, Kabir SMH, Ahmad M, Ahmed ATA, Rahman AKA and Haque EU (eds.). 2008a. Encyclopedia of Flora and Fauna of Bangladesh, Angiosperms: Dicotyledons (Acanthaceae – Asteraceae). Asiatic Society of Bangladesh, Dhaka. **6**: 1-408.

Ahmed ZU, Hassan MA, Begum ZNT, Khondker M, Kabir SMH, Ahmad M, Ahmed ATA, Rahman AKA and Haque EU (eds.). 2009a. Encyclopedia of Flora and Fauna of Bangladesh, Angiosperms: Dicotyledons (Fabaceae – Lythraceae). Asiatic Society of Bangladesh, Dhaka. **8**: 1-478.

Ahmed ZU, Hassan MA, Begum ZNT, Khondker M, Kabir SMH, Ahmad M and Ahmed ATA (eds.). 2009b. Encyclopedia of Flora and Fauna of Bangladesh, Angiosperms: Dicotyledons (Magnoliaceae – Punicaceae). Asiatic Society of Bangladesh, Dhaka. **9:** 1-488.

Ahmed ZU, Hassan MA, Begum ZNT, Khondker M, Kabir SMH, Ahmad M and AhmedATA (eds.).2009c. Encyclopedia of Flora and Fauna of Bangladesh, Angiosperms: Dicotyledons (Ranunculaceae – Zygophyllaceae). Asiatic Society of Bangladesh, Dhaka. **10**: 1-580.

Ahmed ZU, Hassan MA, Begum ZNT, Khondker M, Kabir SMH, Ahmad M, Ahmed ATA, Rahman AKA and Haque EU (eds.). 2008b. Encyclopedia of Flora and Fauna of Bangladesh, Angiosperms: Monocotyledons (Orchidaceae – Zingiberaceae). Asiatic Society of Bangladesh, Dhaka. **12**: 1-505.

Ahmed ZU, Hassan MA, Begum ZNT, Khondker M, Kabir SMH, Ahmad M, Ahmed ATA, Rahman AKA and Haque EU (eds.). 2008c. Encyclopedia of Flora and Fauna of Bangladesh, Angiosperms: Dicotyledons (Balsaminaceae –Euphorbiaceae). Asiatic Society of Bangladesh, Dhaka. **7**: 1-546.

Alam M and Pasha MK. 1999. A floristic account of Chittagong University Campus. *Chittagong University Journal Science*. **23(**1): 81-99.

Alexiades M. N. (eds.). 1996. *Selected Guidelines for Ethno botanical Research*: A Field Manual. The New York Botanical Garden, New York. **10**: 53-94.

Balick MJ, Anderson AB and Silva da MF. 1982. Plant taxonomy in Brazilian Amazonia: The state of systematic collection in regional herbaria. *Brittonia*. **14**: 463-477.

Chakraborty S, Karmaker D, Das SK and Hossen R. 2020. First report on phytoplankton communities of Barishal City, Bangladesh. *Current Botany*. **11**: 142-147.

Cronquist A. 1981. An Integrated System of Classification of Flowering Plants. Columbia University Press, New York. 248-250.

Heywood V. 1993. Flowering plants of the world. B.T. Batsford Ltd., London, UK.

Heywood VH. 1995. Global Biodiversity Assessment. Cambridge University Press, Cambridge, UK.

Hooker JD. 1872-1897. *Flora of British India*. L. Reeve and Co. Ltd. London, U.K. **1-7.**

Hossain MZ, Khan MAA, Kashem MA and Hoque S. 2016. Plant community composition in relation to soil physic-chemical properties of the Ratargul Swamp Forest, Bangladesh. *Dhaka Univ. J. Biol. Sci.* **25**(1): 1-8.

Hossain SM, Misbahuzzaman K, Muhammad S and Mamun AA. 2014. Tree species diversity in the south western human impact hills at Chittagong University campus in Bangladesh. *Journal of Biodiversity and Environmental Sciences*. **4**(1): 205-212.

Huq AM. 1986. *Plant Names of Bangladesh*. Bangladesh National Herbarium, BARC, Dhaka, Bangladesh.

Hyland BPM. 1972. A technique for collecting botanical specimens in rain forest. *Flora Malesiana Bulletin.* **26**: 2038-2040.

Kirtikar KR and Basu BD. 1987. *Indian Medicinal Plants*. Lalit Mohan Basu, Allahabad, Jayyed Press, New Delhi, India. **1-4.**

Pasha MK and Uddin SB. 2013.*Dictionary of Plant Names of Bangladesh (Vascular Plants*). Janokalyan Prokashani. Chittagong, Dhaka, Bangladesh.

Prain D. 1903. *Bengal Plants*. Botanical Survey of India. Calcutta. **1-2.**

Siddiqui KU, Islam MA, Ahmed ZU, Begum ZNT, Hassan MA, Khondker M, Rahman MM, Kabir SMH, Ahmad M, Ahmed ATA, Rahman AKA and Haque EU (eds.). 2007a. Encyclopedia of Flora and Fauna of Bangladesh, Angiosperms: Monocotyledons (Agavaceae-Najadaceae). Asiatic Society of Bangladesh, Dhaka. **11**: 1-399.

Siddiqui KU, Islam MA, Ahmed ZU, Begum ZNT, Hassan MA, Khondker M, Rahman MM, Kabir SMH, Ahmad M, Ahmed ATA, Rahman AKA and Haque EU (eds.). 2007b. Encyclopedia of Flora and Fauna of Bangladesh, Bryophytes, Pteridophytes, Gymnosperms. Asiatic Society of Bangladesh, Dhaka. **5**: 1-391.

Singh JS. 2002. The biodiversity crisis: a multifaceted review. *Current Science.* **82**: 638–647.

Uddin M, Gias and Pasha MK. 1999. Taxonomic account of fern-allies and ferns of Chittagong University Campus. *Chittagong Univ. J. Sci.* **23**(1): 41-58.

Uddin MZ and Hassan MA. 2004. *Flora of Rema-Kalenga Wildlife Sanctuary.* IUCN Bangladesh Country Office, Dhaka, Bangladesh.

Uddin ZM and Hassan MA. 2016. Plant diversityof Dhaka University campus, Bangladesh. *Journal of Asiatic Society Bangladesh, Science.* **42**(1): 49-68.

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EVALUATION OF YIELD ATTRIBUTES OF DHEROSH (*Abelmoschus esculentus* L. Moench) GENOTYPES IN BARISHAL REGION

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Abstract

The present investigation was carried out to evaluate the dherosh genotypes for yield related parameters under natural condition in Barishal region. Various morphological parameters viz., germination rate (%) of seed, plant height (cm) and length of leaves (cm) at different days interval, number of branches per plant, number of pods per plant, number of seed per pod, days required for first anthesis, length and diameter of pod (cm), fruit weight (g), 100 seed weight (g) and yield per plant were recorded. Among seven genotypes, Bari dherosh-1 took minimum 41.5 days for first anthesis whereas genotype Shyamol Bangla took maximum 45 days. Bari dherosh-1 genotype was rated as superior genotype on the basis of plant height (85.9 cm), number of branches (5.8), number of fruits (15.1), number of seed (61.3) and fruit yield (222.72 g) per plant. From the present investigation it is observed that okra genotype Bari dherosh-1 performed well for various growth and yield traits in Barishal region.

Keywords: Dherosh; Yield attributes; Suitable genotypes; Barishal

Introduction

Dherosh (*Abelmoschus esculentus* L. Moench) is one of the popular and widely grown crops found throughout the tropical and sub-tropical regions of the world. It is a warm-season annual herbaceous and high yielding crop with numerous cultivars varying in plant height, period of maturity, pod shape and size (Chattopadhyay *et al.*, 2011). Because of its multiple virtues like high nutritive and medicinal value, ease of cultivation, wide adaptability, year-round cultivation, good portability, export potential and bountiful returns, dherosh has a prominent position among fruit vegetables (Reddy *et al.*, 2010). Dherosh is also known as Okra, Ochro, Okoro, Bhindi (SouthAsia), Ladies finger, Gombo, Kopi Arab, Kacang Bendi, Quingumbo , Bamia in Ethiopia, Bamya or Bamieh (middle east) or Gumbo (Southern USA) in the various part of the world (Semagn k *et al.*, 2006). Dherosh was earlier belonging to the genus *Hibiscus*, section *Abelmoschus* in the family Malvaceae (Linnaeus, 1753). West Africa, India and Southeast Asia is the centers of genetic diversity of okra (Charrier, 1984; Hamon and Sloten, 1989). Dherosh seeds may be roasted and ground to form a caffeine-free substitute for coffee (Moekchantuk *et al.*, 2004) as well as the leaves of this plant is eaten as Salad (Chauhan, 1972).

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Nutritionally, tender Green pods of okra are vital sources of vitamins A, B1, B3, B6, C and K, folic acid, potassium, magnesium, calcium and trace parts such as copper, manganese, iron, zinc, nickel, and iodine (Lee *et al*., 2000), that are typically lacking in the diet of folks in most developing countries. The young Green pod may be an alimental vegetable containing 86.1% wetness, 9.7% carbohydrates, 2.2% protein, 0.2% fat, 1.0% fiber and 0.8% ash (Saifullah *et al*., 2009). On the opposite hand, mature seeds of okra contain 20% protein, with associate amino acid profile like their composition in soybean. The seeds conjointly contain about twenty percent oil that's similar in fatty acid composition to cotton seed oil (Siemonsma *et al*., 2002). The okra pod macromolecule assists in building muscle tissues and enzymes, that management the hormones of the organs. Its soluble fiber conjointly helps in lowering blood serum sterol, reducing cardiovascular disease and cancer, particularly large intestine cancer (Dattijo *et al*., 2016). Dherosh is conjointly one the potential natural plant that been used to manage diabetes (IPCBE, 2011). The antioxidant activity of this crop is thinks to presence of vitamin A, B and C that forestalls the oxidative damages by free radicals conjointly which helps in lowering down the aging method (Phisut *et al*., 2013).

The morphological nature of a plant is very important for improving its yield, seed quality, resistance to multiple biotic and abiotic stresses and nutrient utilization efficiency. Information on the genetic variability of crop is crucial for the identification and breeding of unique accessions vital for curators of gene banks for germplasms conservation (Saifullah *et al*., 2009). The suitable knowledge of such associations between yield and yield related characters could appreciably augment the efficiency of the crop improvement through the utilization of the appropriate selection indices (Adekoya *et al*., 2014). Production and productivity of dherosh is affected by different factors like, the use of low yielding local varieties, heavy attack of insect-pests and diseases, sub optimal plant density, weeds etc. Among them selection of low yielding varieties is the major problem for lower production of dherosh in Bangladesh. So, productivity of crop could be improved through proper evaluation and selection of suitable genotypes based on location (Deepak *et al*., 2015). Keeping these considerations, the present investigation was carried out with an objective to select suitable genotypes of dherosh for Barishal region on the basis of their growth and yield parameters.

Materials and Methods

The experiment was conducted at the Department of Botany in University of Barishal under field condition during the month of March to August in the year 2020.The pictures of the dherosh grown on the field are presented in Fig. 1 and Fig. 2. In this investigation, a total of seven dherosh cultivars **(**Shyamol Bangla, Local dherosh, Nilsagar, Abak**,** Bari dherosh-1, Shom**,** Bankim) were used**.** Seeds of different variety were collected from local

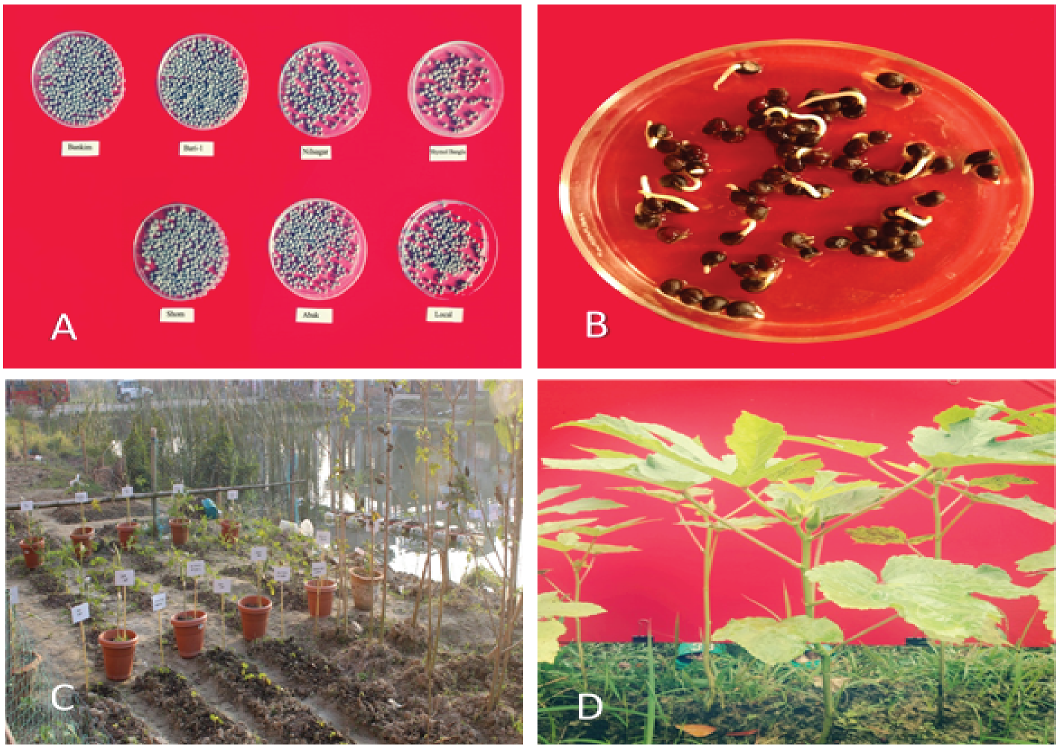

Fig. 1. Different stages of growth A) Seed of different dherosh genotypes, B) Seed germination, C) Experimental field and D) Plant before flowering.

market, Barishal Sadar, Barishal, stored in the MS Laboratory and maintained in Botanical garden at University of Barishal. The size of the plot was 480 sq. feet (30 ft. ×16 ft) and each variety was planted in two rows. Cultural and agronomic practices were followed as per the standard recommendations and need based plant protection measures were taken to maintain healthy crop stand. The whole amount of TSP, MP, Gypsum and Zinc at the rate of 13 kg/h, 9 kg/h, 8 kg/h and 1.5 kg/h respectively were applied at the time of final land preparation. Proper irrigation system was maintained during the whole growing season. Unwanted weeds were removed two times by uprooting them from the field during the period of cropping season. Data were recorded randomly from each variety on the following manners: Seed weight (g), Seed germination rate (%), Number of leaves per plant at 30 days and 70 days after seed sown, Days required for first anthesis, Number of pods per plant, Length and diameter of pod (cm), Number of seeds per pod, Pod weight (g), Plant height (cm) at 30 days and 70 days after seed sown, Number of branches per plant and Yield per plant(g)

Multivariate statistical analyses were applied to enumerate the possible relationship between the dherosh genotypes based on the collected quantitative morphological characteristics. Data were collected on plant growth and yield parameters were subjected to one-way analysis of variance (ANOVA) to determine least significant difference (LSD) and level of significance at 0.05 percent. The variability of each agronomic character was estimated by simple measures such as ranges, means, standard error, values of 'F' (variance ratio) test among the sevendherosh genotypes using Statistic MS Excel (Ver. 2016).

Results and Discussion

The results of the study based onthe evaluation of morphological and yield contributing characters of dherosh and possible interpretations have been presented in the following heads (Table 1).

Seed weight (g)

For the calculation of seed weight, 100 seed were harvested randomly and weighted. Significant difference was observed among the seven dherosh genotypes in respect of seed weight. Seed weight varied from 4.06 to 4.81 g with a mean of 4.55 g (Table 1). Shyamol Bangla having the highest (4.81 g) seed weight which was followed by Abak (4.76 g) and Nilsagar (4.69 g). The lowest seed weight was observed in Local (4.06 g).

Seed germination (%)

Seed germination rate differed significantly among the tested genotypes. The highest seed germination rate was observed in Bari dherosh-1 (96%) with the overall mean of 85.52% which was followed by Shyamol Bangla (93%) and the lowest germination was observed in Bankim (76%).

Days required for first anthesis

As regards to days required for first flowering were varied significantly among the seven genotypes of dherosh. Shyamol Bangla has required the highest number of days (45) for first flowering. Nilsagar, Shom and Abak were almost taken same days (44, 44.4 and 44.80 days, respectively). The lowest days required for first anthesis in Bari dherosh-1 (41.6). This observation is very much identical with the observation of Muhammad *et al*. (2001) where 45 days was reported for the first flowering in four high yielding okra genotypes. This revealed that okra cultivars were morphologically different from one another in flower-bearing habits. Several researchers have also found that days to flowering varied significantly among the okra genotypes.

Number of leaves at 30 and 70 days after seed sown

Figure 03 showed that, the numbers of leaves are varied in seven dherosh genotype at 30 and 60 days after seed showed. Thenumber of leaves were ranged from 5 to 5.7 and 16.2 to

20.7 at 30 days and 60 days of seed sown respectively. The maximum number of leaves per plant obtained from Bari dherosh-1 (5.7) which was mostly similar with Local (5.6). Minimum number of leaves (5.0) was obtained from Shom and Abak at 30 days. At 70 days of seed sowing maximum number of leaves per plant was obtained from Local dherosh (20.7) followed by Shom and Abak where number of leaves per plant was 16.7 and 16.9 respectively and minimum number of leaves obtained from Nilsagar (16.2). The average number of leaves was 12.40 at the time of maturity which was reported by Falusi *et al*. (2012). The finding of the present investigation is varied from the reported result because of different genotype and environmental factors.

Fig. 2. Mature plant on the field; a) Shyamol Bangla, b) Nilsagar, c) Bari dherosh-1, d) Bankim, e) Local, f) Abak, g) Shom.

Length of pod (cm)

The pod length was measured after seven to nine days of pollination and all the data were recorded randomly. Among the seven dherosh genotype, longest pod length was found in Bankim (13.1 cm) followed by Bari dherosh-1(12.91 cm), Local (12.56 cm) respectively. This result was in agreement with the result obtained by Kuwar *et al*. (2001) where maximum fruit lengthwas 13.86 cm. The result of pod length is also relevant with the findings of the experiment by Biswas *et al.* (2016).

Diameter of pod (cm)

Significant difference was found in seven genotypes in respect of pod length. The widest pod diameter was observed in Local dherosh (2.03 cm) which is followed by Bankim (1.99 cm) and Bari dherosh-1 (1.9 cm). On the other hand, the lowest diameter of pod was observed in Shom (1.77 cm) which as par with Abak (1.78 cm). Biswas *et al.* (2016) reported that the maximum okra fruit diameter was17.83 mm.

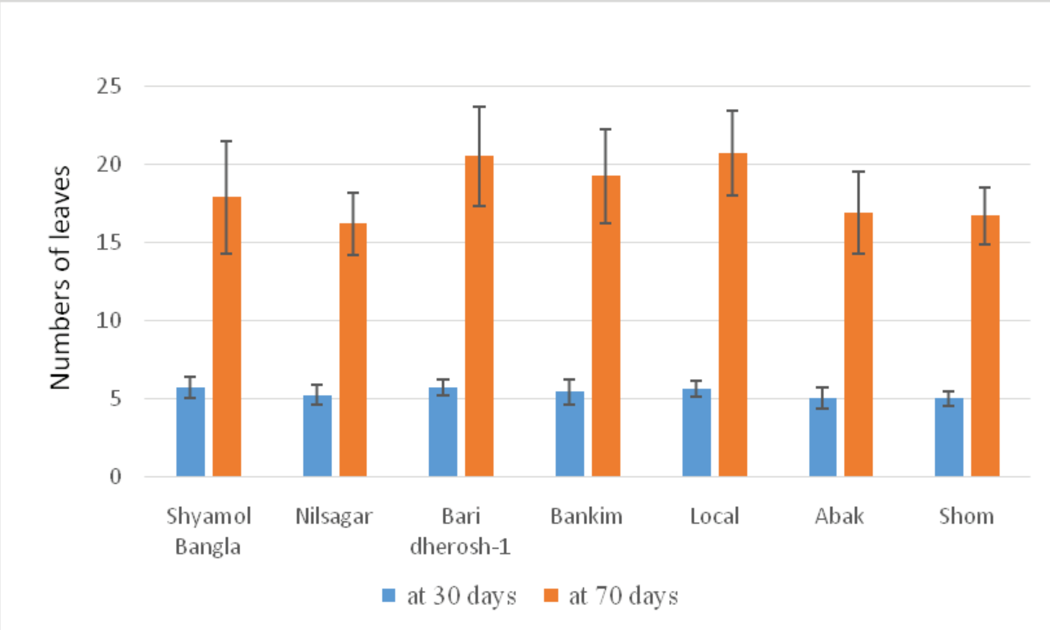

Fig. 3. Numbers of leaves per plant at 30 days and 70 days after seed sown.

Number of pods per plant

The number of pods per plant of the tested entries ranged from 9.5 to 15.1. Bari dherosh-1 genotype produced the highest number (15.1) of pod per plant among the studied genotypes. The lowest edible pod per plant was recorded from Nilsagar (9) which was identical with Shyamol Bangla (11.1), Shom (12.2) respectively. According to Rahman *et al*. (2012) the present result is within the range of the previous findings. The wide variability recorded for pod yield among the genotypes showed that there is copious opportunity for selection and improvement.

Number of seed per plant

In respect of the number of seed per pod, it was found that it differed significantly among the dherosh genotype. It was ranging from 30.2 to 61.3. Among the testes genotype, the highest number of seed per pod was found in Bari dherosh-1 (61.3). The around equal number of seed per plant was recorded in the other genotypes of the experiment.

Plant Height (cm)

Plant height of dherosh genotypes was measured at 30 days and 70 days after seed sown. Significant variation was observed among the seven genotypes of dherosh (Fig. 4). At 30 days after seed sown, the tallest plants were recorded for Bari dherosh-1 with a mean value of 7.61 cm and the lowest height was observed in Nilsagar (6.19 cm) among all genotype studied.

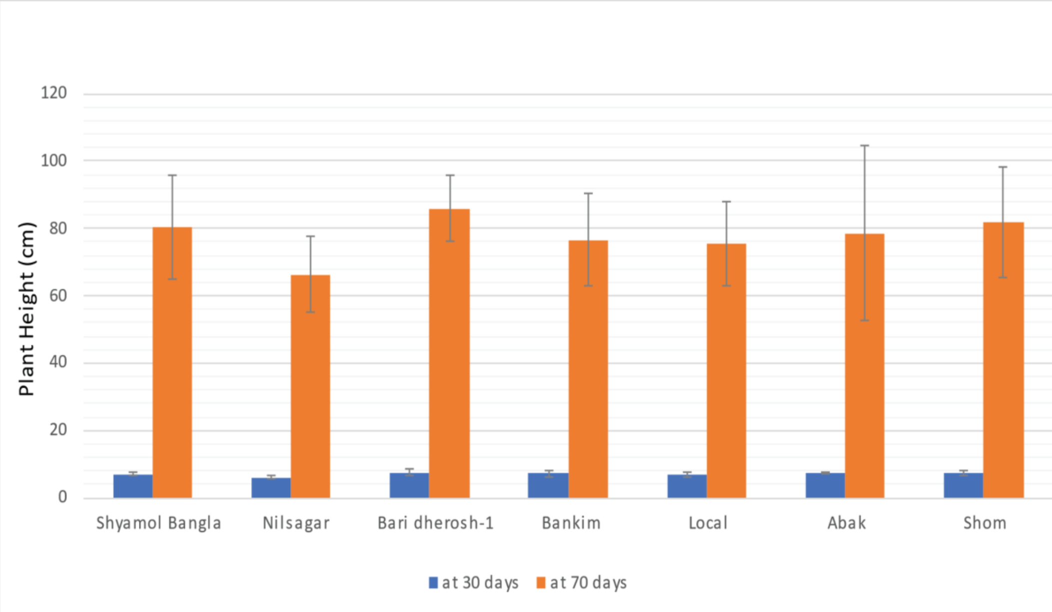

Fig. 4. Plant height at 30 days and 70 days after seed sown.

At 70 days after seed sown, significant different was observed in plant height which was ranged from 66.4cm to 85.9 cm. The lowest plant height was observed in Nilsagar (66.4 cm) which is par with Local (75.5 cm), Bankim (76.6 cm) respectively. The plant height of Bari dherosh-1 was 85.9cm which the longest tested genotypes. Due to environmental factors and genotypical variation of genotype, plant height of different genotypes varied. The highest plant height was 100.62 cm in summer season which was reported by during Karri and Pinaki (2012). Under the field trial, the highest plant height 91.33 cm among five dherosh genotype found by Rahman *et al*. (2012). The highest plant height was 130.4 cm which was reported result by Kuwar *et al*. (2001) and the present result is within the range.

Number of Branches

The branches number of dherosh genotype was ranged from 3.8 to 5.8. Kuwar *et al*. (2001), Nwangburuka *et al*. (2012), Singh and Jain (2012) also proposed similar results. The highest number of branches was observed in Bari dherosh-1 (5.80) as almost similar with Local (5.5) and Bankim (5.3). The yield per plant related with high number of branches which was reported by Mihretu *et al*. (2014) and Prasad *et al*. (2016).

Pod weight (g)

The okra genotypes showed significant variation in respect of pod weight (Table 1). Pod weight ranged from 13.76 to 15.87 g. Pod weight was highest observed in Local (15.87 g) which was at par with Bankim (15.63 g) and Bari dherosh-1 (14.75 g). The lowest pod weight was observed in Shom (13.76 g).

Table 1. Growth and yield attributes of the seven dherosh genotypes

Genotypes	Seed germination (%)	Number of pods per plant	Length of pod (cm)	Diameter of pod (cm)	Weight of pod (g)	Number of seed per pod	Seed weight(g)	Days to first anthesis	Number of branches per plant	Yield per plant (g)
Shyamol Bangla	93.33	11.1	12.15	2.05	14.57	30.2	4.81	45.0	4.5	161.73
Nilsagar	80	9.5	12.05	1.82	13.95	36.8	4.69	44.3	3.8	132.52
Bari dherosh-1	96.97	15.1	12.93	1.9	14.75	61.3	4.25	41.6	5.8	222.72
Bankim	76.67	13.4	13.2	1.99	15.63	38.3	4.64	42.3	5.3	209.44
Local	85	13.6	12.56	2.03	15.87	40.7	4.06	43.4	5.5	215.83
Abak	83.33	13.4	12.05	1.78	13.91	33.7	4.76	44.8	4.6	186.39
Shom	83.33	12.2	11.85	1.77	13.76	34.8	4.64	44.4	4.2	167.87
Mean	85.52	12.61	12.39	1.91	14.63	39.4	4.55	43.68	4.81	185.22
Range	20.3	5.6	1.35	0.28	2.11	31.1	0.75	3.4	2.0	90.2
SE±	2.72	0.69	0.19	0.04	0.32	3.86	0.11	0.49	0.28	12.49
SD	7.19	1.85	0.51	0.12	0.84	10.23	0.28	1.30	0.73	33.07
CV (%)	8.41	14.67	4.11	6.24	5.78	25.96	6.19	2.98	15.24	17.85
F value	11.04	3.86	1.33	11.08	3.96	13.29	37.3	3.73	5.27	2.45
LSD($P \leq 0.05$)	5.74	2.23	0.95	0.09	1.00	6.62	0.12	1.60	0.76	24.52
Level of significance	**	**	**	**	*	**	**	**	**	**

Level of Significance: $P > 0.05$ = Non Significant; $P \leq 0.05$ = Significant; $P \leq 0.01$ = Highly significant.

Yield per plant

Significant difference was present in pod yield per plant among the evaluated dherosh genotype (Table 1). In this study yield per plant was varied from 132.52 g to 222.72 g.The highest yield per plant were observed in Bari dherosh-1 (222.72 g) and lowest yield per plant was observed in Nilsagar (132.52 g). Local and Bankim genotype showed the round similar yield per plant which was (215.83 g) and (209.94 g). The yield per plant was 242.61 g which was reported by Reddy *et al.* (2012) and the highest yield per plant was observed in Bari dherosh-1 which was reported by Biswas *et al.* (2016). Due to environmental condition, yield per plant probably varied.

Conclusion

Result obtained from present investigation provided useful information on various morphological traits of the seven dherosh genotypes. The findings of this study revealed that Bari dherosh-1, Local and Bankim genotypes will be comparative more suitable for cultivation of dherosh under Barishal region. However, further research needs to be conducted with a wider range of native and exotic dherosh genotype to enable a more emphatic selection of useful accessions for cultivation and future breeding programmes, particularly increase yield of this crop.

Author Contribution

All the authors figure out and designed the program. MH conducted the experiments including statistical analyses and wrote the manuscript. SM and SKD supervised the experiments and co-ordinate the study.

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References

Adekoya MA, Ariyo OJ, Kehinde OB and Adegbite AE. 2014. Correlation and path analyses of seed yield in okra (*Abelmoschus esculentus* L. Moench) grown under different cropping seasons. *Pertanika Journal of Tropical Agricultural Science*. **37**: 39–49.

Biswas A, Hossain MM, Alam Z, Islam MM and Biswas A. 2016. Nutritive Value and Yield Potential of Okra (*Abelmoschus esculentus* L. Moench) Genotypes. *Bangladesh Journal of Agricultural Research*. **41**: 541-554.

Chauhan DVS. 1972. Vegetable Production in India. 3rd ed. Ram Prasad and Sons. Agra.

Charrier A. 1984. Genetic resources of *Abelmoschus* (okra). IBPGR Secretarial, Paris, France

Chattopadhyay A, Dutta S and Chatterjee S. 2011. Seed yield and quality of okra as influenced by sowing dates. *African Journal of Biotechnology*. **10**: 5461-5467.

Dattijo A, Omolaran BB, Babagana AG, Alafe HA, Oludare JA, Ali I, Usman AA. 2016. Varietal performance and correlation of okra pod yield and yield components. *Acta universitatis sapientiae agriculture and environment*. **8**: 112-125.

Deepak K, Saryam SK, Mittra AK, Meh ta, Prajapati S. And Kadwey 2015. Correlation and path co-efficient analysis of quantitative traits in okra (*Abelmoschus esculentus* L. Moench). *The bioscan*. **10**(2): 735-739.

Falusi OA, daudu OA, teixeira DA and Silva JA. 2012. Studies on morphological and yield parameters of three varieties of nigerian okra (*Abelmoschus esculentus* L. Moench). *Journal of horticulture and forestry*. **4**: 126-128

Hamon S and Van Sloten DH. 1989. Characterization and Evaluation of Okra. In: The Use of Plant Genetic Resources, Brown, A.H.D. (Eds), Cambridge University Press, Cambridge, ISBN-**10**: 0521368863, pp: 173-174

IPCBEE. 2011. International Conference on Biomedical Engineering and Technology, IACSIT Press, Singapore 11.

Karri SK and Pinaki A. 2012. Performance of okra (*Abelmoschus esculentus* L. Moench) cultivars under summer and rainy environment. *International Journal of Advance life Science*. **2**: 16-26.

Kuwar RP, Kubde KJ, Malvi SD, Dangore ST and Rault PD. 2001. Response of okra genotypes to varying plant density. *Pakistan Research Journal*. **25**: 65-67.

Lee KH, Cho CY, Yoon ST and Park SK. 2000. The effect of nitrogen fertilizer, plant density and sowing date on the yield of okra. *Korean Journal of Crop Science*. **35**: 179-183.

Linnaeus C. 1753. Species Plantarum.Vol I & II. Stockholm.

Mihretu Y, Weyessa G and Adugna D. 2014. Variability and association of quantitative characters among okra (*Abelmoschus esculentus* L. Moench) collection in South Western Ethiopia. *Journal of Biological Sciences*. **14**: 336-342.

Moekchantuk T and Kumar P. 2004. Export okra production in Thailand. Inter-country programme for vegetable IPM in South & SE Asia phase II Food & Agriculture Organization of the United Nations, Bangkok, Thailand.

Muhammad A, Muhammad S, Anjum MA, Ayyub CM and Muhammad M. 2001. Comparative study on the performance of some exotic okra cultivars. *International Journal of Agriculture and Biology*. **3**: 423-425.

Nwangburuka CC, Kehinde OB, Ojo DK, Denton OA, Popoola AR. 2011. Morphological classification of genetic diversity in cultivated okra, *Abelmoschus esculentus* (L) Moench using principal component analysis (PCA) and single linkage cluster analysis (SLCA). *African Journal of Biotechnology*. **10**: 11165-11172.

Phisut, N, Rattanawedee M and Aekkasak K. 2013.Effect of osmotic dehydration process on the physical, chemical and sensory properties of osmo-dried cantaloupe. *International Food Research Journal*. **20**(1): 189-196.

Prasad K, Mahesh B and Neha P. 2016. Evaluation of okra varieties for yield and quality traits cultivated under hill zone of Karnataka India. An International Variety. *Journal of Life Science*. **11**: 1319-1321.

Rahman K, Waseem K and Masum-ur-Rashid M. 2012. Performance of different okra (*Abelmoschus esculentus*) cultivars under the agro climatic conditions of Dera Ismail Khan. *Pakistan Journal of Time*. **64**: 316-319

Reddy MT. 2010. Genetic Diversity, Heterosis Combining Ability and Stability in Okra (*Abelmoschus esculentus* L. Moench). Ph.D. Thesis, Acharya N. G. Ranga Agricultura University, Hyderabad.pp. 313

Reddy MT, Haribabu K, Ganesh M, Reddy KC and Begum H. 2012. Genetic divergence analysis of indigenous and exotic collections of okra (*Abelmoschus esculentus* L. Moench). *Journal of Agricultural Technology*. **8**: 611-623.

Saifullah M and Rabbani MG. 2009. Evaluation and characterization of okra (*Abelmoschus esculentus* L. Moench.) genotypes. *SAARC Journal of Agriculture*. **7**: 92–99.

Semagn k, Bjornstad A and Djionsjop MN. 2006. An overview of molecular markers method for plants. *African Journal of Biotechnology*. **5**: 2540- 68.

Siemonsma JS and Hamon S. 2002. *Abelmoschus caillei* (A. Chev.) Stevels. In Oyen, L.P.A. And Lemmens R.H.M. (eds) Plant Resources of Tropical Africa. Precusor PROTA Programs Wageningen, The Netherlands. 27-30

Singh DK and Jain SK. 2012. Performance of okra hybrids for quantitative attributes. *Pantnagar Journal of Research*. **10**(1): 66-70.

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COMPARATIVE STUDY OF LIPID PROFILE IN FASTING AND RANDOM STATE OF DIABETIC PATIENTS IN BANGLADESH

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Abstract
Diabetes mellitus is one of the most significant causes of mortality and morbidity in all over the world. Coronary artery disease is the most important vascular complication among diabetic patients. Serum lipid profile is an important biochemical parameter, which is measured for cardiovascular risk prediction. The study was conducted to measure and compare serum lipid profiles between 2 (two) groups of diabetic and non-diabetic individuals in fasting and random state. The study group was consisted of 600 male and female participants in fasting and random state. Venous blood samples were collected from those subjects for determining the levels of glucose and lipid profiles [total cholesterol, triglycerides (TG), high density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C)]. Glucose and total cholesterol, TG, HDL-C were determined by enzymatic method and LDL-C is a calculative value. High levels of total cholesterol and TG were found in almost all age groups of diabetic patients, compared to the non-diabetic individuals. In this study it can be concluded that in fasting and random state, high levels of total cholesterol, TG and low levels of HDL-C were more prevalent in diabetic patients compared to non-diabetic individuals. Abnormal level of serum lipid profiles can play a major role for developing cardiovascular diseases and cerebrovascular accidents among diabetic individuals. Routine monitoring of blood glucose and serum lipid profile in fasting state should be needed as the optimal care for diabetic patients.

Keywords: Diabetes, Lipid profiles, Fasting blood Sugar, Random blood Sugar, Coronary heart disease,

Introduction

Diabetes is a global public health problem, which is a group of metabolic diseases characterized by absolute or relative deficiencies of insulin secretion, insulin action, or both. This disease is associated with chronic hyperglycemia and disturbances of carbohydrate, protein and lipid metabolism (American Diabetes Association 2008; Ozder, 2014). It is marked as the seventh leading attributable risk factor for burden of disease in South Asian countries (Lim, Vos *et al.* 2010). Long term chronic hyperglycemia of diabetes mellitus can lead to cardiovascular diseases, nerve damage (neuropathy), kidney damage (diabetic nephropathy), kidney failure, damage to the blood vessels of retina (diabetic retinopathy) and other life-threatening complications (Lim, Vos *et al.* 2010; Rahman, Gilmour *et al.* 2013). Current estimates (in 2013) indicate that Bangladesh has the second largest number of adults with diabetes (5.1 million adults, 6.31%) in the South

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Asian region (Rahman, Akter *et al.* 2015). After two years, another research showed that about one in ten Bangladeshi adults are suffering from diabetes (Rahman, Akter *et al.* 2015). Therefore, prevalence of diabetes is increasing (Saquib *et al.* 2012) drastically in Bangladesh, which is very alarming for Bangladeshi people. In the present world, diabetes mellitus is one of the most significant causes of mortality and morbidity. The most common of diabetes mellitus is type 2, occurs when the body becomes resistant to insulin or doesn't make enough insulin. Most of the studies conducted on glucose have shown that approximately 90-95% of people around the world who have diabetes have type 2 diabetes mellitus (Daboul, 2011).

In 2000, Diabetes mellitus was responsible for approximately 10% of all deaths, particularly in those aged between 45-64 years (Veeramalla and Madas 2017). Cho NH et al. showed that in 2017, about 451 million (age 18-99 years) people were living with diabetes and by 2045, the total number of affected people was expected to increase to 693 million globally (Cho, Shaw *et al.* 2018). In 2017, approximately 5 million deaths were owing to diabetes in the 20-99 years age range (Cho, Shaw *et al.* 2018). In Bangladesh, which has a total population of more than 160 million, the International Diabetes Federation (IDF) estimated that 7.1 million people have diabetes and almost an equal number with undetected diabetes. This number is expected to become double by 2025 (Islam, Lechner *et al.* 2017).

Coronary artery disease is the most important vascular complication among diabetic patients. In both male and female diabetic patients, the occurrence of coronary artery diseases is 3 to 5 times higher, compared to the normal population (4). Lipid profile is a panel of blood tests, serves as initial screening tool for detecting abnormalities in lipids, and also used as a tool for cardiovascular risk prediction. Serum lipid profile includes four basic parameters: total cholesterol (TC), triglycerides (TG), high density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C). Individuals with diabetes mellitus exhibit characteristic pattern of abnormalities in serum lipid levels, often termed "diabetic dyslipidemia", consisting of high total cholesterol, high TG, low HDL-cholesterol and elevated levels of small dense LDL particles.

Numerous studies have suggested the association between high glucose and lipid profile level (Bhowmik and Siddiquee, 2018; Pantoja-Torres and Toro-Huamanchumo*,* 2019; Vydehi Veeramalla, 2017; Yang, Rigdon *et al.*, 2019). However, none of these studies have performed a detailed analysis to establish a link of comparison between fasting and random state of the pattern of lipid profiles in diabetic and non-diabetic individuals. There is a paucity of data regarding this relationship. Since data of lipid profiles are not enough in Bangladeshi population having diabetes mellitus, in the present study, we aimed to compare the effect of high glucose on serum lipid profile level in fasting and random state among individuals with and without diabetes mellitus. Furthermore, the progression of complications due to diabetes mellitus can be reduced through this analysis.

Materials and Methods:

Procedure for data collection and study population

This study was performed with 600 diabetic and non-diabetic individuals. The study was consisted of two groups where group 1 was maintained fasting of 8 to 12 hours and the group 2 was maintained random state. All of them were patient of the Medinova Medical services, Barishal, from October, 2019 to March, 2020. Those who were included in the study fill up a written consent form fulfilling the required criteria. At the same time, those who were taking any anti-dyslipidemic drugs were excluded in this study.

Measurements of anthropometric, clinical and biochemical parameters

To measure fasting and random blood sugar, serum lipid profile, venous blood was collected as sample in fluoride containing vials and plain vials with proper aseptic techniques. The first aforementioned vials were utilized for estimating plasma glucose to determine diabetic and non-diabetic individuals; and the later was used for serum lipid profiles. Subsequent research procedures were followed after separating the plasma and serum by centrifugation (Sarkar and Dawn, 2017).

Reference ranges of different biochemical parameters considered in this study are listed in Table 1.

Table 1. Reference ranges of the biochemical parameters

Biochemical parameter		**Reference range**
Fasting Blood Sugar (FBS)		3.9-6.1 mmol/L
Random Blood Sugar (RBS)		<7.8 mmol/L
Lipid Profile	Total Cholesterol (TC)	<200 mg/dL
	Triglycerides (TG)	<150 mg/dL
	High Density Lipoprotein Cholesterol (HDL-C)	>35 mg/dL
	Low Density Lipoprotein Cholesterol (LDL-C)	<130 mg/dL

Blood glucose estimation was performed by using the glucose oxidase (GOD)/peroxidase (POD) method in which a red colored "quinoneimine dye complex" was formed. The intensity of the color was directly proportional to the concentration of glucose present in the sample (Veeramalla and Madas, 2017).

Total cholesterol was measured by using the cholesterol oxidase and peroxidase method (Allain, Poon *et al.* 1974).

In the serum sample, triglycerides were estimated by an accurate enzymatic method by producing intensity of the color which is directly proportional to the amount of triglycerides in the sample (Sarkar and Dawn, 2017; Sullivan and Kruijswijk,1985).

HDL-cholesterol was estimated by using phosphor-tungstate/magnesium precipitation method. After centrifugation the cholesterol in the supernatant containing HDL was assayed with enzymatic cholesterol method by using cholesterol esterase, cholesterol oxidase, peroxidase and the chromogen 4-aminoantipyrine (Ozder, 2014).

Friedwald's formula was used to estimate LDL-cholesterol by relating the levels of total cholesterol, TG and HDL-cholesterol: (Veeramalla and Madas, 2017).

LDL-cholesterol = Total cholesterol – HDL-cholesterol - (TG/5)

Ethical clearance for this study was obtained from the Ethics Review committee of the University of Barishal.

Statistical analysis

All data are presented as means ± standard errors of means (SEM). Statistical analyses were performed with one-way ANOVA followed by Paired t test. $P<0.05$ was considered statistically significant.

Results and Discussion

In this study, we revealed and compared the influence of elevated glucose on serum total cholesterol, TG, HDL-cholesterol and LDL-cholesterol. The biochemical parameters were normal and high/low depending on the reference ranges in Table 1. The study was conducted among 600 diabetic and non-diabetic individuals including male and female. They were categorized into two groups depending on their state of blood sugar levels. Group 1 was comprised of 150 non-diabetic individuals and 150 diabetic patients were maintaining fasting state; Group 2 was comprised of 150 non-diabetic individuals and 150 diabetic patients were maintaining random state.

Table 2. Baseline characteristics of all patients enrolled in the study.

Group		Non diabetic (N=150)	Diabetic (N=150)
Group 1 (FBS) 300 individuals	Age (Mean)	49.1	50.8
	Gender (N, %)		
	Male	99 (66.3)	76(50.7)
	Female	51 (33.7)	74(49.3)
Group 2 (RBS) 300 individuals	Age (Mean)	48.7	50.2
	Gender (N, %)		
	Male	77 (51.3)	74 (49)
	Female	73 (48.7)	76 (51)

Table 2 shows summary of two groups (in fasting and random state) where 300 patients are in each group. In fasting group 1, among 150 non-diabetic individuals aged between 18-82 years, 99 individuals (66.6 %) were male and 51 individuals (33.3 %) were female. All of them have a fasting blood sugar (FBS) level of 3.9-6.1 mmol/L. Among 150 diabetic patients aged between 18-83 years, 76 patients (50.7 %) were male and 74 patients (49.3 %) were female. All of them have fasting blood sugar level of >6.1 mmol/L. On the other hand, in random group, among 150 non-diabetic individuals aged between 18-82 years, 77 individuals (51.3%) were male and 73 individuals (48.7 %) were female. All of them have a random blood sugar (RBS) level of <7.8 mmol/L. Among 150 diabetic patients aged between 18-83 years, 74 patients (49 %) were male and 76 patients (51.0 %) were female. All of them have a random blood sugar (RBS) level of >7.8 mmol/L.

Table 3. Prevalence of normal and high values of total cholesterol, TG, LDL-cholesterol and low HDL-cholesterol level in non-diabetic and diabetic patients in fasting state.

	Lipid Profiles							
	Total Cholesterol		TG		HDL Cholesterol		LDL Cholesterol	
	Normal	High	Normal	High	Normal	Low	Normal	High
Non-diabetic individuals (N, %)	110 (73.3 %)	40 (26.7%)	87 (58%)	63 (42%)	106 (70.7%)	44 (29.3%)	125 (83.3%)	25 (16.6%)
Diabetic patients (N, %)	96 (64%)	54 (36%)	60 (40%)	90 (60%)	86 (57.3%)	64 (42.7%)	118 (78.6%)	32 (21.3%)

The above table also represents the prevalence of normal and high/low values of total cholesterol, TG, HDL-cholesterol and LDL-cholesterol in serum of non-diabetic and diabetic individuals in fasting condition. In non-diabetic groups, 110 individuals (73.3%) had normal levels and 40 individuals (26.7%) had high value of total cholesterol, whereas, in diabetic patients, 96 individuals (64%) had normal levels and 54 individuals (36%) had high value of total cholesterol. In non-diabetic groups, 86 (57.3%) had normal levels and 64 (42.7%) had high value of TG, whereas, in diabetic patients, 60 individuals (40%) had normal levels and 90 individuals (60%) had high value of TG. In non-diabetic groups, 133 individuals (88.6%) had normal levels and 17 individuals (21.4%) had low value of HDL-cholesterol, whereas, in diabetic patients, 117 individuals (78%) had normal levels and 33 individuals (22%) had low value of HDL-cholesterol. In non-diabetic groups, 125 individuals (83.3%) had normal levels and 25 individuals (26.7%) had high value of LDL-cholesterol, whereas in diabetic patients, 117 individuals (78%) had normal levels and 33 (22%) had high value of LDL-cholesterol. In non-diabetic groups, 144 individuals (96%) had normal levels and 06 individuals (4%) had high value of LDL-cholesterol, whereas, in diabetic patients, 140 individuals (93.3%) had normal levels and 10 individuals (6.7%) had high value of LDL-cholesterol.

From table 3, it can be concluded that high levels of total cholesterol, TG and LDL-cholesterol were more prevalent in diabetic patients compare to non-diabetic individuals. Moreover, low-HDL levels were also more prevalent in diabetic patients compare to non-diabetic individuals which is another risk predictor for cardiovascular disease (CVD) for human.

Table 4. Prevalence of normal and high values of total cholesterol, TG, LDL-cholesterol and low-HDL cholesterol level in non-diabetic and diabetic individuals in random state.

	Lipid Profiles							
	Total Cholesterol		TG		HDL Cholesterol		LDL Cholesterol	
	Normal	High	Normal	High	Normal	Low	Normal	High
Non-diabetic individuals (N, %)	94 (62.6%)	56 (37.4%)	76 (50.7%)	74 (49.3%)	76 (50.7%)	74 (49.3%)	101 (67.3%)	49 (32.7)
Diabetic patients (N, %)	89 (59%)	61 (41%)	45 (30%)	105 (70%)	51 (34%)	99 (66%)	108 (72%)	42 (28%)

The Table 4 also represents the prevalence of normal and high/low values of total cholesterol, TG, HDL-cholesterol and LDL-cholesterol in serum of non-diabetic and diabetic patients in fasting condition. In non-diabetic groups, 94 individuals (62.6%) had normal levels and 56 individuals (37.4%) had high value of total cholesterol, whereas, in diabetic patients, 89 individuals (59%) had normal levels and 61 individuals (41%) had high value of total cholesterol. In non-diabetic groups, 76 individuals (50.7%) had normal levels and 74 individuals (49.3%) had high value of TG, whereas, in diabetic patients, 45 individuals (30%) had normal levels and 105 individuals (70%) had high value of TG. In non-diabetic groups, 113 individuals (75.3%) had normal levels and 37 individuals (24.7%) had low value of HDL-cholesterol, whereas, in diabetic patients, 108 individuals (72%) had normal levels and 42 individuals (28%) had low value of HDL-cholesterol. In non-diabetic groups, 101 individuals (67.3%) had normal levels and 49 individuals (32.7%) had high value of LDL-cholesterol, whereas, in diabetic patients, 108 individuals (72%) had normal levels and 42 individuals (28%) had high value of LDL-cholesterol.

Table 4 shows the difference of the parameters related to lipid profiles between diabetic and non-diabetic individuals, which can be understood further by the graph. In Table 2 and Table 3, the abnormal levels of different biochemical parameters (Glucose, TG, HDL-C, LDL-C) in some non-diabetic individuals were observed whereas some diabetic patients had normal levels as they were concerned about their health. In most of the cases, diabetic patients had abnormal parameters levels of glucose, total cholesterol and TG; and the non-diabetics individuals had normal levels which is illustrated in Figure 1.

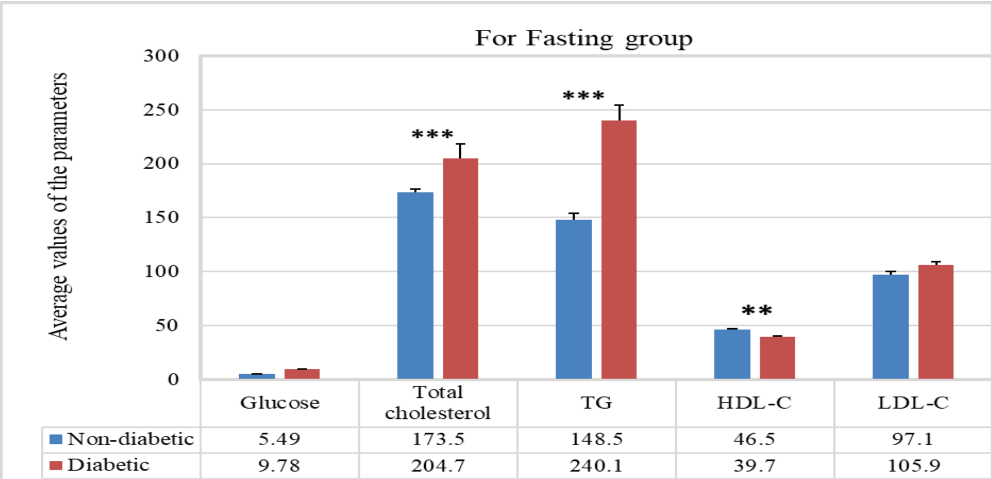
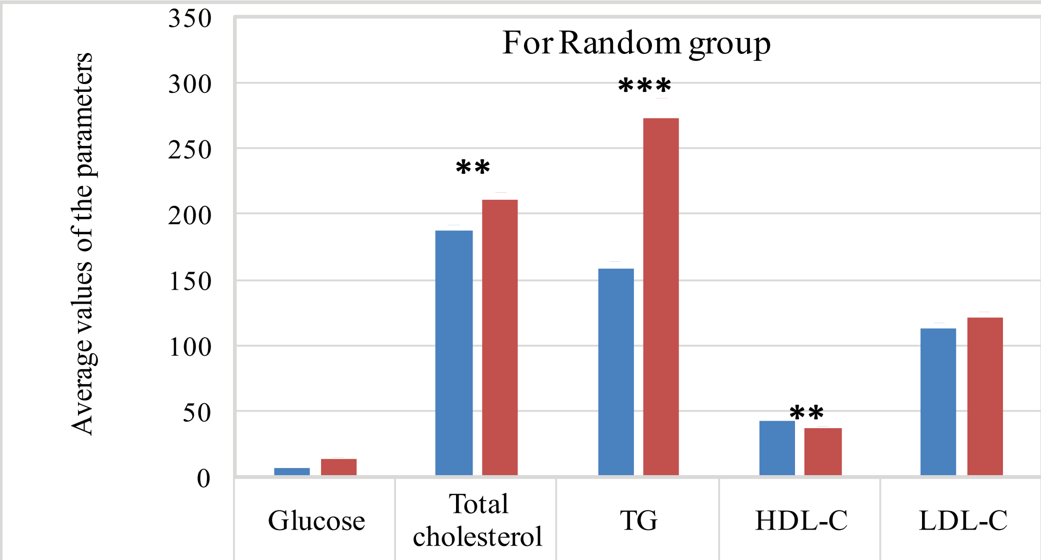


Fig. 1. Average levels of total cholesterol, TG, HDL-cholesterol, LDL-cholesterol level in non-diabetic and diabetic patients in fasting state. ***P<0.001, **P<0.01, significantly different from the level of non-diabetic group.

In figure 1, it was found that glucose, TG, and total cholesterol levels were significantly higher in diabetic patients compared to non-diabetic individuals. Whereas level of HDL-cholesterol was significantly lower in diabetic patients compared to non-diabetic individuals in fasting group.



	Glucose	Total cholesterol	TG	HDL-C	LDL-C
Non-diabetic	6.22	187.56	158.8	43.1	113.6
Diabetic	13.6	211.3	272.5	37.5	121.1

Fig. 2. Average values of total-cholesterol, TG, HDL-cholesterol, LDL-cholesterol level in non-diabetic and diabetic patients in random state.***$P<0.001$, **$P<0.01$, significantly different from the level of non-diabetic group.

Moreover, the average values of the parameters in random state between diabetic and non-diabetic patients are also represented in figure 2. In this graph, it was found that in random group, glucose, total cholesterol and TG levels were significantly higher in diabetic patients compared to non-diabetic patients. The level of HDL-cholesterol was significantly lower in diabetic patients compared to non-diabetic individuals in random group.

Our study highlights lipid abnormalities in patients with diabetes mellitus in different situations. Previous studies have clearly established that chronic hyperglycemia due to untreated diabetes mellitus exert harmful effect to health through various mechanisms: dyslipidemia, altered endothelial metabolism, platelet activation etc. (Hadi and Suwaidi 2007; Ozder, 2014). Therefore, diabetes mellitus and lipid profile have been considered to be the significant predictors for metabolic disturbances including dyslipidemia, cardiovascular diseases, hypertension etc. In this present study, we compared the prevalence of normal and high levels of total cholesterol, TG, LDL-cholesterol and low levels HDL-cholesterol in diabetes and non-diabetic participants in fasting and random state.

Diabetic patients have 5 times increased risk of coronary artery disease, compared to the normal population (https://www.webmd.com/diabetes/heart-blood-disease). There are numerous causes behind it including dyslipidemia, obesity, hypertension and smoking. In diabetic patients, dyslipidemia which is normally present due to decrease of HDL-cholesterol and elevated TG; it confers much of increased and accelerated early risk of coronary artery disease (CAD), peripheral vascular disease, cerebrovascular disease and sudden cardiac death. According to the study of CDC (Centers for Disease Control and Prevention), 97% of adult population with diabetes have at least one lipid abnormalities while the prevalence of diabetic dyslipidemia varies from 25% to 60% in other surveys. A report by Ahmed et al showed that 21% patients with type 2 diabetes have elevated serum cholesterol and 34.2% patients have increased TG in serum. In the present study, the high incidence of lipids was found in diabetic patients, compared to the non-diabetics. The reasons behind the increasing levels of total cholesterol, TG and LDL-cholesterol are rising in the incidence of the sedentary life, obesity, lack of physical activities, diet, and risk factors like hypertension etc. Despite of several important findings in our study, relatively small sample size is considered as a limitation of it (Veeramalla and Madas, 2017).

In diabetes, numerous factors may affect lipid levels in blood, because of interrelationship between lipid and carbohydrate metabolism. So, any disease in carbohydrate metabolism can lead to disorder in lipid metabolism and vice versa. Hypertriglyceridemia (a condition in which triglyceride levels are elevated) which usually accompanies reduced HDL-cholesterol, is also a leading feature of plasma lipid abnormalities found in diabetic individuals. The cluster of lipid abnormalities related with diabetes is ascertained by a low HDL concentration and high concentrations of TG and LDL-cholesterol. Our finding was consistent with previous studies suggesting that adequate glycemic control usually maintain normal or near-normal total cholesterol level, whereas worsening the control increases the cholesterol level. So, promoting glycemic control may substantially decrease the risk of cardiovascular events in patients with diabetes.

In diabetic patients, abnormal glucose reading is the most common metabolic abnormality which is accompanied by increased LDL-cholesterol, reduced HDL-cholesterol levels, hypertriglyceridemia and hypercholesterolemia. Hypertriglyceridemia and poor glycemic control are significant biochemical abnormalities in patients with type 2 diabetes mellitus. Therefore, dyslipidemia management in diabetic patients which aims to recognize secondary causes, might contribute to the abnormal lipid profile level in the serum.

The highest priority for diabetic patients having poor glycemic control should achieve normal blood glucose level, that effort may improve the problems of dyslipidemia. Therefore, it is clear from our study that lipid profile levels are abnormal in diabetic patients; they have the chance of developing cerebrovascular and cardiovascular diseases. Lifestyle changes, including dietary modifications and increased physical activities, can be the milestones of management. In addition, optimum treatment with lipid lowering drugs concomitant with proper antidiabetic drugs and dietary precautions will help to obtain fair glycemic control (Ozder, 2014).

Conclusion

In the present study, we have compared the effect of increased blood glucose on lipid profile in blood in fasting and random condition. From this study it can be concluded that monitoring of lipid profile status of diabetic patients in fasting state is more important compared to random state. Lipid profile monitoring by blood tests in fasting state can play a significant role to take care of diabetic patients.

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Author Contribution

Conceptualization: RP, AS; Formal Analysis: RP; Investigation: RP, MT, FSR; Writing-Original draft: RP; Writing-Review and Editing: RP, AS. The authors have also declared that no competing interests exist.

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References

Allain CC, Poon LS, Chan CS, Richmond W, Fu PC (1974) Enzymatic determination of total serum cholesterol. *Clin Chem*, **20**: 470-5.

American Diabetes Association (2008) Diagnosis and classification of diabetes mellitus. *Diabetes Care*, **31:** 55-60.

Bhowmik B, Siddiquee T*, et al.* (2018) Serum Lipid Profile and Its Association with Diabetes and Prediabetes in a Rural Bangladeshi Population. *Int J Environ Res Public Health*, **15** (9): 1944.

Cho NH, Shaw JE, Karuranga S, Huang Y, da Rocha Fernandes JD, Ohlrogge AW, Malanda B (2018) IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes Res Clin Pract*, **138**: 271-281.

Daboul M (2011) A study measuring the effect of high serum triglyceride and cholesterol on glucose elevation in human serum. *Oman Med J*, **26**: 109-113.

Hadi HA, Suwaidi JA (2007) Endothelial dysfunction in diabetes mellitus. *Vasc Health Risk Manag*, **3**: 853-76.

https://www.webmd.com/diabetes/heart-blood-disease.

Islam SMS, Lechner A, Ferrari U, Laxy M, Seissler J, Brown J, Niessen LW, Holle Rolf (2017) Healthcare use and expenditure for diabetes in Bangladesh. *BMJ Global Health*, **2**(1): 33.

Lim SS, Vos T, *et al.* (2010) A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet,* **380**: 2224-60.

Mellitus DJDc (2005) Diagnosis and classification of diabetes mellitus. **28**: 5-10.

Ozder A (2014) Lipid profile abnormalities seen in T2DM patients in primary healthcare in Turkey: a cross-sectional study. *Lipids Health Dis*, **13**:183.

Pantoja-Torres B, Toro-Huamanchumo CJ, Urrunaga-Pastor D, Guarnizo-Poma M, Lazaro-Alcantara H, Paico-Palacios S, Del Carmen Ranilla-Seguin V, Benites-Zapata VA (2019) High triglycerides to HDL-cholesterol ratio is associated with insulin resistance in normal-weight healthy adults. *Diabetes MetabSyndr*, **13**: 382-388.

Rahman MM, Gilmour S, Saito E, Sultana P, Shibuya K (2013) Health-related financial catastrophe, inequality and chronic illness in Bangladesh. *PLoS One*, **8**: 56873.

Rahman MS, Akter S, Abe SK, Islam MR, Mondal MN, Rahman JA, Rahman MM (2015) Awareness, treatment, and control of diabetes in Bangladesh: a nationwide population-based study. *PLoS One*, **10**: 0118365.

Saquib N, Saquib J, Ahmed T, Khanam MA, Cullen MR (2012) Cardiovascular diseases and type 2 diabetes in Bangladesh: a systematic review and meta-analysis of studies between 1995 and 2010. *BMC Public Health*, **12**: 434.

Sarkar S, Dawn (2017) Prevalence of diabetic dyslipidaemia in younger age group. *BJMS*, **16**: 557-563.

Sullivan DR, Kruijswijk Z, West CE, Kohlmeier M, Katan MB (1985) Determination of serum triglycerides by an accurate enzymatic method not affected by free glycerol. *Clin Chem*, **31**: 1227-8.

Vydehi Veeramalla SM (2017) Comparison of lipid levels in the diabetic and non-diabetic patients: a study in a tertiary care hospital. *Int J Adv Med*, **4**(6): 1573-1577.

Yang M, Rigdon J, Tsai SA (2019) Association of triglyceride to HDL cholesterol ratio with cardiometabolic outcomes. *J Investig Med*, **67**: 663-668.

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Change of Soil Phosphorus Fractions and Degree of Phosphorus Saturation as Amended by Lime and Phosphorus Fertilizer in a Finnish Acid Soil

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Abstract

The dynamics and 'sorption' properties of soil phosphorus (P) and its effect due to lime and fertilizer amendment on plant availability and mobilization from soil to water were studied in this research. Experimental treatments consisted of phosphorus, lime (KOH), lime-phosphorus combination and control. All the treatments were incubated at 20°C for 8 weeks. This study consisted of determination of total P using microwave technique, different inorganic fractions of soil P by modified Chang and Jackson method and degree of phosphorus saturation (DPS) was determined by extracting soils with ammonium oxalate-oxalic acid solutions and measuring iron and aluminium concentrations of the extracts with ICP-OES (Inductively Coupled Plasma- Optical Emission Spectrophotometry). Phosphorus fertilization clearly increased total P, Aluminium oxides or hydroxides bound P (NH_4F-P) and degree of phosphorus saturation of Finnish acid soil. And, lime treatment didn't have any significant effect on P fractions and DPS. The results of this research reveal the better availability of soil P to plants and increased risk of P loss from soil to water.

Keywords: Soil phosphorus (P), fractionations of P, degree of P saturation, acid soil, lime.

Introduction

Phosphorus (P) is one of the most important macro-nutrient elements in the plant and animal cells, where it constitutes several cellular structures like ATP, DNA, RNA, phospholipids etc. So far more than 170 phosphate minerals have been identified (Holford, 1997). Orthophosphate or derivatives of phosphoric acid is the main inorganic fraction existing in soil (Stevenson and Cole, 1999). The dominant phosphate compounds are compounds of Calcium (Ca), Aluminium (Al) and Iron (Fe) phosphates.

Phosphorus can be originated in soil from dissolution from rocks or, addition as fertilizer. it's availability of plants is governed by pH dependent charge of soils (Bolan and Hedley, 1990). Soil pH plays a significant role in controlling P availability for plants. Slightly acid to neutral pH range is most favourable for agriculture (Stevenson and Cole, 1999). Acidic soil promotes phosphate fixation as highly insoluble Fe or Al-phosphates through precipitation or ligand exchange reactions (Wild, 1950), where soils have abundant soluble Fe or Al like highly weathered soils of tropics.

The acidic nature of Finnish soils results significant retention of P, making it less available to plants and accumulating on the surface soils when applied as fertilizer (Hartikainen, 1989).

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That's why, liming is a very frequent practice to increase the pH and P availability to plants. (Oades, 1988; Marschner and Waldemar , 1991; Zech *et al*., 1997).

According to Koljonen (1992), the total P of cultivated surface soils of Finland is 690 mg kg^{-1}, where the total P concentration of the uncultivated surface soils of Finland ranges from 600 to 800 mg kg^{-1} and in mineral agricultural subsoils it varies from 430 to 920 mg kg^{-1} (Kaila, 1963b).

Different inorganic P fractions can be quantified separately by the method of Chang and Jackson (1958), whereas, NH_4Cl solution extracts most easily dissolvable P, NH_4F solution extracts the P bound by Al oxides and hydroxides, NaOH solution extracts P bound by Fe oxides, H_2SO_4 extracts primary calcium phosphates. In Finland, major part of the applied fertilizer P is retained in the soil as NH_4F- soluble P and as NaOH soluble P, which are considered to bound by Al oxides and Fe oxides respectively (Kaila, 1963a; Hartikainen, 1989). But, the extractability of P by NH_4Cl is found low according to the studies of Kaila (1964), Hartikainen (1979), and Niskanen (1987). The ratio between NH_4F soluble P and weakly crystallized Al compounds (oxalate extractable Al) indicates the amount of water-soluble P in soil (Hartikainen, 1982). Also, large portion of total inorganic P of weakly weathered acidic soils of Finland are found as primary calcium phosphates (Kaila, 1964; Peltovuori *et al*., 2002).

The quantity of accumulation of phosphate in soil when added as fertilizer or manure P can be determined as the "saturation degree of phosphorus" as the transport and deposition of fertilizer P in non-calcareous soil is governed by short-range ordered Fe and Al-oxides (Hartikainen, 1989). The most significant property for determining the amount of desorbable P was the degree of P saturation whereas amount of P released using a successive dilution method had no relationship with either total soil P content or P sorptivity (Hooda *et al*., 2000). This parameter is also very useful for determining loading tendency of soluble P because soluble phosphate leaching has been found correlated with degree of P saturation (Kalkhajeh *et al*., 2017).

The aim of this study was to find out how liming, P-fertilization and lime + P-fertilization affect total, inorganic fractions and saturation degree of soil P.

Materials and methods

Description of soil samples

The soil samples used in this research were supplied by the University of Helsinki. The description of the soil samples was given in the table 1. All the treatments (Table 1) were incubated at 20°C for 8 weeks. Moisture of the soils was adjusted to 40% from the soil water holding capacity (WHC). After the incubation, the soils were dried and stored at room temperature.

Table 1. Description of the soil samples.

Treatments	Description	pH
Control	Soil+ only water added	4.8
Lime	Soil + liming (0.085 mol kg^{-1} soil KOH)	6.7
Phosphorus	Soil + 100 mg P kg^{-1} soil corresponding P fertilization about 200 kg P ha^{-1}	4.9
Lime + Phosphorus	Soil + liming (KOH) + 100 mg P kg^{-1} soil	6.7

The soil used in the incubation experiment was taken from Kemira's Kotkaniemi research station in Vihti (located in Southern Finland). The soil textural class was sandy loam, with 7.4% of organic matter.

Dry matter content

At first, weight of the empty cup was measured. Then, approximately 5 g of soils were taken in the cups and weighed. They were dried in the oven at 105°C for 24 hours. On the next day, the soils with cups were first let to cool down in a desiccator for 30 minutes after which they are weighed again. Dry matter content of the soil was determined by dividing the oven-dried weight of the soil with air-dried weight of the soil.

Total P

About 0.5 g of soils of each treatment was weighed in the Teflon tubes in triplicate. A solution of 6 ml of HCl, 2 ml of HNO_3 (aqua regia) and 1 ml of H_2O_2 was taken with pipette, the tubes were closed, the caps were tightened with special equipment's and then they were put them in the microwave oven. The soils were then degraded in a microwave oven (CEM MarsX). The tubes were opened in a fume hood and the extracts were filtered through blue ribbon filter paper into 50 ml volumetric flasks. The volumetric flasks were then filled upto the mark and the extracts were collected in the plastic bottle for the measurement and preserved in the fridge (+4° C). After that, the total P concentration of the extracts was measured with ICP-OES (Inductively Coupled Plasma- Optical Emission Spectrophotometry, Thermo Scientific iCAP 6000 series).

Fractionations of inorganic P

The different fractions of inorganic P in the soil samples were determined using a fractionation method according to Hartikainen (1979), which was modified method of Chang and Jackson (1957).

Extractions

Phosphorus was fractionated from each sample in triplicate.

NH_4Cl-P: This extraction solution was used to extract the most easily dissolvable P and remove exchangeable Ca. Approximately 1.0 of air-dried sieved soil was weighed into a centrifugation tube. A solution of 50 ml of 1 M NH_4Cl was added, the tube was closed with a rubber plug, and agitated for 30 minutes in the shaker (VKS 75 control) at 180 rpm speed. The suspension was centrifuged for 10 min at 2500 rpm in the centrifuge machine (Hermle Z513K) and the extracts were filtered through filter paper (Whatman™ 589/3 Blue ribbon) into a plastic bottle. Easily soluble P and exchangeable Ca were extracted through this method.

NH_4F-P: Phosphorus bound by Al oxides and hydroxide was extracted by this method. A solution of 0.5 M NH_4F which was adjusted at pH 8.5 using 10 M NaOH was added in the soil left in the centrifugation tube after the previous phase, agitated (VKS 75 control ravistelijan) for an hour, and the suspension was centrifuged. the extract was filtered through blue ribbon filter paper (Whatman™ 589/3 Blue ribbon) into a plastic bottle. Boric acid was used for inactivation of fluoride as it interferes with determination. The soil was then washed with adding 25 ml of saturated NaCl by pouring pipette and shaking vigorously by hand. After this it was centrifuged and NaCl was discarded.

NaOH-P: Phosphorus bound by Fe oxides was extracted by this method. A solution of 50 ml of 0.1 M NaOH was added to the centrifugation tube and agitated for 30 minutes in the shaker. The solution was left in the centrifugation tube overnight and agitated the suspension again in the next day for 30 minutes. The suspension was then centrifuge again and the extract was filtered through filter paper into a plastic bottle. Then, again, the left soil in the centrifuge tube was washed with saturated NaCl as described above.

H_2SO_4-P: Calcium phosphates was extracted by this method. After washing, 50 ml of 0.25 M H_2SO_4 was added into the centrifugation tube, agitated for an hour in the shaker, centrifuged, and filtered into a plastic flask. Ca-bound apatitic P was extracted by this method.

Phosphorus was determined with this ascorbic acid colorimetric method according to Murphy and Riley (1962). The absorbance was measured with the spectrophotometer (Shimadzu, UV-VIS Spectrophotometer, ORDIOR aUVmini 120) at a wavelength of 880 nm. The complexes are formed by co-ordination of molybdate ions with phosphate as the central atoms. And, the oxygen of the molybdate radicals is substituted for that of phosphate (Jackson, 1958).

Degree of P saturation (DPS)

Approximately 2.5 g of soil was weighed into a centrifugation tube in triplicate and 50 ml of extraction solution (0.029 M $(NH_4)_2C_2O_4$ and 0.021 M $H_2C_2O_4$ which was adjusted at a pH of 3.3) was added. Then they were covered with black plastic wrap to create dark environment. Then they were agitated in a shaker (VKS 75 control ravistelijan) at 180 rpm in for two hours. After that, they were centrifuged (Hermle Z513K) for 10 min at 2500 rpm. The extracts were filtered through blue ribbon filter paper into plastic bottle. The extracts were then diluted 10 times by mixing 1 ml of sample with 9 ml of 0.1M HCl. The Fe and Al concentrations of the extracts were measured with ICP-OES.

The concentrations of oxalate-extractable metals (Feox and Alox, mmol kg^{-1}) were used to calculate the theoretical P sorption capacities of the soils (PSC, mmol kg^{-1}) according to Lookman *et al*., (1995).

$$PSC = 0.5 \times (Al_{ox} + Fe_{ox})$$

The saturation of the theoretical sorption capacity with P was estimated by calculating the molar ratio of the sum of the secondary Chang and Jackson P fractions (NH_4Cl-P, NH_4F-P and NaOH-P) to the sorption capacity (Peltovuori *et al*., 2002):

$$DPS = \frac{(NH4C1)\text{-}P + NH4F\text{-}P + NaOH\text{-}P)}{0.5 \text{ x } (Alox + Feox)} \times 100$$

Statistical analysis

A one-way ANOVA was conducted to see the differences for groups with different soil treatments in case of total P and DPS. A two-way ANOVA was conducted in case of fractions of inorganic P in order to see two-way variations of means of two different factors. All the treatments were in triplicates. Tukey's post hoc multiple comparison test was done to check the significant differences among the individual treatment groups. P-value was set at <0.05 level. SPSS 24.0 was used for statistical analysis.

Results and discussions

Total P

The amount of total P was found to be statistically significantly higher in the phosphorus and lime treated soils comparing to control. The highest values were found in P treated soils although they didn't differ significantly from lime treated soils (Figure 1). High concentration of total P after phosphate fertilization is consistent with the previous studies (Yli-Halla, 1989; Hooda *et al*., 2001). Typical total P (Control treatment) was found 830 mgkg^{-1} which is well-consistent with the previous studied results (Saarela, 2002; Peltovuori, 2006) about soils of Finland. The higher concentrations of total P in lime treated soils compared to control may be due to contaminations or other experimental error. Also, heterogeneity of soil may be another reason behind this.

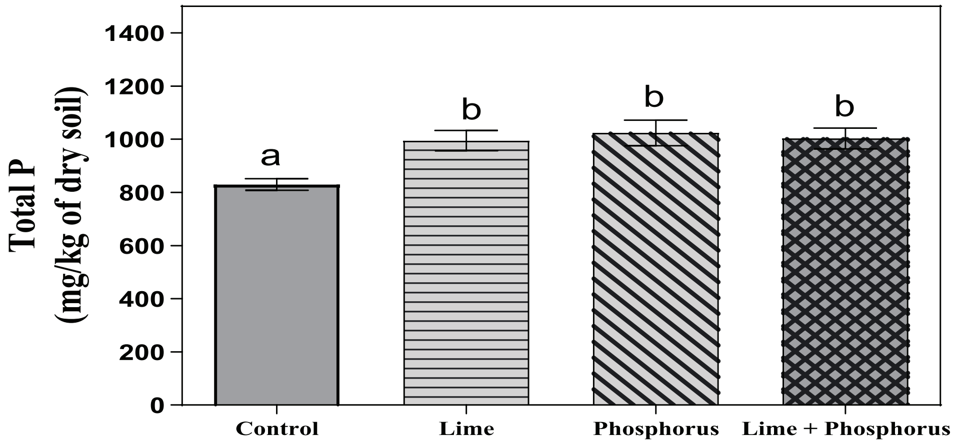

Fig. 1. Total P in different treatments (mean ± standard deviation, n=3). Different lowercase letters showed statistically significant difference among various treatments (ANOVA, Tukey's post hoc multiple comparison test, $p<0.05$)

Fractions of inorganic P

The very low amount of NH_4Cl-soluble P (Fig. 2) is in line with previous studies of Finnish mineral soil (Kaila, 1964; Hartikainen, 1979; Niskanen, 1987). Because chloride (Cl^-) ion is an anion of a strong acid which is unable to take part in ligand exchange reactions (Niskanen, 1987). In all the treatments, NH_4F-soluble and NaOH-soluble fractions were found in very large amounts compared to other inorganic fractions (Fig. 2). The large amounts of NH_4F and NaOH-soluble fractions found in all the treatments indicated that, P adsorption is regulated by short-ranged-ordered Al and Fe oxides; this result accorded with the previous studies with Finnish soils (Kaila, 1964; Hartikainen, 1989; Yli-Halla, 1989; Hartikainen, 1991; Peltovuori, 2006). The large Al and Fe oxide phosphate fractions is also attributed to large deposits of fertilizer P into these fractions and is regulated by the molar ratio of active Al and Fe contents (Kaila, 1964) and low pH (Pratt, 1961) of Finnish soils. Also, according to the study of Kaila (1965), larger application of phosphate in soils accounts for occurrences of higher portion of NH_4F- soluble phosphate. The amount of water soluble P in Finnish soil is regulated by the ratio between NH_4F-P and weakly crystallized Al compounds (Hartikainen, 1982). The lability of NH_4F-P or Al bound P is higher (Hartikainen, 1982; Hartikainen *et al*., 2010) than Fe-bound P because of the stronger bond between Fe and oxygen of phosphate group than the Al and oxygen of phosphate group as well as smaller isotopic exchange rate of Fe-phosphate complexes (Kyle *et al*., 1975). This depicts the better availability of P to plants as well as greater risk of P loss from soil to water.

The P fertilization of both limed and non-limed soils increased the NH_4F-soluble P and NaOH-soluble P and the increase was statistically significant (Fig. 2) which is consistent with the study of Hartikainen (1989). The large proportions of the H_2SO_4-soluble P were found but their quantity is unchanged with respect to lime and fertilizer addition. The liming didn't affect NH_4F-soluble P or, Al-bound P compared to control which is not in accordance with the study of Kaila (1961, 1965), but in accordance with the study of Chang and Jackson (1958). However, lime + phosphorus treatment increased NH_4F-soluble P statistical significantly which might be the effect of only P fertilization (Fig. 2). The large proportions of The H_2SO_4-soluble P is consistent with the previous studies (Kaila, 1964; Peltovuori *et al*., 2002). But, The H_2SO_4-soluble P or, Ca bound P didn't change at all in any of the treatments. As they are apatitic primary Ca-phosphates, their stability in this study are as per expectation and in line with the previous studies about Finnish mineral soils (Turtola and Yli-Halla, 1999; Peltovuori *et al*., 2002) due to slow rate of dissolution of apatitic minerals.

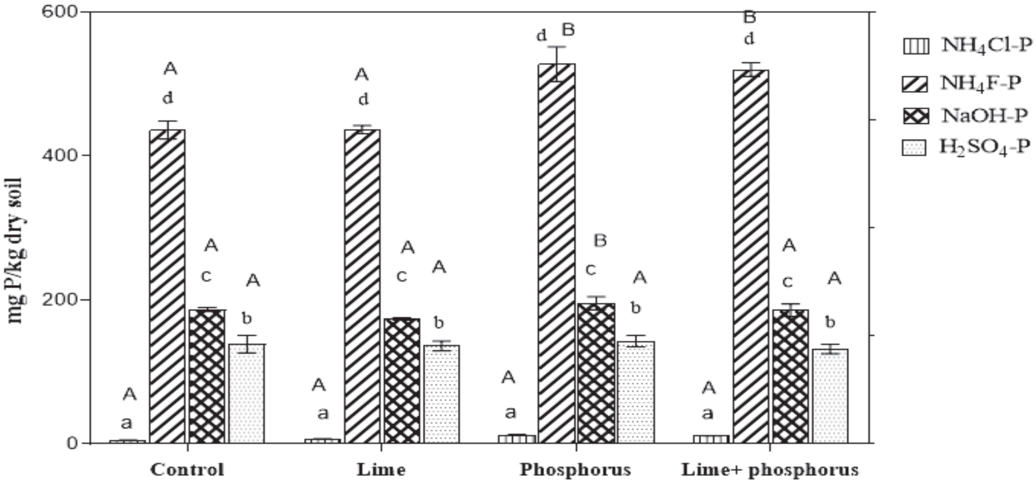

Fig. 2. Fractionations of soil inorganic phosphorus in different treatments (Mean ± Standard deviations). Different lowercase letters stand for statistically significant differences among various fractions of individual soil treatments and uppercase letters stand for statistically significant differences of each fractions among various soil treatments (ANOVA, Tukey's post hoc multiple comparison test, $p<0.05$).

Degree of P saturation (DPS) and phosphorus sorption capacity (PSC)

The lower PSC values compared to the results of Peltovuori *et al*., (2002) about Finnish soils in all the four treatments attributed to the low content of Fe oxides (Table 2) in the soils and supports the study of Zeng *et al*., (2004) and Peltovuori (2006), which was clearly in line with the results of fractionation studies. Although statistically non-significant lime addition decreased the DPS (%) which was attributed to increase of pH and in accordance with the earlier studies (Naidu *et al*., 1990).

Phosphorus treated soils had significantly higher response of DPS (%) when compared to control (Figure 3). The DPS (%) was found much higher than the studied three Finnish soil pedons (Sjökulla, Kotkanoja, and Toholampi) of fair P status (13.1-14.9%) but lower than one pedon (Loppi) of excessive P status (43.2%) according to the study of Peltovuori *et al*., (2002).

Table 2. Acid oxalate-extractable aluminium (Al_{ox}) and iron (Fe_{ox}) in the soils and estimates of the phosphorus sorption capacity (PSC).

Treatments	**Al_{ox} ($mmolkg^{-1}$)**	**Fe_{ox} ($mmolkg^{-1}$)**	**$Al_{ox}+Fe_{ox}$ ($mmolkg^{-1}$)**	**(PSC) ($mmolkg^{-1}$)**
Control	105.3	32.3	137.6	68.8
Phosphorus	97.7	31.5	129.2	64.6
Lime	108.8	34.8	143.6	71.8
Lime + Phosphorus	102.9	33.5	136.4	68.2

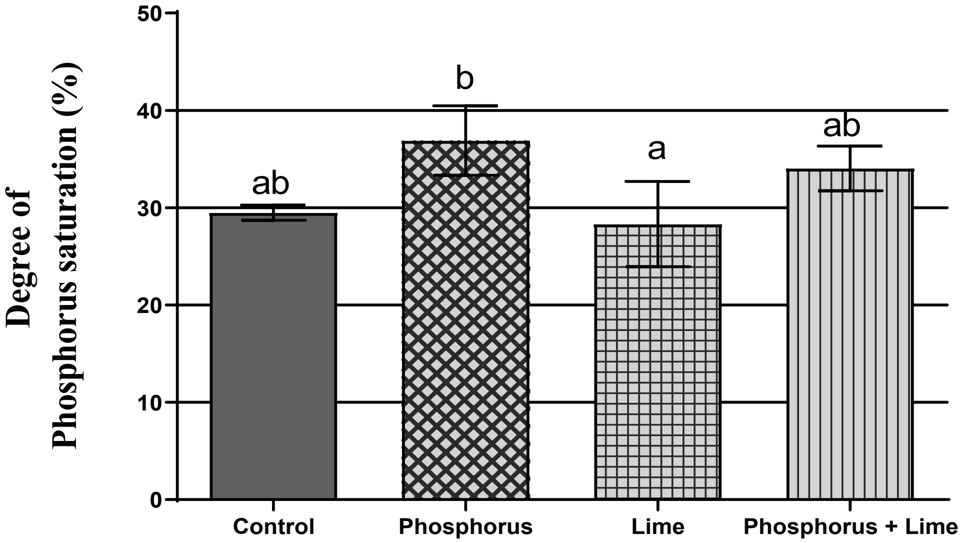

Fig. 3. Degree of phosphorus saturation (%) in different treatments(mean± standard deviation, n=3). Different lowercase letters indicate statistically significant differences among treatment groups (ANOVA, Tukey's post hoc multiple comparison test, $p<0.05$)

Conclusion

Phosphorus fertilization alone or in combination with lime increased total P of the studied acid soil of Finland. Easily available P or NH_4Cl-P was found very low and could not be changed by any of the treatments. Statistically significant increase of NH_4F-P by the P addition both alone or in presence of lime depicted that, Al and Fe oxides or hydroxides can bind added P. None of the treatments changed the PSC and P bound by Al oxides was more than thrice than Fe oxides. DPS was significantly higher than lime treated soil, but non-significant with control and P-lime combination. These results of this research delineated the mobility and dynamics of soil P of acid soils and paved the way of this kind of research about acid soils of Bangladesh, which will provide important information regarding P dynamics of acid soils of Bangladesh.

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References

Bolan NS and Hedley MJ. 1990. Dissolution of phosphate rocks in soils. 2. Effect of pH on the dissolution and plant availability of phosphate rock in soil with pH dependent charge. *Nutrient Cycling in Agro ecosystems.* **24**(3)**:** 125–134.

Chang SC and Jackson ML. 1957. Fractionation of soil phosphorus. *Soil Science*. **84**(2)**:** 133–144.

Chang SC and Jackson ML. 1958. Soil phosphorus fractions in some representative soils. *European Journal of Soil Science*. **9**(1)**:** 109–119.

Hartikainen H. 1979. Phosphorus and its reactions in terrestrial soils and lake sediments. *Journal of the Scientific Agricultural Society of Finland*. **51**: 537-634.

Hartikainen H. 1982. Water soluble phosphorus in Finnish mineral soils and its dependence on soil properties. *Journal of the Scientific Agricultural Society of Finland*. **91**: 73-85.

Hartikainen H. 1989. Effect of cumulative fertilizer dressings on the phosphorus status of mineral soils. I. Changes in inorganic phosphorus fractions. *Journal of Agricultural Science in Finland*. **61**: 55-59.

Hartikainen H. 1991. Potential Mobility of Accumulated Phosphorus in Soil as Estimated by the Indexes of Q/I Plots and by Extractant. *Soil Science*. **152**(3)**:** 204–209.

Hartikainen H, Rasa K and Withers PJA. 2010. Phosphorus exchange properties of European soils and sediments derived from them. *European Journal of Soil Science*. **61**(6)**:** 1033–1042.

Holford ICR. 1997. Soil phosphorus: its measurement, and its uptake by plants. *Soil Research.* **35**(2)**:** 227–240.

Hooda PS, Rendell AR, Edwards AC, Withers PJA, Aitken MN and Truesdale VW. 2000. Relating soil phosphorus indices to potential phosphorus release to water. *Journal of Environmental Quality*. **29**(4)**:** 1166–1171.

Hooda PS, Truesdale VW, Edwards AC, Withers PJA, Aitken MN, Miller A and Rendell AR. 2001. Manuring and fertilization effects on phosphorus accumulation in soils and potential environmental implications. *Advances in Environmental Research.* **5**(1)**:** 13–21.

Jackson ML. 1958. Soil chemical analysis. Englewood Cliffs, N.J.Prentice-Hall Inc. pp. 135.

Kaila A. 1961. Effect of incubation and liming on the phosphorus fractions in soil. *Journal of Scientific Agricultural Society of Finland*. **33:** 185–193.

Kaila A. 1963a. Total content of phosphorus in some Finnish soils. *Journal of the Scientific Agricultural Society of Finland.* **35:** 19-26.

Kaila A. 1963b. Phosphorus conditions at various depths in some mineral soils. *Journal of the Scientific Agricultural Society of Finland*. **35:** 69-79.

Kaila A. 1964. Fractions of inorganic phosphorus in Finnish mineral soils. *Journal of the Scientific Agricultural Society of Finland.* **36:** 1-13.

Kaila A. 1965. Effect of liming on the mobilization of soil phosphorus. *Journal of the Scientific Agricultural Society of Finland.* **37:** 243-254.

Koljonen T. 1992. The geochemical atlas of Finland. Part 2: Till. Geological Survey of Finland, Espoo.

Kalkhajeh YK, Huang B, Hu W, Holm PE and Hansen HCB. 2017. Phosphorus saturationand mobilization in two typical Chinese greenhouse vegetable soils. *Chemosphere.***172:**316–324.

Kyle JH, Posner AM and Quirk JP. 1975. Kinetics of isotopic exchange of phosphate adsorbed on gibbsite. *European. Journal of Soil Science.* **26**(1): 32–43.

Lookman R, Vandeweert N, Merckx R and Vlassak K. 1995. Geostatistical assessment of the regional distribution of phosphate sorption capacity parameters (Feox and Alox) in northern Belgium. *Geoderma.* **66**(3–4)**:** 285–296.

Marschner B and Waldemar Wilczynski A. 1991. The effect of liming on quantity and chemical composition of soil organic matter in a pine forest in Berlin, Germany. *Plant and Soil*. **137**(2)**:** 229–236.

Murphy J and Riley JP. 1962. A Modified Single Solution Method for the Determination of Phosphate in Natural Waters. *Analytica Chimica Acta*. **27**: 31-36.

Naidu R, Syersy JK, Tillman RW and Kirkman JH. 1990. Effect of liming on phosphate sorption by acid soils. *European Journal of Soil Science*. **41**(1)**:** 165–175.

Niskanen R. 1987. Release of phosphorus, aluminium and iron in fractionation of norganic soil phosphorus. *Journal of Agricultural Science in Finland*. **59:** 141- 145.

Oades JM. 1988. The retention of organic matter in soils. *Biogeochemistry.* **5**(1)**:** 35–70.

Peltovuori T. 2006. Phosphorus in agricultural soils of Finland - characterization of reserves and retention in mineral soil profiles.(Doctoral thesis). Available online at: https://helda.helsinki.fi/handle/10138/20819.

Peltovuori T, Uusitalo R and Kauppila T. 2002. Phosphorus reserves and apparent phosphorus saturation in four weakly developed cultivated pedons. *Geoderma.* **110(**1–2)**:** 35–47.

Pratt PF. 1961. Phosphorus and aluminum Interactions in the Acidification of Soils. *Soil Science Society of America Journal.* **25**(6)**:** 467–469.

Saarela I. 2002. Phosphorus in Finnish soils in the 1900s with particular reference to the acid ammonium acetate soil test. *Agricultural and Food Science in Finland*, **11**: 257-271.

Stevenson FJ and Cole MA. 1999. Cycles of Soils: Carbon, Nitrogen, Phosphorus, Sulfur, Micronutrients. John Wiley & Sons Publishers. 245-246 pp, 450 pp.

Turtola E and Yli-Halla M. 1999. Fate of phosphorus applied in slurry and mineral fertilizer: accumulation in soil and release into surface runoff water. *Nutrient Cycling in Agroecosystems*. **55**(2)**:** 165–174.

Wild A. 1950. The Retention of Phosphate by Soil - a Review. *Journal of Soil Science*. **1**(2)**:** 221–238.

Yli-Halla M. 1989. Effect of different rates of P fertilization on the yield and P status of the soil in two long-term field experiments. *Journal of Agricultural Science in Finland*. **61:** 361–370.

Zech W, Senesi N, Guggenberger G, Kaiser K, Lehmann J, Miano TM, Miltner A and Schroth G. 1997. Factors controlling humification and mineralization of soil organic matter in the tropics. *Geoderma.***79**(1–4)**:** 117–161.

Zeng L, Li X and Liu J. 2004. Adsorptive removal of phosphate from aqueous solutions using iron oxide tailings. *Water Resources*. **38**(5)**:** 1318–1326.

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CLIMATE CHANGE, ENVIRONMENTAL CONSEQUENCES, PRESENT PROTECTION MEASURES AND ADAPTIBILTY IN THE SOUTHERN REGION OF BANGLADESH:

A SOCIO-ENVIRONMENTAL PERSPECTIVES AND FUTURE CHALLENGES

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Abstract

Developing countries like Bangladesh suffering severe natural Hazards owing to climate change especially the coastal area are in most vulnerable situation. Therefore, this research was aimed to find out present socio-environmental status of the studied area. Research data showed that people living in Taltali Upazila, Barguna district have lack of knowledge (52.90%) on climate change and natural hazard protection measures. 32.90% people work as day laborer. Their (85.70%) monthly income less than 20,000 BDT which is not sufficient to expend for food, treatment, education and infrastructure. Almost half of the respondent is suffering food crisis in the studied area. 54.30% respondent answered that they were not economically stable. Soil salinity is a critical problem for unfavorable crop production. In addition, the lack of knowledge (74.30%) about saline tolerant crop varieties. For safe drinking water they had to go 1200-1500 feet of depth which is costly. Combined installation of tubewell in the studied area but it needed time to bring the water to drink. Addition of Alum was the only water purification process. The studied area suffer water pollution mostly (81.40%) in the rainy season. Unhygienic sanitation system (42.90%) might cause serious health diseases. The respondents suffer with different diseases mostly during summer and rainy season which is enhanced by the pollution and natural disaster events. According to their opinion, salinity, erosion, crop loss, safe water scarcity and loss of lives were increased in recent years. Based on the evaluation, immediate actions required to improve present socio-environmental crisis in that area.

Keywords: climate change, natural disaster, salinity, safe water, food security, health disease.

Introduction

Climate change has become global issue in 21st century. The whole world is suffering from climate change impacts adversely. Human health and food security is in vulnerable condition in coastal areas which is most affected zone due to climate change (Rakib *et al*., 2019b; Filho, 2015). Forests, wetlands, agricultural lands, freshwater bodies, ground water and infrastructures are affected owing to climate change which have direct impacts on livelihood (Alam *et al*., 2017). The countries located in sea facing area are encountering more natural hazards like; storm surges, cyclones, flash floods, sea level rise, droughts and salinity (Rahman and Rahman, 2015; Dasgupta *et al.,* 2015a). In recent years, different countries facing extreme temperature events, floods, prolonged droughts and extreme cold

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events (Mukul *et al*., 2019). World Health Organization (WHO) and Lancet Commission has been declared about climate change and predicted that world will suffer extreme climate change events globally in 21st century (Rahman *et al*., 2019). Forest fire, tornado, cyclone and flash floods already damaged millions of lives in different countries. Unstable climatic condition favors to introduce toxic and hazardous microorganisms and virus which causes severe health impact worldwide (Ahsan and Warner, 2014). From January 2020, more than forty six millions of people affected and out of which more than one million people already died because of Corona virus (Wang *et al.,* 2020). Developing and under developed countries are suffering more climate change effects (Ahmed *et al.,* 2019).

Geographically Bangladesh is a low-lying land area. The highest elevation from sea level is 105 m occur in the north. However, most of the elevations are less than 10 m above sea level. The elevations decreased (<1 m) in the coastal area close to Bay of Bengal (Filho, 2015). The country has more than 580 km coastline area (Chowdhury, 2015). Southern part of Bangladesh bounded by Bay of Bengal which is maintaining the climatic pattern of the country. Largest mangrove forest Sundarbans is protecting the country from severe damage by different climatic events like Sidr, Aila, Mahasen, Roanu etc. According to World Bank, Bangladesh is most vulnerable country due to climate change (Dasgupta *et al.,* 2015b). Tropical cyclone, tornado, lightening, landslides, flash flood and river bank erosion is occurring more in recent years (Bernier *et al.,* 2016). If sea level rises 0.5-2.0 m, southern region of Bangladesh will go underwater and millions of people will lose their lives (Castro Ortiz, 1994; Hale *et al.,* 2019; Brammer, 2014; Pethick and Orford, 2013).

Based on historical data, Bangladesh faced approximately sixty eight tropical depressions, forty three cyclonic storms and forty eight severe cyclonic storms during 1877-2009 (Sultana and Mallick, 2015). More than 35 million peoples living in coastal area of Bangladesh and exposed to extreme natural events due to climate change. On the other hand, southern coastal zone receives approximately 2.4 billion tons/year of sediments through different rivers and channels. These sediments deposited in the river beds of southern area and in the Bengal basin which decreases the river height (Emran *et al.,* 2017). Peoples in that area suffering more salinity problem in recent years (Bernzen *et al.,* 2019). The water transport cycle in the coastal area brings more saline water in the coastal surface area which affects agricultural production tremendously (Huq *et al.,* 2015). Peoples are suffering different health problems in coastal area like diarrhea, fever, hypertension, acute respiratory infections, miscarriage, hypertension etc.(Rakib *et al.,* 2019a).

Are the peoples living in coastal area of Bangladesh knows about climate change and its effects? It is an important question to combat against climate change and the central objective of our present research. Before making a policy or management plan against extreme climatic events, understanding the people's perception who directly facing the events is necessary. Past data showed that many literatures have been published on health effects, migration, soil salinity, agriculture and sea level rise in the coastal area owing to climate change (Rakib *et al.,* 2019b; Rahman *et al.,* 2019; Dasgupta *et al.,* 2015b; Hasan and Kumar, 2019; Clarke *et al.,* 2015; Akib Jabed *et al.,* 2020). However, this research is the first attempt to evaluate people's knowledge about climate change and natural hazards due to climate change. This research gave priority on active elements (peoples) because they are living in that area and facing directly the climatic events.

Materials and Methods

Present research was carried out in three villages named Malipara, Noyapara and Chotovijora under Taltali Upazila, Barguna district. This area is located not far from the Bay of Bengal. Sundarbans is in west side which is far from the studied area. No other natural protector stands between the studied area and the Bay of Bengal. As a result, serious climatic hazards directly hit the area. Major cyclones in recent years (Sidr-2007, Nargis-2008 and Aila-2009) caused severe damage among the coastal communities in this area. Geographically, the present studied area located in most vulnerable and disaster prone location.

GPS location of the study area is latitude: 21.980848˚N and longitude: 90.083340˚E. The studied are is showing in figure 1. Total area of Barguna district is 1831.3 km^2 and Taltali Upazila is 258.94 km^2. About 88,004 peoples living in Taltali Upazila. Population density is 541 per km^2 whereas the population density in Bangladesh is 1265 per km^2. Total 97 families containing total 508 people are living in present studied area.

Data was collected through personal observation, focus group discussion and personal interview during the period of August-September 2020. The questionnaire was designed through open and closed-ended questions to evaluate the socioeconomic crisis, agricultural limitations, scarcity of safe drinking water and health related impacts. People's perception on climate change and its impact on their lives was critically evaluated. Traditional disaster risk reduction measures and present government and NGO supported measures are evaluated. The study covered all 97 families through door to door discussion. Focus group discussion was carried out in the different tea shop and bazar where was much gathering occurred. The questionnaire had five segments: (1) Socioeconomic condition of the residents; (2) Agricultural practice and limitations; (3) Drinking water availability; (4) Health diseases; and (5) Climate change perception. Total 83 questions were prepared under this five segments. Raw data was arranged in table and made comparison with different parameters. For percentage calculation and correlation calculation statistical software, SPSS version-25 was used.

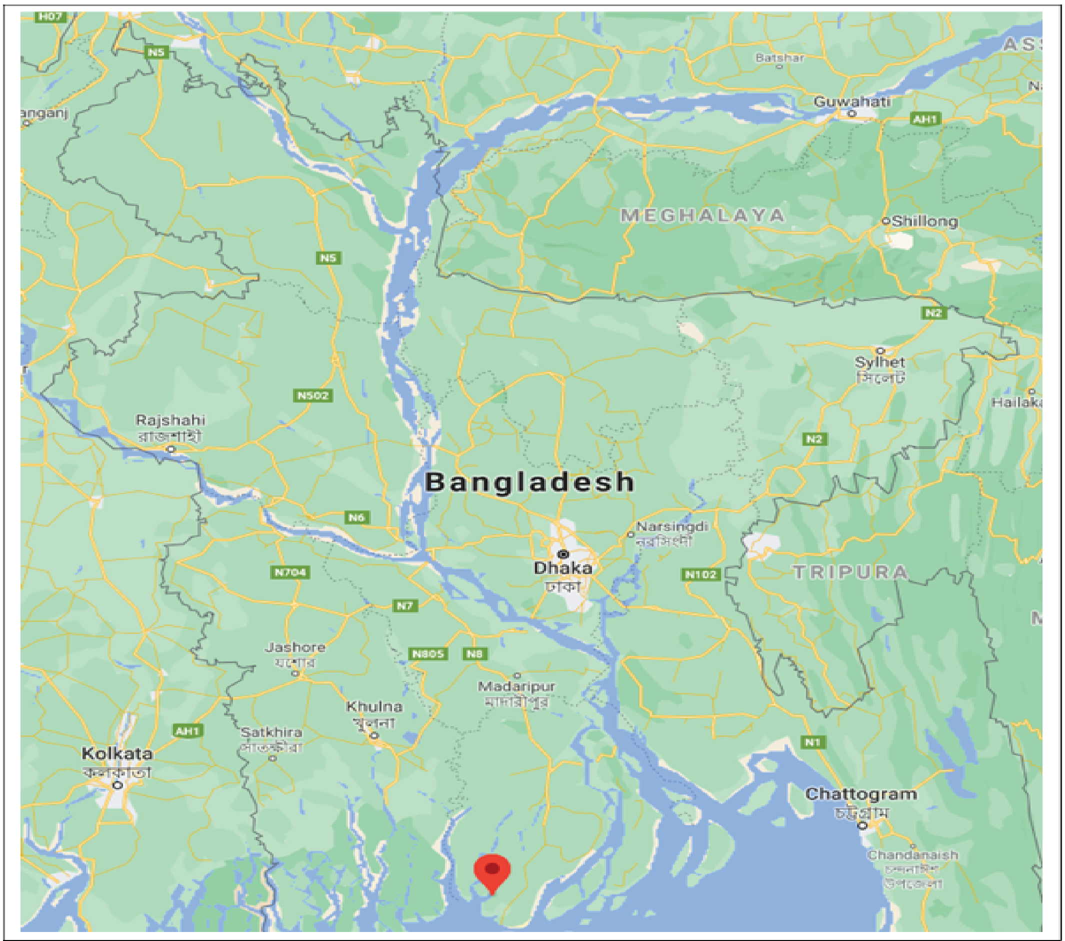

Fig. 1. Studied area in Google map.

Results and discussion

Socioeconomic condition

The infrastructure in present study area is poorly developed. Most of the respondent (64.30%) living in a house made of soil and bamboo called kacha ghor. 47.1% families were small (≤ 4 family members) and 40% families have 5-7 family members (figure 2). 72.9% respondents were the earning member for their family. Most of the people (32.90%) work as a day laborer for earning. However, 31.40% people are engaged with small business and only 12.90% people were farmers in the studied area. The average monthly income was found 10001-20000 BDT for 47.10% people and 31.40% people have less than 10000 BDT.

Although 57.10% peoples were using healthy sanitation system but 42.90% peoples were still using unhealthy sanitation. Healthy sanitations constructed by using cement slab in underground and upper fences were made of bamboo. Besides, the unhealthy sanitations were made by digging a hole in ground and use bamboo fences in the top.

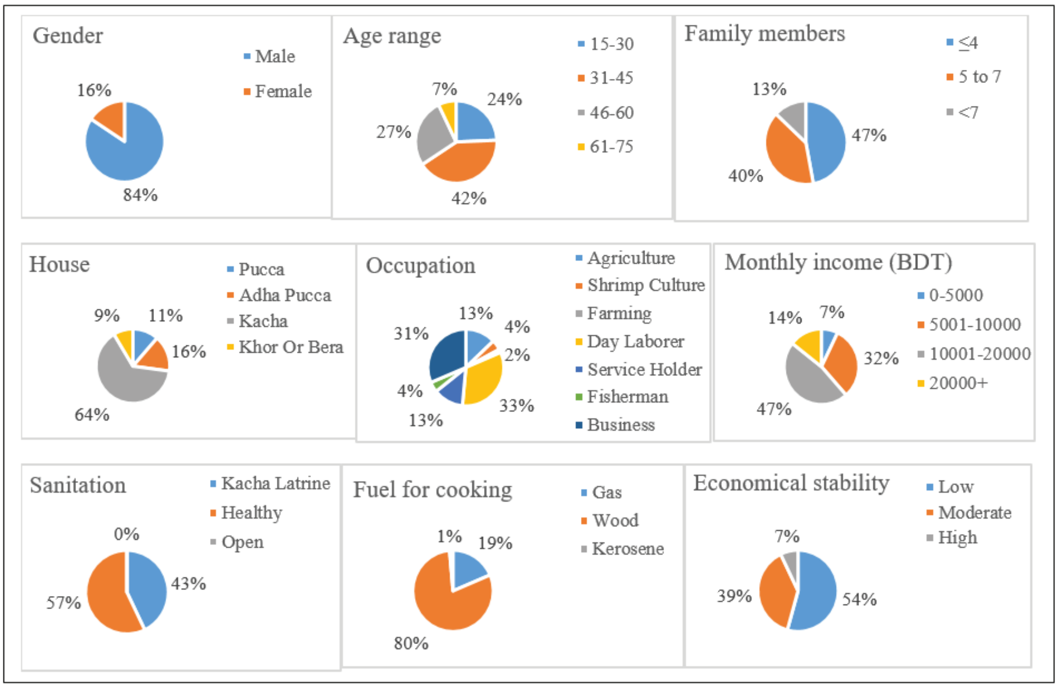

Fig. 2. Socioeconomic condition in the studied area.

About 80% peoples were using wood as fuel for cooking. Most of the families (72.9%) have 1-3 School going children. 50% of the respondents suffering food crisis in most of the time. For better earning, 62.90% respondents were growing domestic animals. 57.10% respondent supply the fundamental needs moderately to their family while 35.70% respondent cannot. The studied area have one primary school, one college and one madrasa. This places are also using as a cyclone shelter during extreme climatic events.

Water status

Taltali Upazila is surrounded by Burishwar river in the west, Andharmanik river in the east, Kochupatra and Pochakoraliya river in the north and Bay of Bengal in the South. Therefore, the study area have surface water in most of the part. However, people cannot use this water for household and agricultural purpose because of high salinity. Respondents mostly depend on tubewell water for drinking. For construction of tubewell about 1200-1500 feet deeper pipes are required to collect saline free water. If the pipes are in 600-700 feet depth, respondents cannot use the water because of salinity. Therefore, the installation of tubewell is expensive and they are not able to afford the cost for their own. So they mutually install tubewell close to their house. Government (only 5.70%) and NGOs (only 4.30%) had little support on tubewell installation. About 44.30% peoples required >15 minute to collect drinking water from their house.

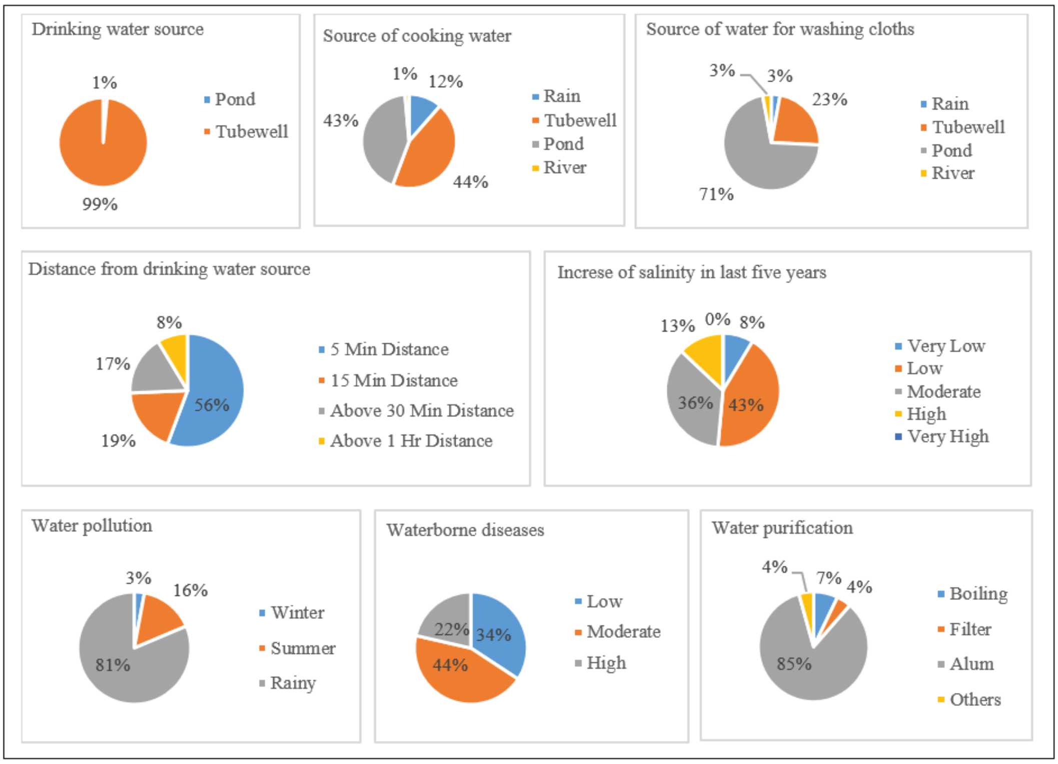

Fig. 3. Present water consumption status in the studied area.

About 78.60% respondents supported that salinity in water increased during last five years (2015-2020). 45.70% respondents agreed that they have serious drinking water crisis (figure 3). Some of the respondents harvested rain water by making small ponds and khals. Most of the people used surface water from pond, river and rainwater reservoir for cooking (57.10%) and for washing cloths (77.20%). In rainy season, higher amount of pollution loads coming from upper urban areas through river and deposited in the Bay of Bengal. The pollution scenario increased in recent years in that area. 81.40% respondent supported water pollution during rainy season every year. 65.70% respondent responded that they were suffering by waterborne diseases owing to the use of surface water for household activity. Although most of the peoples were using tubewell water collecting from deeper aquifer but the water was not found safe. Because, physical appearance of the water is red color. Water causes teeth problem and skin diseases. In addition, cooking with this water changed the taste of the food. From the past, they have some practical experience of purification of this red color water. Traditionally, 84.30% respondent used Alum to remove red color. However, they don't know about the appropriate alum dose so, it was risky for them. From practical experience, we assume that the tubewell water contains higher concentrations of iron (Hossain *et al.,* 2015). Extensive research is required to evaluate water pollution in that area.

Agriculture

Present study found that only 12.90% respondent chooses agriculture as their primary occupation (figure 4). Density people in the studied area are very low. Therefore, huge surface area for cultivation. Most of the land area either under government ownership or river bank area. As previously mentioned that this area is the door of Bay of Bengal. Salinity intrusion increases the salt concentration in the agricultural land which is not suitable for crop production. Most of the respondent (81.40%) said that the agricultural land under water and higher salinity in <4 months' time period in a year. Besides that, 74.30% respondent had no knowledge about saline tolerant crop variety available in Bangladesh. In addition, extreme climatic events occurred in each year caused huge production loss in the studied area. Moreover, they had little knowledge on green manure (87.10%) and vermicomposting (91.40%). Home gardening (61.40%) and duck farming (52.90%) was found profitable for the villagers. Women's are not involved in outdoor agricultural activities. Although, they have lots of difficulties in crop production but they were not interested to change their profession from agriculture.

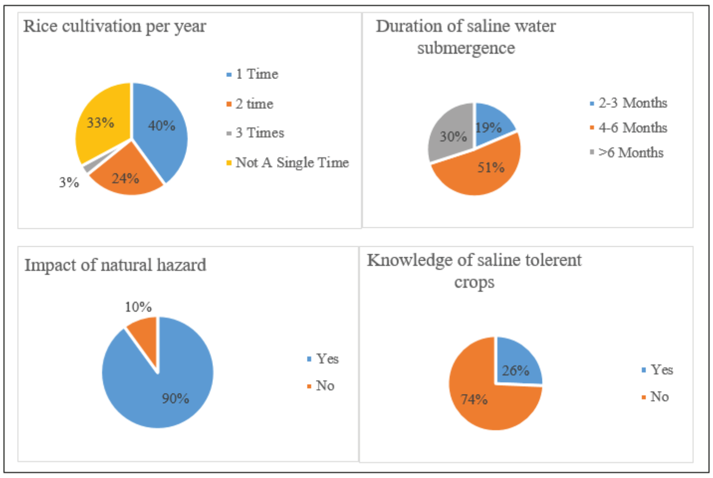

Fig. 4. Present agricultural condition in the studied area.

Health

The area is mosquito prone (57.10%) due to stagnant water, unhygienic sanitation and anthropogenic pollution. Most of the people (47.10%) suffer diarrhea and cholera diseases (figure 5). 31.40% respondent suffered from heart problem and 21.40% suffered from skin diseases. Fever was common disease in the study area. 12.90% peoples were found diabetic patient. Frequency of diseases were higher in summer (35.70%) and rainy season (34.30%). 11.40% respondents were suffered from high blood pressure. 84.30% patients used to go to the government hospital located in Taltali, Barguna and Barisal city. However, 15.70% respondents were still going to village doctor for treatment. More than 10000 BDT was the medical cost per year for 88.60% respondents. Therefore, most of their earning was expend for food and treatment and they had no future savings. As a result, they cannot afford stable infrastructure for their living to protect cyclone, flood and erosion.

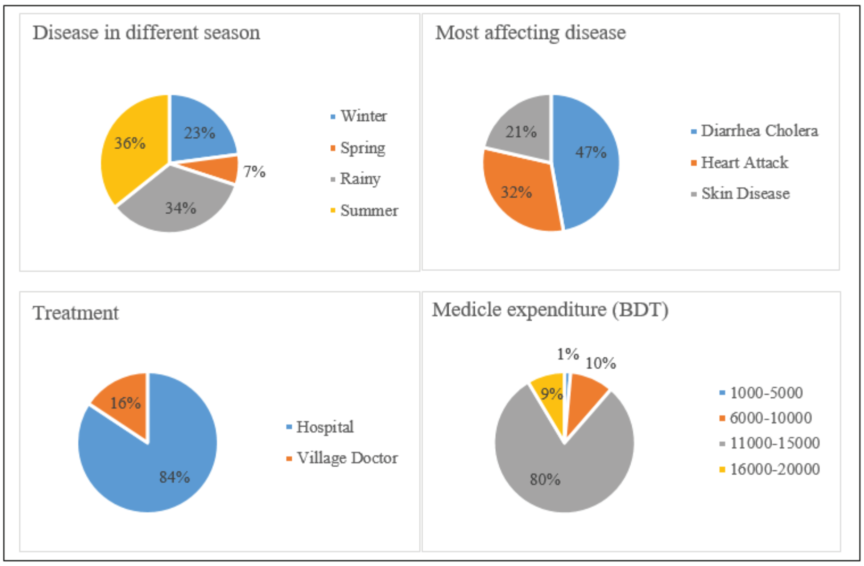

Fig. 5. Respondent health condition in the studied area.

People's perception on climate change

Most of the respondent (52.90%) had no knowledge on climate change and global warming (figure 6). 47.10% respondents have little knowledge through television and newspaper but they didn't have any practical experience and training about how to protect themselves from extreme climatic conditions. According to the respondent, most dangerous natural disasters were cyclone (67.10%), flood (28.60%) and riverbank erosion (4.30%). During natural disaster local authorities played warning siren from cyclone shelter and people take shelter at that period in the shelter. 27.10% respondent wants to shift their house to safe area to avoid natural hazards while majority respondents (72.90%) wanted to stay in their ancestor's house. They were not interested to leave their parental living place for this reason.

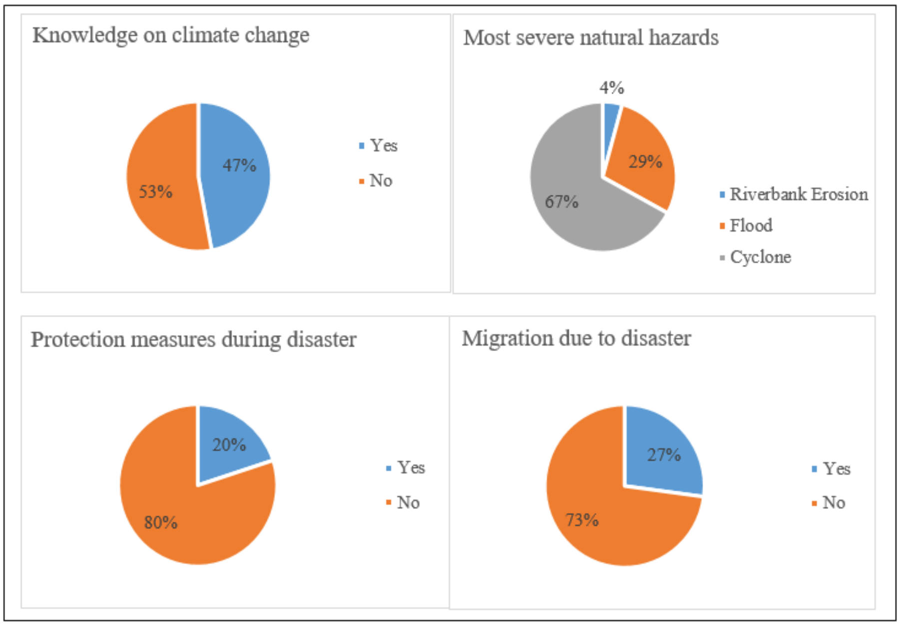

Fig. 6. Climate change perception and natural hazards in the studied area.

Future challenge

To reduce the socioeconomic loss and protect people from extreme natural hazards caused by climate change, appropriate action plans needed. As the inhabitants living in the southern coastal area suffering severe damages directly. Therefore, the knowledge on climate change and training on disaster protection measures are crucial for the protection of the disaster prone area. According to BBS (Bangladesh Bureau of Statistics) 2020, during 1980 to 2010 total 234 natural events occurred in Bangladesh which caused 191,836 death. More than 323 million peoples were affected in this time period. Approximately 17 million BDT was damaged due to natural events (BBS, 2020). Rakib *et al.,* (2019) found that severe natural hazard crisis and knowledge gap in Gabura union, Shymnagar Upazila, Satkhira district. This area is also located in the southern region close to Bay of Bengal (Rakib *et al.,* 2019b). Higher concentration of salinity was found in drinking water which caused safe drinking water scarcity in that area (Rakib *et al*., 2019a). A positive correlation was found between farmer's perception and meteorological data in the southern coastal area Kalapara, Potuakhali district (Hasan and Kumar, 2019). All these research data supported that extreme climatic events occurring in the southern coastal region. To improve the present scenario, understanding the resident's perception on climate change and the environmental condition is very much important. Many scientist predict that if the present environmental condition prevail in that area, serious damage will occur in future. Present research will help to understand the socioeconomic condition, water scarcity, agriculture, food crisis and health related issues in the coastal area. Immediate actions are required for the sustainable development in the southern coastal area.

Conclusion

Climate change is a well-known phenomenon around the world. The world is experiencing extreme climatic events in recent years. Because of geographic location Bangladesh is a vulnerable country. Habitat loss, crop loss and loss of lives in southern coastal area are very common owing to extreme natural hazards. Present studied area is located in the most vulnerable side facing natural hazards produced in the Bay of Bengal directly. Based on people perception that natural hazards increased compared to past and salinity intrusion increased as well which hampered crop production in a greater extent. Safe drinking water was found scarce in the studied area and most of the peoples are directly exposed to serious health risks. Using surface water caused waterborne diseases like diarrhea and cholera which found common in the studied area. About 42.90% resident using unhygienic sanitation systems which were flooded in the rainy season. The respondents answered that diseases affected them more in winter and summer season. Besides that, in rainy season surface water in the studied area were more polluted. In addition, the most of the natural hazards occurred in summer and rainy season. Based on the above results, it was clear that the respondents suffer more during summer and rainy season. Historically they were facing economic crisis to maintain their family. Because of food crisis most of the respondent in the studied area suffer malnutrition in most of their life time. They had traditional thinking about how to protect themselves against natural disaster which cannot reduce damage in that area. As a result they lost their resources from the past. Lack of knowledge on climate change caused more damage in the studied area. Government and NGOs had very little support in the studied area. Besides that, earning opportunity was very much limited. Therefore, most of the income they expend for food and cloths. They suffer for health treatment and to build strong structure to combat natural hazards. Further research regarding pollutants identification, salinity intrusion, health diseases and annual climate change is required. Government should give special focus on coastal area during policy making and immediate management plans need to execute to overcome present socio-environmental condition of the studied area.

References

Ahmed I, Ayeb-Karlsson S, Van der Geest K, Huq S and Jordan JC. 2019. Climate change, environmental stress and loss of livelihoods can push people towards illegal activities: a case study from coastal Bangladesh. *Clim. Dev.* **11:** 907–917.

Ahsan MN and Warner J. 2014. The socioeconomic vulnerability index: A pragmatic approach for assessing climate change led risks-A case study in the south-western coastal Bangladesh. *Int. J. Disaster Risk Reduct.* **8:** 32–49.

Akib Jabed M, Paul A and Nath TK. 2020. Peoples' Perception of the Water Salinity Impacts on Human Health: A Case Study in South-Eastern Coastal Region of Bangladesh. *Expo. Heal.* **12:** 41–50.

Alam MZ, Carpenter-Boggs L, Mitra S, Haque MM, Halsey J, Rokonuzzaman M, Saha B and Moniruzzaman M. 2017. Functional recovery of the bladder in patients with spinal cord injury. Prognosticating programs of an aseptic intermittent catheterization. *J. Food Qual.* 1–23.

BBS, (Bangladesh Bureau of Statistics). 2020. *Statistical Yearbook Bangladesh.*

Bernier Q, Sultana P, Bell AR and Ringler C. 2016. Water management and livelihood choices in southwestern Bangladesh. *J. Rural Stud.* **45:** 134–145.

Bernzen A, Jenkins JC and Braun B. 2019. Climate change-induced migration in coastal Bangladesh? A critical assessment of migration drivers in rural households under economic and environmental stress. *Geosci.* **9**(1)**:** 51

Brammer H. 2014. Bangladesh's dynamic coastal regions and sea-level rise. *Clim. Risk Manag.* **1:** 51–62.

Castro Ortiz CA. 1994. Sea-level rise and its impact on Bangladesh. *Ocean Coast. Manag.* **23:** 249–270.

Chowdhury MH. 2015. Bangladesh [WWW Document]. *Banglapedia Natl. Encycl. Bangladesh.*

Clarke D, Williams S, Jahiruddin M, Parks K and Salehin M. 2015. Projections of on-farm salinity in coastal Bangladesh. *Environ. Sci. Process. Impacts* **17:** 1127–1136.

Dasgupta S, Hossain MM, Huq M and Wheeler D. 2015a. Climate change and soil salinity: The case of coastal Bangladesh. *Ambio* **44:** 815–826.

Dasgupta S, Kamal FA, Khan ZH, Choudhury S and Nishat A. 2015b. River salinity and climate change: Evidence from coastal Bangladesh. *World Sci. Ref. Asia World Econ.* 205–242.

Emran A, Rob MA and Kabir MH. 2017. Coastline change and erosion-accretion evolution of the Sandwip Island, Bangladesh. *Int. J. Appl. Geospatial Res.* **8:** 33–44.

Filho WL. 2015. Handbook of Climate Change Adaptation. *Handb. Clim. Chang. Adapt.* 1–2198.

Hale RP, Wilson CA and Bomer EJ. 2019. Seasonal Variability of Forces Controlling Sedimentation in the Sundarbans National Forest, Bangladesh. *Front. Earth Sci.* **7:** 1–13.

Hasan MK and Kumar L. 2019. Comparison between meteorological data and farmer perceptions of climate change and vulnerability in relation to adaptation. *J. Environ. Manage.* **237:** 54–62.

Hossain D, Islam MS, Sultana N and Tusher TR. 2015. Assessment of Iron Contamination in Groundwater at Tangail Municipality, Bangladesh, *J. Environ. Sci. Nat. Resour.* **6:** 117–121.

Huq N, Hugé J, Boon E and Gain AK. 2015. Climate change impacts in agricultural communities in rural areas of coastal bangladesh: A tale of many stories. *Sustain.* **7:** 8438–8460.

Mukul SA, Alamgir M, Sohel MSI, Pert PL, Herbohn J, Turton SM, Khan MSI, Munim SA, Reza AHMA and Laurance WF. 2019. Combined effects of climate change and sea-level rise project dramatic habitat loss of the globally endangered Bengal tiger in the Bangladesh Sundarbans. *Sci. Total Environ.* **663:** 830–840.

Pethick J and Orford JD. 2013. Rapid rise in effective sea-level in southwest Bangladesh: Its causes and contemporary rates. *Glob. Planet. Change.* **111:** 237–245.

Rahman MM, Ahmad S, Mahmud AS, Hassan-uz-Zaman M, Nahian MA, Ahmed A, Nahar Q and Streatfield PK. 2019. Health consequences of climate change in Bangladesh: An overview of the evidence, knowledge gaps and challenges. *Wiley Interdiscip. Rev. Clim. Chang.* **10:** 1–14.

Rahman S and Rahman MA. 2015. Climate extremes and challenges to infrastructure development in coastal cities in Bangladesh. *Weather Clim. Extrem.* **7:** 96–108.

Rakib MA, Sasaki J, Matsuda H and Fukunaga M. 2019a. Severe salinity contamination in drinking water and associated human health hazards increase migration risk in the southwestern coastal part of Bangladesh. *J. Environ. Manage.* **240:** 238–248.

Rakib MA, Sasaki J, Pal S, Newaz MA, Bodrud-Doza M and Bhuiyan MAH. 2019b. An investigation of coastal vulnerability and internal consistency of local perceptions under climate change risk in the southwest part of Bangladesh. *J. Environ. Manage.* **231:** 419–428.

Sultana Z and Mallick B. 2015. Adaptation Strategies after Cyclone in Southwest Coastal Bangladesh – Pro Poor Policy Choices. *Am. J. Rural Dev.* **3:** 24–33.

Wang W, Tang J and Wei F. 2020. Updated understanding of the outbreak of 2019 novel coronavirus (2019-nCoV) in Wuhan, China. *J. Med. Virol.* **92:** 441–447.

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EFFECT OF SALINITY ON *IN VITRO* SEED GERMINATION, SEEDLING DEVELOPMENT AND CHLOROPHYLL CONTENT OF PEANUT (*ARACHIS HYPOGAEA* L.)

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Abstract

Peanut (*Arachis hypogaea* L.) is considered as one of the major economic crops of the world. Responses and salinity tolerance of two local peanut varieties, Dhaka-1 and BARI Badam-8 at different salt concentrations (0, 50, 100, 200, and 300 mM NaCl) were studied. The salinity stress inhibited seed germination, seedling development in these varieties. It also decreased chlorophyll content of leaves under salt stress. At 300 mM NaCl, the seed germination was completely inhibited for the Dhaka-1 variety and low germination (5%) was observed for BARI Badam-8 variety. No shoot development was observed when seedlings were cultured on MS medium containing 300 mM NaCl solution for both the varieties. The number of roots and leaves were also found to be decreased with the increase of salt concentration. Leaf disc senescence assay was also carried out to determine the changes in chlorophyll content of peanut leaves under salt stress. The leaf chlorophyll content decreased gradually with the increasing levels of NaCl in both the varieties. 300 mM NaCl decreased chlorophyll content by 87.35% and 85.26% in Dhaka-1 and BARI Badam-8, respectively.

Key words: Peanut, Salinity tolerance, Abiotic stress, Leaf disc senescence assay

Introduction

Peanut or groundnut (*Arachis hypogaea* L.) is one of the most important legume crops. It is a good source of protein (26 percent) and edible oil (49 percent) (Ros, 2010). Peanut also contains potassium, calcium, phosphorus, magnesium, zinc, iron, riboflavin, thiamine, vitamin E, niacin, etc. (Arya *et al*., 2016). In Bangladesh, peanut occupies third place among oilseed crops regarding its area and production. It is cultivated primarily for human consumption, and as fodder. This crop is grown either as a Rabi or as a Kharif crop, in about 87,131 acres. The annual production is about 62,832 metric tons. The major peanut producing districts are Faridpur, Panchagarh, Noakhali, Bhola, and Laksmipur (BBS, 2019).

Biotic stress like fungal diseases and abiotic stresses, like climatic factors, is highly responsible for the production and quality degradation of peanuts (Kumar and Kirti, 2015). Soil salinity is a major problem that affects the total nitrogen uptake resulting in reduced yields (van. Hoorn *et al*., 2001). Among all the stresses, a significant amount of global

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arable land is affected by salinity and the affected area is increasing day by day. Over the globe 20 percent of irrigated lands have been ruined by salt stress which accounts for 45 million hectares. Moreover, due to high soil salinity, 1.5 M ha lands are taken out of production each year (Munns and Tester, 2008).

Salinity is an important abiotic factor for hampering the production of crop plants in Bangladesh. The local peanut cultivars of Bangladesh are characterized by their low production rate. The coastal zone of the country includes a large saline prone area. This area covers almost 29,000 km^2 or about 20% of the whole country (Haque, 2006). The arable areas in the coastal districts of the country are affected with different levels of soil salinity. To meet the increasing demand for higher crop production and to maintain yield stability, the need for development of stress or salinity tolerant peanut variety is very high. However, breeding programs for stress resistance did not achieve remarkable success due to problems with incompatibilities, sterility barriers, high degree of self-pollination, and non-availability of desired traits in the available germplasm. Moreover, conventional breeding programs are also time-consuming.

The present investigation was undertaken to understand the inherent salinity tolerance of two local varieties of Peanut (Dhaka-1 and BARI Badam-8). These two varieties were subjected to various concentrations of NaCl to assess their tolerance against salinity at seed germination stage and seedling development stage. Studies were also carried out to assess the amount of chlorophyll loss under salt stress. The results help us understand the tolerance level of local peanut varieties against salinity.

Materials and Methods

Two varieties of peanut were used in the present investigation (Dhaka-1 and BARI Badam-8). The seeds were collected from Oil Seed Division of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

For rapid seed germination and subsequent seedling development autoclaved cotton soaked with sterile distilled water was used. About five seeds were placed into each flask. The cultured seeds were incubated in dark for germination. To determine the effect of salt stress condition on germination rate seeds were germinated on cotton beds containing 0, 50, 100, 200 and 300 mM of NaCl solution.

To determine the effect of salt stress on growth and development of seedlings, 8-day-old seedlings (raised on cotton beds) were cultured on Murashige and Skoog medium (Murashige and Skoog, 1962) supplemented with 50, 100, 200 and 300 mM NaCl. As control MS medium without any NaCl supplementation was used. Culture vessels were incubated under continuous white light at 25±2°C under 16-hours photoperiod.

For leaf disc senescence assay leaf discs of 6 mm diameter were excised from healthy and fully expanded *in vitro* peanut leaves of similar age and floated on a 10 ml solution of different concentrations (50, 100, 200 and 300 mM) of NaCl or water (as control) for 7 days in continuous white light at 25±2°C under 16-hours photoperiod. Following the method of Sanan-Mishra *et al*. (2005) and Arnon (1949) the chlorophyll content of the leaf discs was measured spectrophotometrically after extracting the content with 80% acetone. The phenotypic changes of the leaf discs after salt stress treatment were also observed and recorded.

Data were presented as mean ± standard errors of mean (SEM). For statistical analysis one-way ANOVA was performed followed by Tukey's post hoc test. A P-value <0.05 was considered as statistically significant.

Results and Discussion

In the current study, the effect of salinity on seed germination of peanut varieties was investigated. It was observed that the rate of germination decreased with the increase of salt stress in case of both the varieties (Fig. 1a, 1b and Fig. 2). The germination was completely inhibited at 300 mM NaCl concentration in Dhaka-1. However, in the case of the BARI Badam-8, about 5% germination was observed at 300 mM NaCl solution. The above result indicated that BARI Badam-8 has slightly better tolerance against salinity compared to Dhaka-1 variety in terms of seed germination. Moreover, the days required for seed germination also increase with the increase of salt stress. Similar observations have been reported by Liu *et al.* 2018, where they observed a significant decrease in rice seed germination at 120 mM NaCl. In the present investigation the radicle length of seeds was also found to be decreased with the increasing concentration of NaCl. High salinity significantly reduced the radicle length of the seeds for both peanut varieties (Fig. 1a, 1b and Fig. 3). Salinity-induced reduction of radicle length was also recorded in five different peanut varieties of Africa (Mensah *et al.,* 2006), suggesting different genotypes of *Arachis hypogaea* are vulnerable to salt stress.

The effect of salt stress was also investigated at the seedling stage of peanut. It was observed that the root and shoot length of plantlets were gradually decreased with the increase of salinity (Fig. 1c, 1d, and Table 1). The longest shoot was found in plantlets cultured on MS medium without any supplementation, which were 8.85 and 12.5 cm for Dhaka-1 and BARI Badam-8 variety respectively. No shoot development was observed when plantlets were cultured on MS medium supplemented with 300 mM NaCl solution. A similar trend was observed for the length of the roots for both varieties. Salt stress induced reduction of root and shoot length was previously reported for BARI Badam-8 and other peanut varieties (Satu and Ahmed*,* 2019; Mensah *et al.,* 2006). The salinity induced stunted growth in plants is generally a result of ionic toxicity caused by the high salt concentration (Gupta and Huang, 2014; Shrivastava and Kumar, 2015).

Fig. 1. Salinity tolerance of two local cultivars of peanut *(Arachis hypogaea* L.) var. Dhaka-1 and BARI Badam-8. **a**. Germination of seeds of Dhaka-1 variety on different concentrations of NaCl solutions and without any salt stress (control). **b.** Same as Fig. 1a but showing results for BARI Badam-8 variety. **c**. Seedlings of Dhaka-1 cultured on MS medium supplemented with different concentrations of NaCl solution and on MS medium without salt supplementations (control). **d.** Same as Fig. 1c but showing results for BARI Badam-8 variety. **e.** Leaf disc senescence assay of Dhaka-1 under different concentrations of NaCl solutions and on water (control). **f.** Same as Fig. 1e but showing results for BARI Badam-8 variety. **g.** Root of BARI Badam-8 induced on MS medium without salt supplementations (control) showing pointed root tip. **h.** Root of BARI Badam-8 induced on MS medium containing 200 mM NaCl solution showing blunt root tip (arrow). *The numbers shown in Fig. 1 (a-f) indicate NaCl concentration in mM.

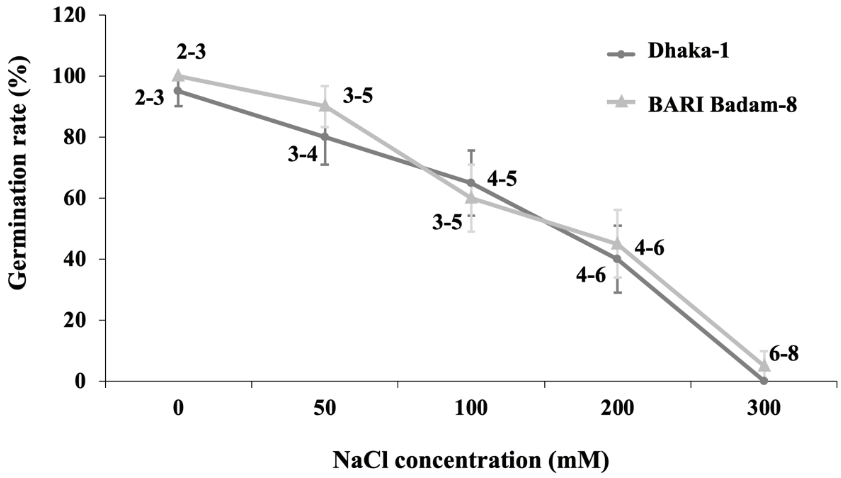

Fig. 2. Effect of different concentrations of NaCl on seed germination of Dhaka-1 and BARI Badam-8. Data presented as mean ± SE. Numbers at each data point indicates the number of days required for germination.

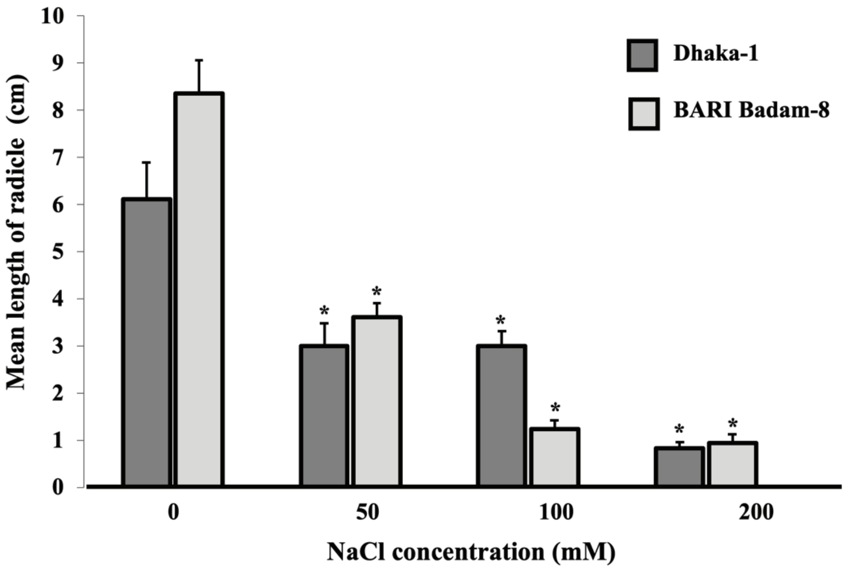

Fig. 3. Effect of different concentrations of NaCl on radicle length of Dhaka-1 and BARI Badam-8. Data presented as mean ± SE. *$P < 0.05$ vs control.

The salt stress affected the number of roots and leaves of peanut as well (Fig. 1c, 1d, and Fig. 4a, 4b). Extensive root formation occurred on MS medium alone and the number of roots significantly decreased with the increase of NaCl solution. At 300 mM NaCl, only one root was visible. Interestingly, the root tips of plantlets cultured on or above 200 mM were found to be blunted whereas, the root tips of control plants were pointed (Fig. 1g and 1h). Similar root tip damage has also been reported in rice due to compromised cell elongation (Shahidur *et al*., 2001). The high salt stress also significantly reduced the number of leaves for both varieties. Salinity-induced leaf senescence was reported in two peanut cultivars when treated with 200 mM NaCl solution (Taffouo, 2010).

The major factor that limits plant production under salt stress is leaf senescence. This process is regulated by the accumulation of some specific toxic ions (e.g. Na+) and also by inducing changes in leaf hormone (Ghanem *et al*., 2008). In the present investigation, a leaf disc senescence assay was performed in order to determine the changes in chlorophyll content of peanut leaves under salt stress. For this purpose, healthy and fully expanded leaves (of same age plant) from two peanut varieties were taken and leaf discs were punched out and floated in different concentrations of NaCl solutions (50, 100, 200 and 300 mM) or on water as experimental control for seven days (Fig. 1e, 1f and Fig. 5). After salt treatment the phenotypic changes in the discs were observed and recorded. At the same time the chlorophyll contents were extracted and quantified. The chlorophyll content of the leaf decreased gradually with increasing levels of NaCl in both the varieties. The control seedlings contain 20.48 and 20.49 µg of chlorophylls in Dhaka-1 and BARI Badam-8 respectively. The level of chlorophyll then gradually decreased to 2.59 and 3.02 µg at 300 mM NaCl solutions. This result in a 87.35% and 85.26% decrease in chlorophyll content in Dhaka-1 and BARI Badam-8, respectively.

Table 1. Effect of different concentrations of NaCl on root and shoot length of seedlings of Dhaka-1 and BARI Badam-8.

	NaCl concentration (mM)				
	0	50	100	200	300
Root length (cm)					
Dhaka-1	8.85 ± 0.89	7.8 ± 0.77	5.45 ± 0.51	3.57 ± 0.58	5.9 ± 0.47
BARI Badam-8	12.5 ± 1.03	10.5 ± 0.86	9.5 ± 0.55	7.5 ± 0.47	6.3 ± 0.44
Shoot length (cm)					
Dhaka-1	4.2 ± 0.51	4 ± 0.56	2.3 ± 0.27	1.6 ± 0.31	-
BARI Badam-8	5.5± 0.52	4.9 ± 0.49	4.5 ± 0.49	3.8 ± 0.44	-

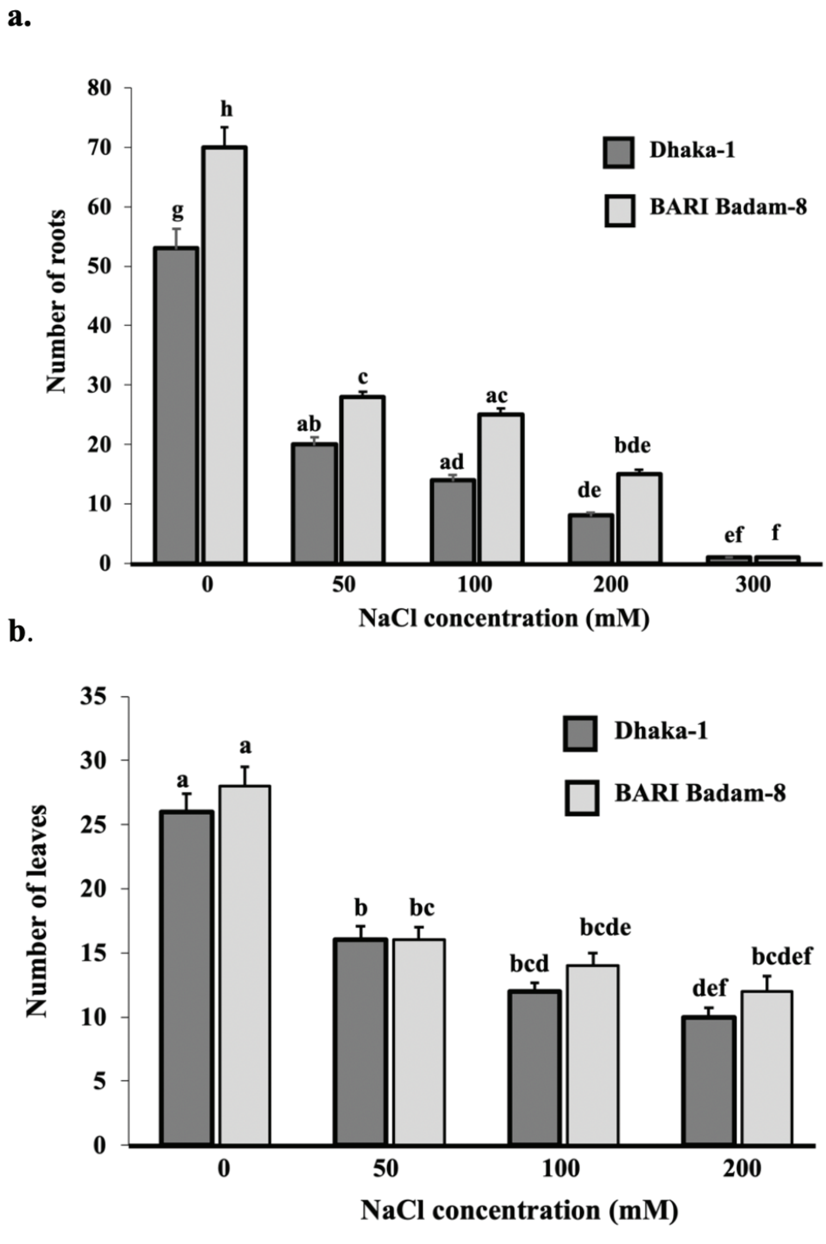

Fig. 4. Salt stress effect on number of roots (a) and leaves (b) of seedlings of Dhaka-1 and BARI Badam-8. Data presented as mean ± SE, different letters indicate significantly different value ($P < 0.05$).

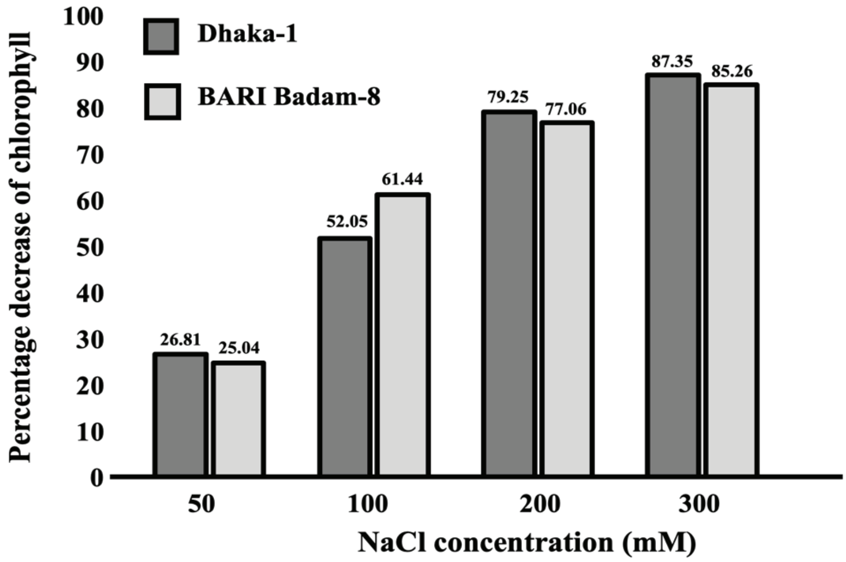

Fig. 5. Effect of different concentration of NaCl on the chlorophyll content of leaves of Dhaka-1 and BARI Badam-8.

These results suggest that salinity affects all the stages and parts of the two local peanut varieties. Higher concentration of NaCl not just inhibited and delayed seed germination, but it also inhibited the growth of radicle. Under salt stress, the developing stage of the plant is deeply affected leading to fewer roots and leaves. Moreover, stunted growth is visible. The root system of the plant is mostly affected, even anatomically different structures were observed. In addition to the roots, the leaves of the plant also start losing the chlorophyll pigments, resulting in chlorosis. This study could be used as a source of information to understand the salinity tolerance of local peanut varieties. It will also help future research regarding the development of salinity resistant peanut varieties.

Author Contribution

All the authors figure out and designed the program. IH conducted the experiments including statistical analyses and wrote the manuscript. RHS and MI supervised the experiments and coordinate the study.

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References

Arnon DI. 1949. Copper enzymes in isolated chloroplasts. Polyphenol oxidase in *Beta vulgaris*. Plant Physiol. **24**: 1-15.

Arya SS, Salve AR, and Chauhan S. 2016. Peanuts as functional food: a review. *J. Food Sci. Technol.* **53**(1): 31-41.

BBS. 2019. Yearbook of agricultural statistics. Bangladesh Bureau of Statistics, Ministry of Planning, Peoples republic of Bangladesh. pp. 129.

Ghanem ME, Albacete A, Martinez-Andujar C, Acosta M, Romero-Aranda R, Dodd IC, Lutts S, and Pe´rez-Alfocea F. 2008. Hormonal changes during salinity-induced leaf senescence in tomato (*Solanum lycopersicum* L.). *J. Exp. Bot.* **59**: 3039–50.

Gupta B, and Huang B. 2014. Mechanism of salinity tolerance in plants: physiological, biochemical, and molecular characterization. *Int. J. Genomics*. **2014**: 701596.

Haque SA. 2006. Salinity problems and crop production in coastal regions of Bangladesh. *Pak. J. Bot.* **38**(5): 1359-1365.

Kumar D and Kirti PB. 2015a. Pathogen-induced SGT1 of *Arachis diogoi* induces cell death and enhanced disease resistance in tobacco and peanut. *Plant Biotechnol. J.* **13**: 73–84.

Liu L, Xia W, Li H, Zeng H, Wei B, Han S, and Yin C. 2018. Salinity inhibits Rice seed germination by reducing α-amylase activity via decreased bioactive Gibberellin content. *Front. Plant Sci.* **9**: 275.

Mensah JK, Akomeah PA, Ikhajiagbe B, and Ekpekurede EO. 2006. Effects of salinity on germination, growth and yield of five groundnut genotypes. *African J. Biotech.* **5**(20): 1973-1979.

Munns R and Tester M. 2008. Mechanisms of salinity tolerance. *Annu. Rev. Plant Biol.* **59**: 651–681.

Murashige T and Skoog F. 1962. A Revised Medium for Rapid Growth and Bio Assays with Tobacco Tissue Cultures. *Physiol. Plant*. **15**(3): 473–497.

Ros E. 2010. Health benefits of nut consumption. *Nutrients*. **2**(7): 652-82.

Sanan-Mishra N, Pham XH, Sopory SK, and Tuteja N. 2005. Pea DNA helicase 45 overexpression in tobacco confers high salinity tolerance without affecting yield. *PNAS.* **102**(2): 509-514.

Satu S, Mansora, and Ahmad S. 2019. Effects of salinity on the growth and development of groundnut plant (*Arachis hypogaea* L.). *Journal of Bangladesh Academy of Sciences.* **43**(1): 25-30.

Shahidur R, Tomomi M, Hiroshi M, and Yoji T. 2001. Effects of salinity stress on the seminal root tip ultra-structures of rice seedlings (*Oryza sativa* L.). *Plant Prod. Sci.* **4**(2): 103-111.

Shrivastava P, and Kumar R. 2015. Soil salinity: A serious environmental issue and plant growth promoting bacteria as one of the tools for its alleviation. *Saudi J Biol Sci.* **22**(2): 123-131.

Taffouo VD, Meguekam TL, Ngueleumeni MLP, Pinta IJ, and Amougou A. 2010. Mineral nutrient status, some quality and morphological characteristics changes in peanut (*Arachis hypogaea* L.) cultivars under salt stress. *African J. Environ. Sci. Technol.* **4**(7): 471-479.

van Hoorn JW, Katerji N, Hamdy A, and Mastrorilli M. 2001. Effect of salinity on yield and nitrogen uptake of four grain legumes and on biological nitrogen contribution from the soil. Agric. *Water Manag.* **51**: 87–98.