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Contents

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DETECTION OF *Escherichia coli* AND *Salmonella* SPECIES FROM VEGETABLES SALAD IN DHAKA CITY

M. A. Mannan[1*], S. Rahman[2], R. Adnan[3], B. Saud[4] and S. Chowdhury[5]

ABSTRACT

The vegetable salad is a popular and healthy food for human beings. It may be contaminated by a lot of microbes. This research work was conducted to isolate and identify the *Escherichia coli* and *Salmonella* bacteria from mixed vegetable salad in Dhaka City, Bangladesh from 2020 to 2021. A total number of 120 mixed vegetable salad samples were collected from different restaurants, food corners and street vendors. Bacteria were identified based on cultural, staining and biochemical properties. Total viable count (TVC) and total coliform count (TCC) were determined. The mean ±SD values of TVC (log10CFU/gm) were 6.07±0.69, 5.42±0.69 and 7.04±0.48 for restaurant, food corner and street vendor, respectively. The TCC (log10CFU/gm) were 6.20±0.59, 5.23±0.59 and 6.70±0.57 in restaurant, food corner and street vendor samples, respectively. The highest contaminations of *E. coli* and *Salmonella spp.* were observed in street vendor salads which were 15% and 7.5%, respectively. The antimicrobial sensitivity test showed resistance to ampicillin, amoxicillin and tetracycline, while sensitive to ceftriaxone, gentamicin and streptomycin for both types of bacteria. So, these bacteria are zoonotic and the salad from different food shops should be prepared hygienically prior to consumption.

Keywords: *Salmonella*, *Escherichia coli,* vegetables salad, prevalence, Dhaka city

INTRODUCTION

Vegetables are important components of a healthy and balanced diet which provide an extraordinary dietary source of nutrients, micronutrients, vitamins, and fiber for humans (Ahmed, 2014). Health agencies such as World Health Organization (WHO), European Food Safety Authority (EFSA), Food and Agriculture Organization (FAO), and French Agency for Food Safety (AFSSA) encourage their consumption to protect against a range of illnesses such as cancers and cardiovascular diseases (Olaimat *et al.,* 2012). Vegetables consist of leaves, roots, tubers, fruits, and flowers. These plants or plant parts may be eaten raw as salad or added to some cooked foods like rice. Common vegetables utilized as salad consists of cucumber, onions, tomatoes, lettuce, carrots, spring onions, green pepper, radish, and other ingredients which include olives. Ready-to-eat salads (RTES) technology implies procurement of raw vegetables from different local markets, cutting, sorting, washing, drying, packaging in permeable plastics, and retailing in a cold chain regime. The increased consumption of RTE fresh vegetables, in particular, leafy greens, which are used in salad mixtures that are consumed as raw has increased the chance of foodborne illnesses associated with these products in different regions of the world (Jeddi *et al.*, 2014).

Foodborne illness is a major public health concern worldwide in terms of the number of persons affected and economic cost. An estimated 600 million almost one in 10 people in the world fall ill after eating contaminated food and 420 000 die every year, resulting in the loss of 33 million healthy life years (Khater *et al.*, 2013).The predominant bacterial types found on vegetables are lactic acid bacteria, *Corynebacterium, Enterobacter, Proteus, Micrococcus, Enterococcus, Pseudomonas, Salmonella, Escherichia coli, Staphylococcus* and spore-formers. They may also possess different types of molds, such as *Alternaria, Fusarium, and Aspergillus* growing on their surface (Sagoo *et al.*, 2003).

Vegetables can be contaminated by enteric pathogens if animal or human wastes and polluted water are used for fertilization and irrigation. A variety of microorganisms including pathogens can be

[1*]Corresponding author (mam1982@sau.edu.bd) & Assistant Professor, [2,&3] MS Students, Dept. of Microbiology and Parasitology, [4]MS Student, Dept. of Pathology, Sher-e-Bangla Agricultural University, Dhaka, [5]Professor, Dept. of Pathology and Parasitology, Chattagram Veterinary and Animal Sciences University, Chattagram, Bangladesh

introduced from the surface of vegetables during the processing of fresh vegetable salad. Many bacterial diseases such as food poisoning, anthrax, salmonellosis, listeriosis, Crohn's disease and arthritis have been reported to be caused through consumption of contaminated vegetable salad by pathogenic microorganisms. Pathogens present in contaminated foods may harbor virulence genes, toxins and enzymes, which aids in the pathogenesis of infectious diseases. Pathogens present in contaminated foods may harbour virulence genes, toxins and enzymes, which aids in the pathogenesis of infectious diseases (Froder *et al.,* 2007).

Foodborne disease outbreaks originating in prepared raw green vegetable salads were more likely to occur on commercial food service premises than outbreaks from other sources, with restaurants and hotels accounting for maximum outbreaks. In Bangladesh, food-borne enteric disease is responsible for one-third of childhood deaths each year from diarrheal diseases (Gomez *et al.*, 2013). *Staphylococcus*, *E. coli* and *Salmonella* are very common and great indicators of unhygienic food handling and cross-contamination. The authentic and relevant research findings are not available at the Dhaka city for detailed information and control strategies development. Therefore, the present study was conducted to identify the *E. coli* and *Salmonella* bacteria from mixed vegetable salad in Dhaka City along with an enumeration of bacterial contamination from salad of the different food corners. This study further investigated the pattern of antimicrobial resistance (AMR) of identified bacteria.

MATERIALS AND METHOD

Study area and sample size

The samples were collected from three categories food shop like restaurants, road side food corners and street vendors from July 2020 to June 2021. These food shops were selected randomly from ten specific areas in Dhaka City such as Farmgate, Uttara, Bashundhara, Mirpur, Kalshi, Matikata, Manikdi, Kochukhet, Mohammadpur and Agargaon.

The sample for this study was mixed vegetables salad. The ingredients of the samples were tomato, cucumber and carrot. The total number of samples was 120. The longitudinal cross sectional study was followed during the sample collection. The research work was conducted at the laboratory of Department of Microbiology and Parasitology of Sher-e-Bangla Agricultural University, Dhaka 1207.

Sample collection and preparation

The 100 gm of samples were weighed aseptically and taken into the zipper bag. Then the samples were transferred to the laboratory for examination. The collected samples were grinded and pasted in sterilized mortar and pestle adding PBS for homogenous mixture and then filtered. Then 0.5 ml of filtered samples were taken into the steriled test tubes having 4.5 ml of 0.1% peptone solution for making the ten-fold dilution according to the protocol described earlier (Denis *et al.,* 2016).

Cultivation in liquid and solid media

The liquid media used in this study were Nutrient broth (NB), Peptone broth, Methyl-red and Voges-Proskauer broth (MR-VP). The solid media were Nutrient agar (NA), Blood agar (BA), MacConkey agar (MC), Salmonella-Shigella agar (SS), Eosin Methylene Blue agar (EMB), Brilliant-Green agar (BGA) and Mannitol salt agar (MSA). 100 microliters of the processed sample was inoculated into Nutrient broth and other solid media by spread plate technique described by Caponigro *et al.* (2010). The inoculated media was incubated at 37°C temperature for 24 hours and observed 6 hour interval. The data were recorded and media was stored in the normal refrigerator for further study.

Observation of the growth properties in various media

Cultural properties of the *Salmonella* and *E. coli* on liquid and various solid media were observed nakedly and microscopically. The data were recorded.

TVC and TCC counts

The TVC and TCC were counted for determination of bacterial load according to the protocol described by (Biyani *et al.,* 2018). The EMB agar and SS agar were used for *E. coli* and *Salmonella,* respectively.

Staining properties and microscopic observation

The staining properties of the *E. coli* and *Salmonella* were observed under microscope. The Gram's staining technique was done according to the established protocol (Caponigro *et al.*, 2010). The colonial morphology was recorded using microscope.

Biochemical properties observation

Some biochemical tests (like Catalase test, Indole test, Methyl Red test, Voges-Proskauer test) were conducted according to the procedure described by Cowan and Steel (1985) and data were recorded properly.

Antibiotic sensitivity test

The antibiotic sensitivity tests were conducted against six types of antibiotic disc (Ampicillin, Amoxicillin, Ceftriaxone, Gentamicin, Streptomycin and Tetracycline) by disc diffusion method. The sensitivity or resistant patterns were analyzed according to Clinical and Laboratory Standards Institute (CLSI, 2007) and zone diameter interpretative standards provided by Wilson *et al.,* (2007).

Data analysis

The recorded data were analyzed using SPSS software (version 20.0). The means value and standard deviations (mean±SD) were determined.

RESULTS AND DISCUSSION

TVC and TCC counts

There was an effect of hygienic condition on the TVC and TCC. The mean ±SD values of TVC ($(\log_{10}$CFU/gm)) were 6.07±0.69, 5.42±0.69 and 7.04±0.48 for restaurant, food corner and street vendor, respectively (Fig. 1). The obtained TVC value of samples collected from the food corner was lower than the findings of Abadias *et al.,* (2008). He reported that the total bacterial population was log 10.57 cfu/gm.

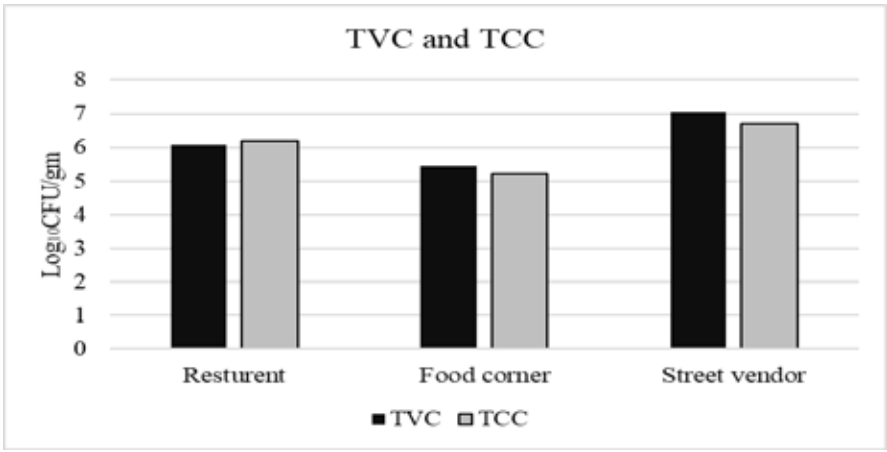

Fig. 1. TVC and TCC of *E. coli* from sample of restaurant, Food corner and Street vendor

In this study, the TCC ($\log_{10}$CFU/gm) for restaurant, food corner and street vendor were 6.20±0.59, 5.23±0.59 and 6.70±0.57, respectively. The observation of Khalil and Gomaa (2014) in Egypt was a wide range of TCC (log 3.63–7.17 cfu/gm) from conventional vegetable salad samples. On the other hand, Nyenje *et al.,* (2012) observed a narrow range of high TCC from log 6.94 to 8.06 cfu/gm in South Africa. This variation may be happen due to management practices in different locations, item of the salad, time duration from ready to eat, seasonal variation and food habit.

Observation of the growth properties in various media

The first step of isolation and identification of the *E coli* and *Salmonella* were conducted in the nutrient broth media that produced turbidity in nutrient broth in case of positive cases.

The cultural properties of these bacteria were observed in different solid media. The *E. coli* bacteria were inoculated in Nutrient agar, MacConkey agar and EMB agar. The colonies characteristics were smooth, circular and white colored colonies on Nutrient agar. The green metallic sheen colored colonies was recorded in EMB agar. In MacConkey agar plates, it was observed as bright pink to the red colored colonies due to fermentation of lactose by *E. coli*. The EMB agar was used to differentiate the coliform enteric bacteria from other enteric bacteria due to the production of acid. In acidic conditions, the dyes produce a dark purple complex which is usually associated with a green metallic sheen. The colony characteristics were smooth, circular, green colored. The colonies of other bacteria are not lactose fermenters appeared as translucent or pink.

The colonies of *Salmonella* spp. in SS agar media produced opaque, translucent, colorless, smooth and round with black centres as they were lactose non-fermenter. On Brilliant Green Agar, the *Salmonella* colonies appeared as pinkish white or red colored by a red halo in the medium, Differentiation was quite pronounced as lactose or sucrose fermenting organisms which were inhibited to produce yellow-green colonies with a green halo.

The microscopic examination of Gram's stained smears of *E. coli* and *Salmonella* revealed that the bacteria were Gram-negative, pink colored small rod shaped bacteria arranged in single, pairs or short chain.

Biochemical properties observation

The *Salmonella* and *E. coli* bacteria showed red color in MR positive test and colour was no changed in VP negative test. In case of catalase test, bubble formation was recorded in positive cases in both *Salmonella* and *E coli*. Red colored ring was formed in case of positive reaction in Indole test for *E. coli* and orange color developed in case of *Salmonella* bacteria for negative cases (Table 1). The cultural, staining and biochemical properties of these *E. coli* and *Salmonella* bacteria were similar according to the description of Ronald (2015) in his book.

Table 1. Biochemical properties of *E. coli* and *Salmonella* species

Properties	*E. coli*	*Salmonella*
MR	Positive	Positive
VP	Negative	Negative
Catalase	Positive	Positive
Indole	Positive	Negative

The *Salmonella* is a common foodborne pathogen that causes food contamination and has higher economic losses and significant threat to public health (Health Protection Agency, 2009). The highest observation of the *E. coli* and *Salmonella* contamination in the street vendor was 15% and 7.5%, respectively (Table 2). According to the WHO in 2016, effect of microbiological hazards such as *Salmonella* on food safety is a major public health concern worldwide. Weldezgina *et al.*, (2016) found 20.7% *Salmonella* contamination in the mixed vegetable sample in Ethiopia. Gomez *et al.,* (2013) and Toe *et al.,* (2018) observed 6.8% in Mexico and 2.6% in Ivory cost, respectively. Most of the street vendors do not take the needed precautions to avoid contamination of the raw salads during preparation and sale. In addition, in many developing countries, street food vending activities are not usually protected or regulated by the governments. So, adequate measures for treatment and cleaning of raw materials, environment and utensils together with hygienic practices of vendors must be implemented to ensure good quality of fresh vegetables and mixed vegetable salad (Alimi *et al.,* 2006).

The prevalence of *E. coli* was 5%, 10% and 15% for the restaurant, food corner and vendor, respectively. According to guidelines of the Health Protection Agency (2009), the vegetable salad will be categorized as satisfactory if the load is less than 20 cfu/g for *E. coli* and not detected for *Salmonella* in 25 gm of samples. The unsatisfactory level for *E coli* was more than 100 ($> 10^2$) cfu/g, categorized as unwholesomeness for human consumption. However, the vegetable salad was unsafe for *Salmonella*

as it was found in 25 gm of the samples. So, all vegetable salad samples from different places and food shop were considered unsafe for consumption based on this guideline.

Table 2. The occurrence of *E. coli* and *Salmonella* has been observed in samples from all sources

Food shop	No. of sample	*E. coli*		*Salmonella* spp.	
		No. of positive sample	Occurrence	No. of positive sample	Occurrences
Restaurant	40	2	5%	2	5%
Food corner	40	4	10%	1	2.5%
Street vendor	40	6	15%	3	7.5%
Total count	120	12	10%	6	5%

Antibiotic sensitivity test

The results of antibiotic sensitivity were presented in Fig. 2 and table 3. Drug resistance problem is a global public health issues now a days. Our study on antimicrobial resistance revealed that both isolates were susceptible to Ceftriaxone, Gentamicin and Streptomycin, whereas 100% resistance to Ampicillin, Amoxycillin and Tetracycline (Table 3).

Table 3. Zone diameter (mm) interpretive standards for *E. coli* and *Salmonella* species

Antibiotics	Disk conc. (µg)	Zone diameter			*E. coli*	*Salmonella*
		R	I	S	Average zone diameter	
Ampicillin	25	≤13	14-16	≥17	8 (100%)	8 (100%)
Amoxycillin	30	≤13	14-17	≥18	7 (100%)	7 (100%)
Ceftriaxone	30	≤19	20-22	≥23	23	30
Gentamicin	10	≤12	13-14	≥15	17	20
Streptomycin	10	≤11	12-14	≥15	16	24
Tetracycline	30	≤11	12-14	≥15	10 (100%)	8 (100%)

Legend: R= Resistant, I= Intermediate, S= Sensitive.

According to Salmanov *et al.,* (2021), the *E. coli* was sensitive to Cefotaxime (99.1%), Ceftazidime, Piperacillin/Tazobactam and Gentamycin, but least susceptibility (70%) was observed for Amoxicillin. The *Salmonella* isolated from salad and were resistance against Amoxicillin (75%) in the observation of Nawas (2012).

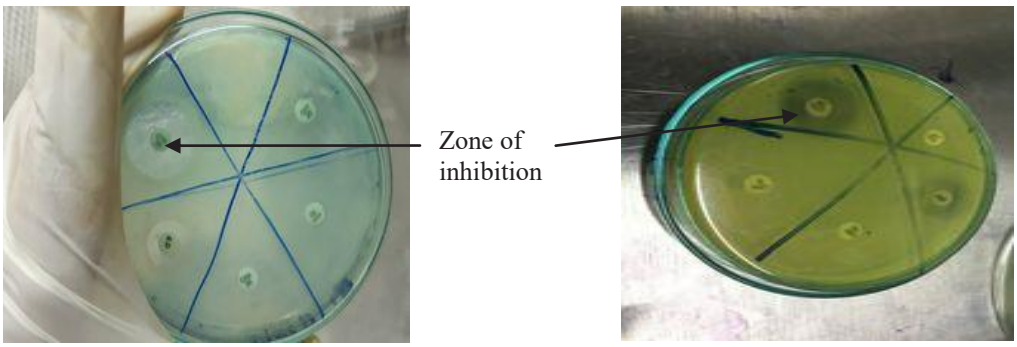

Fig. 2. Antibiotic sensitivity test

CONCLUSION

The *E. coli* and *Salmonella* were identified morphologically based on their cultural properties, staining properties and biochemical properties from the vegetable salad sample. The contamination by *E. coli* was higher (15%) in street vendors and the lowest was 2.5% in food corners by *Salmonella* spp. We should ensure the wholesome condition during the salad making. Proper hygienic management of the food court should be maintained. Because these *E. coli* and *Salmonella* species are zoonotic bacteria and have different pathotypes. The Gentamicin and Streptomycin showed more sensitivity for both bacteria in cultural sensitivity test.

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INVESTIGATION OF THE LIVELIHOOD CONDITIONS OF FISH FARMERS IN FENI DISTRICT

A. K. Dipty[1], M. J. Sarker [2*] and M. B. Fahad[3]

ABSTRACT

The purpose of the study was to evaluate the socioeconomic status and mode of subsistence of fish farmers in the six Upazillas of the Feni area. From June to October 2017, data was gathered from 30 randomly selected fish producers in 6 Upazillas (five from each Upazilla) through personal visits and questionnaires. Excel and SPSS were the statistical tools utilized for data analysis and computation. The majority of the fishing communities were made up of people between the ages of 20 and 45, 93.33% of whom were Muslims. About 16.6% of fishers were primary level, 43.4% secondary level, and 30% Higher Secondary School Certificate passed and above, respectively. Among fish farmers surveyed in the study area, sanitary conditions (46.67%), drinking water (93.33%), and electrical facilities (96.67%) were judged to be at a satisfactory level. In the study area, the average farm size was found 349.52 hectares. The highest income category among fish farmer groups was 50,000–1,20,000 BDT/year, and very few of them took out loans from other institutions. That farmers have improved their socio-economic conditions through pond fish farming, as confirmed by 80% of surveyed fish-farmers. The main obstacles in the research area for fish farming were multiple ownership, lack of technical knowledge and lack of marketing facilities.

Keywords: Fish farm, income, socioeconomic status, livelihood, Feni district

INTRODUCTION

Bangladesh is blessed with an abundance of water resources, including lakes, canals, rivers, estuaries, large floodplains, ponds, and naturally occurring depressions (haors and beels) that span 4.56 million hectares (DoF, 2011). One of Bangladesh's main industries for creating jobs and revenue, the fishing industry is essential to the sociocultural and economic well-being of the country's citizens. 12 million people in our nation depend on the fishing industry for their livelihood, either directly or indirectly through ancillary jobs (DoF, 2013). Aquaculture can play a significant role in the development of underdeveloped rural communities by promoting social well-being and sustainable livelihoods. According to Hannan (1994), Bangladeshi fishermen are viewed as belonging to a lower social class and are typically impoverished. About 12% of Bangladesh's population makes their living either full- or part-time from fisheries and aquaculture-related activities (DoF, 2020). The fishing community lacks personal financial resources and is deprived in terms of social, economic, and educational aspects (Ali *et al.,* 2014). A sustainable livelihood strategy is a manner of thinking about the goals, scope, and priorities for development to accelerate the removal of poverty, according to Carney (1999).

There are six upazillas in Bangladesh's Feni district: Chagalnaiya, Daganbhuiyan, Feni Sadar, Parshuram, Sonagazi, and Phulgazi. With 1,196,219 people living in 45 union parishads, 540 mouzas, and 570 settlements, the district spans 928.34 km³. The district's abundance of ponds, canals, and floodplains, along with its proximity to the Meghna River estuary, guarantee the district's importance to the nation's overall fisheries and harvest (Karim *et al.,* 2008). It has been demonstrated that pond fish farming is a more profitable enterprise than rice growing. According to Ahamed *et al.* (2017), a large number of farmers in rural areas are turning their rice fields into aquaculture ponds.

Due to the Feni district's shifting pattern from paddy fields to fish farms, the locals' standard of living has improved thanks to this chain industry. The state of the fishing settlements in the Feni district is not well enough known. With this background in mind, the current study was conducted to evaluate the socioeconomic state and way of life of the fishing communities within the study area.

[1] Lecturer, [2*] Corresponding author & Professor, [3]MS Student, Dept. of Fisheries and Marine Science, Noakhali Science and Technology University, Noakhali-3814, Bangladesh

MATERIALS AND METHOD

Study area

In the Feni district, a sizable population of fish farmers farmed fish in ponds, beel, etc. Thirty fish farmers, five from each of the six upazillas (Sadar, Sonagazi, Parshuram, Chhagalnaiya, Fulgazi, Daganbhuiyn), were chosen at random to evaluate unambiguous data that encompasses the entire district of the research region. The study area comprises six upazillas, with their respective geographic coordinates as follows: Sadar (23°01'0.12" N 91°23'30.12" E), Sonagazi (22°51'0.00" N 91°23'30.12" E), Parshuram (23°13'0.12" N 91°26'30.12" E), Chhagalnaiya (23°02'9.96" N 91°31'9.84" E), Fulgazi (22.8491° N, 91.3916° E), and Daganbhuiyn (22°56'15.00" N 91°18'15.12" E) in Fig. 1.

Fig.1. Map of Feni district; (Source: https://www.google.com)

Data collection

Primary data collected directly from the farm owner served as the foundation for the study. A detailed questionnaire was created and tested in a few adjacent fish farms before gathering primary data. To achieve the study's aims, a great deal of effort was put into this test (Hossain *et al.*, 2015). The pre-testing experience was used to inform changes, reorders, and enhancements to the final questionnaire. The age distribution and government items were included in the final questionnaire. permission, size of family, literacy and religious status, sanitary facilities, water consumption, farm size and pond types, fish productivity, income level, loan, and socioeconomic improvement, among other factors. Through questionnaire interviews (random sample technique), Participatory Rural Appraisal (PRA) instruments like Focus Group Discussions (FGD), and Crosscheck Interviews (CI) with key informants, primary data from fishermen were gathered. In 2017, information was gathered between June and October. These data were gathered both during the day and at night. To ensure the accuracy of the information gathered from the respondents, all the data were cross-checked, nevertheless.

Data Analysis

Before any data were ever tabulated, they were all carefully examined and summarized. Following data entry, all the information was gathered, examined, and presented in text, tabular, and graphical formats to help comprehend the current state of the fish farmers' livelihood in the researched area. SPSS, MS-Excel, and general calculating methods were used for this analysis.

RESULTS AND DISCUSSION

Age Distribution

The age group of 20–40 years old was found to be the largest (50%) among the 30 fish farmers in the study area, while the age group of 60 years and beyond was the lowest (10%). The oldest fish farmers are those over 60, and as they become older, they start to lose vitality. Most fish farmers between the ages of 20 and 40 were married, and most of them were the heads of their families (Fig. 2). In addition, they all possess a lot of bravery and enthusiasm and more opportunities to make more money. Similar

to the current data, Ali *et al.* (2009) showed that 50% of the fishermen in the Mymensingh district are between the ages of 31 and 40.

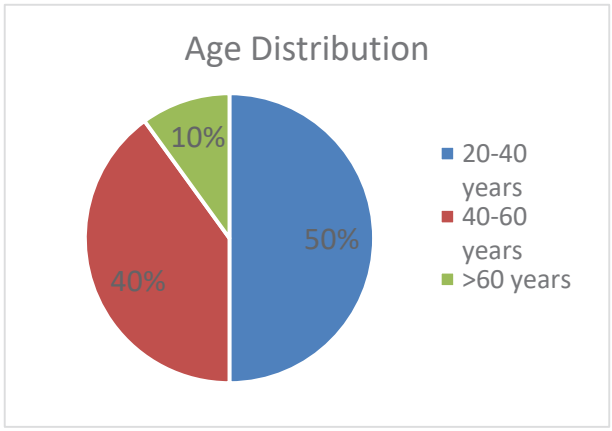

Fig. 2. Age distribution of fish farmer in Feni district

Govt. Approval of the Farm

Govt. approval of a farm denotes the legacy of a farm. It helps govt. to know the total actual productivity of the country and the problems and prospects as well. But in Feni district only 63.33% fish farms are govt. registered and rest 33.67% is not registered. Fulgazi, Parshuram & Sonagazi is in the highest (80%) in registration (Table 1).

Table 1. Govt. approval status of fish farm in Feni district

Govt. approval	Sadar (n=5)	Fulgazi (n=5)	Parshuram (n=5)	Chhagalnaiya (n=5)	Daganbhuiyan (n=5)	Sonagazi (n=5)	Total (n=30)
Yes	2(40%)	4(80%)	4(80%)	2(40%)	3 (60%)	4(80%)	19(63.33%)
No	3(60%)	1(20%)	1(20%)	3 (60%)	2(40%)	1(20%)	11(33.67%)

Size of family

Fish farmers' families were categorized into three sizes: small, medium, and large. According to the study, there were roughly 36.5% of medium-sized fish farmer families (4-5 people), about 27% of tiny fish farmer families (2-4 members), and 36.5% of large fish farmer families (>6 members) (Table 2). The size of the family has a big impact on the family's income and expenses. According to Saha (2004) and Islam *et al.* (2021), the average family size of farmers involved in fish culture was found to be similar, consisting of 5–6 individuals.

Table 2. Family size of the fish farmers in Feni district

Family size	Sadar (n=5)	Fulgazi (n=5)	Parshuram (n=5)	Chhagalnaiya (n=5)	Daganbhuiyan (n=5)	Sonagazi (n=5)	Total (n=30)
2-3	2(40%)	1(20%)	1(20%)	2(40%)	1(20%)	1(20%)	8(27%)
4-5	2(40%)	2(40%)	2(40%)	1(20%)	2(40%)	2(40%)	11(36.5%)
>6	1(20%)	2(40%)	2(40%)	2(40%)	2(40%)	2(40%)	11(36.5%)

Religious status

According to the results of this study, the community of fish farmers was made up of 93.33% Muslims and 6.67% Hindus, respectively. Buddhists and Christians were not present (Table 3). The preponderance of Muslims in the research area suggests that Muslims are progressively entering the field of fish farming by dispelling long-held social superstitions, a finding corroborated by Hossen *et al.* (2020) and Mondal *et al.* (2016).

Table 3. Religious status of Feni district

Religious Status	Sadar (n=5)	Fulgazi (n=5)	Parshuram (n=5)	Chhagalnaiya (n=5)	Daganbhuiyan (n=5)	Sonagazi (n=5)	Total (n=30)
Muslim	5(100%)	4(80%)	5(100%)	4(80%)	5(100%)	5(100%)	28(93.33%)
Hindu	0	1(20%)	0	1(20%)	0	0	2(6.67%)

Housing condition

The type of home reveals a person's social standing. According to the survey, half of the fish farmer's residences were buildings, with 16.67%, 46.67%, and 36.67% being tin sheds (Fig. 3). The current study's percentage of Kacha households was found to be lower than Rahman's (2003) findings, suggesting that fish farmers in the study area are in a better economic situation.

Educational, sanitation, drinking water and electricity facilities

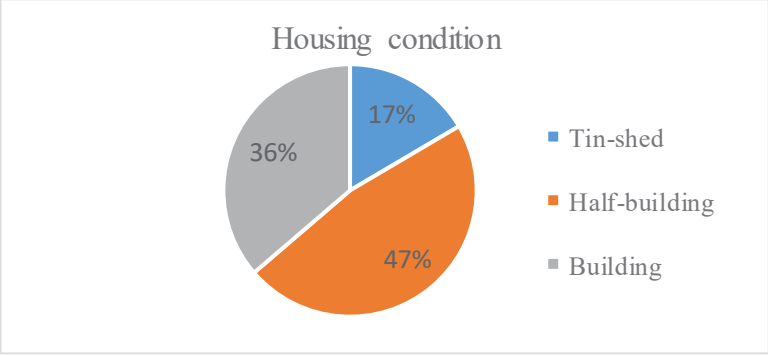

Fig. 3. Housing condition of the fish farmers in Feni district

Status of Education

A person's lifestyle and social standing are mostly determined by their level of education. 83.4% of the 30 fish farmers who were interviewed were literate, and the remaining 16.6% had only completed elementary school, or class 5; a tiny percentage of them could only read in the research region (Table 4). In Mohanpur Upazila, Rajshahi, Zaman *et al.* (2006) performed a survey and found that while 14.4, 8.9, and 6.7% of fish farmers had completed elementary, secondary, or upper secondary education, respectively, 23.3% were illiterate. The greater rate in the studied area could be attributed to differences in geographic location and awareness of schooling.

Table 4. Education, sanitary, drinking water and electricity facilities of the fish farmers in Feni district

Educational level							
Educational level	**Sadar (n=5)**	**Fulgazi (n=5)**	**Parshuram (n=5)**	**Chhagalnaiya (n=5)**	**Daganbhuiyan (n=5)**	**Sonagazi (n=5)**	**Total (n=30)**
Primary	1(20%)	0	1(20%)	2(40%)	0	1(20%)	5(16.6%)
Secondary	1(20%)	3(60%)	2(40%)	2(40%)	3(60%)	2(40%)	13(43.4%)
Higher Secondary	2(40%)	2(40%)	2(40%)	0	2(40%)	1(20%)	9(30%)
Above	1(20%)	0	0	1(20%)	0	1(20%)	3(10%)
Sanitary condition							
Kacha	0	0	0	0	1	0	1(3.33%)
Half-building	2(40%)	2(40%)	3(60%)	3(60%)	2(40%)	3(60%)	15(50%)
Building	3(60%)	3(60%)	1(20%)	2(40%)	2(40%)	2(40%)	14(46.67%)
Drinking water facilities							
	5(100%)	4(80%)	5(100%)	5(100%)	4(80%)	5(100%)	28.(93.33%)
	0	1(20%)	0	0	1(20%)	0	2(6.67%)
Electricity facilities							
Yes	5(100%)	5(100%)	5(100%)	4(80%)	5(100%)	5(100%)	29(96.97%)
No	0	0	0	1(20%)	0	0	1(3.33%)

The state of sanitation

It was shown that over 46.67% of fish farming families use sterilized restrooms. They are therefore in a hygienic state, which demonstrated that the fish farmers' sanitary conditions were better than those of the nation's fishermen (Table 4). It was discovered that 62% of the farmers used semi-pakka sanitary, 28% used pakka sanitary, and only 10% used kacha sanitary (Ali *et al.*, 2008).

Facilities for drinking water

One of society's most prized commodities is the availability of safe and clean drinking water. About 93.33% of farm owners, according to the survey, get their drinking water from deep tube wells, which is a subject of satisfaction (Table 4), which demonstrated agreement with the findings by Ali *et al.* (2009).

Facilities for electricity

According to Table 4, 96.67% of the fish farmers surveyed in the study area had access to electricity, while 3.33% did not have either at their place of living or on their farm. When Ali *et al.* (2008) did a study on the livelihood of fishermen in the Rajshahi district, they found that the state of the electricity facilities was significantly better than that of the Bagmara Upazilla.

Farm dimensions

349.52 hectares was found to be the average farm size in the study area. There are 60 ha to a maximum of 1300 ha in the farm area. The size of the farm is significant since it might indicate the potential for resource efficiency, marginal ability, and capital availability. According to DoF (2017), the total farm area in Feni was recorded 5103 ha, but the present study was conducted in 30 fish farms which might be the reason behind the lower value.

Number and kind of farming ponds

According to the survey, 70% of the ponds were perennial, and 30% were seasonal (Table 5). The perennial ponds' water level dropped during the dry season, but it is still appropriate for fish culture. Conversely, during the dry season, seasonal ponds are completely unsuited for fish culture. Additionally, it was shown that 53.33% of farms have one to five ponds. The remaining 46.67% fall under the 5–10 pond category (Table 6). The findings of this study are essentially consistent with the farm conditions noted by Alam (2006), which suggested that farms were suitable for management.

Table 5. Pond type in the Feni district

Types of ponds	**Sadar (n=5)**	**Fulgazi (n=5)**	**Parshuram (n=5)**	**Chhagalnaiya (n=5)**	**Daganbhuiyan (n=5)**	**Sonagazi (n=5)**	**Total (n=30)**
Seasonal	1(20%)	2(40%)	1(20%)	2(40%)	2(40%)	1(20%)	9(30%)
Perennial	4(80%)	3(60%)	4(80%)	3(60%)	3(60%)	4(80%)	21(70%)

Table 6. Farm categories with pond number in Feni district

Number of ponds	Sadar (n=5)	Fulgazi (n=5)	Parshuram (n=5)	Chhagalnaiya (n=5)	Daganbhuiyan (n=5)	Sonagazi (n=5)	Total (n=30)
1-5	3(60%)	2(40%)	3(60%)	3(60%)	2(40%)	3(60%)	16(53.33%)
5-10	2(40%)	3(60%)	2(40%)	2(40%)	3(60%)	2(40%)	14(46.67%)

Annual Fish Production

The observed farm in the Feni district was found to have an average fish production of ponds 14.08 MT/ha, with the maximum production recorded at 18.78MT/ha and the lowest at 6.17 MT/ha. According to DoF (2017), the average annual pond fish production in Feni was recorded 4.18 MT/ha. Present study represented the value of only four months (peak production period) which might be the reason behind the higher value (present study) from yearlong value of reference data.

Fisherman's income

A family's income level defines their socioeconomic standing in a community. Numerous activities can provide revenue, including fishing, farming, providing services, running a business, raising cattle,

raising poultry, and selling their products. The chosen fish producers were divided into five groups according to the amount of money they made each year. The fish farmers with yearly incomes up to 50,000 BDT were included in the first group. The 2nd, 3rd, 4th and 5th categories had income levels of 50,000-120,000 BDT, 120,000-240,000 BDT, 240,000-320,000 BDT and loss up to 1,00,000 BDT respectively. The majority of farmers who responded fell into the second category. The proportion of farmers in the fourth category was the largest at 36%, while the proportion in the first category was the lowest at 2% (Fig. 4). According to Khan *et al.* (1998), family income levels have a significant economic impact on the use of pond fish farming.

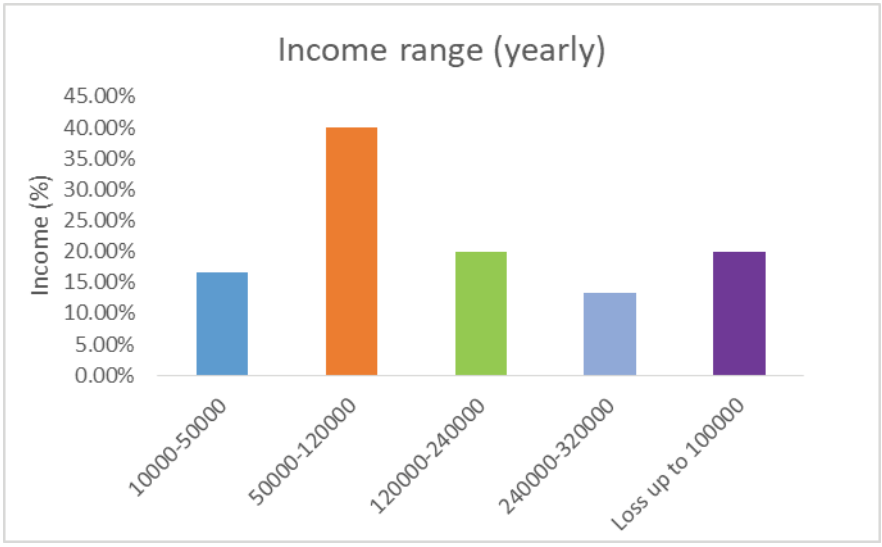

Figure 4. Yearly income of the fish farmers in Feni district

Credit

The majority of fish farmers in Feni did not take out any loans; only 16.67% had taken loan from local depots, NGOs, or banks. The loan amount taken is between 20,000 and 2,00,000 BDT (Fig. 5). According to Hossain *et al.* (1992), lack of funding is the second biggest issue facing fish farmers. Multiple ownership is the biggest issue.

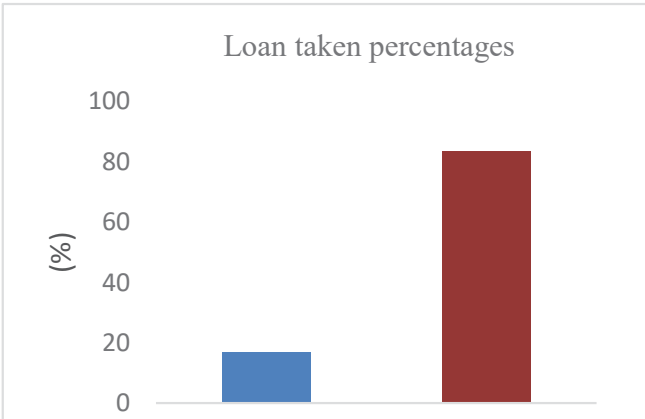

Fig. 5. Status of loan taken from different organizations by fish farmers in Feni district

Socioeconomic development

Pond fish culture has favorable livelihood effects despite limited resources; most of them have enhanced their income, food security, and basic requirements. Eighty percent of fish farmers reported an improvement in their socioeconomic status (Fig. 6). Their housing, food, clothing, and children's education were all superior. However, 20% of farmers still did not have better status.

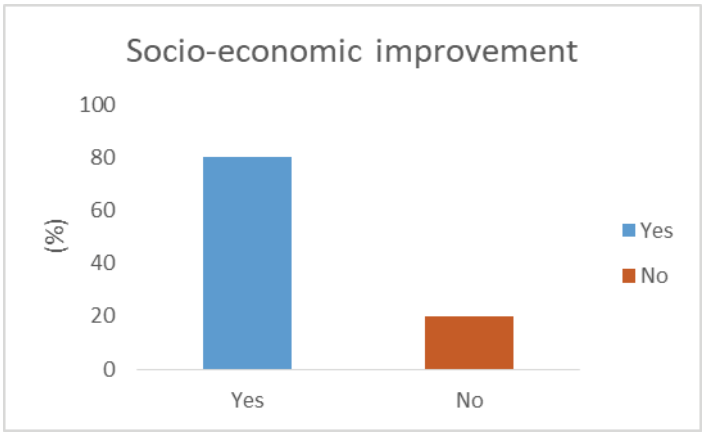

Fig. 6. Status of socio-economic improvement of fish farmers in Feni district

CONCLUSION

The purpose of this study was to learn more about the pond fish farming practices, means of subsistence, and socioeconomic status of rural fish farmers in the Feni district. Data was gathered from 30 randomly chosen fish farmers through personal visits and questionnaire surveys (5 from each Upazilla). The present study shows that farmers have improved their socio-economic conditions through fish farming, as confirmed by 80% of surveyed fish-farmers. Their food, clothing, shelter, and children's education have all improved. However, 20% of farmers still do not have better status since they do not know enough about fish farming. The primary obstacles to fish production in the investigated area included a lack of extension work, multiple ownership, a lack of technical knowledge, a lack of good-quality seed, a high cost of feed, a lack of funds, etc.

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OCCURRENCE AND ANTIBIOTIC SENSITIVITY PROFILING OF *Staphylococcus aureus* ISOLATED FROM RAW CHEVON

N. Hasnain[1], A. Khatun[2], M. Islam[3] and M. A. Mannan[4*]

ABSTRACT

The chevon is an animal source protein that is delicious, nutritious and a very well-known food for all. This study aimed to determine the prevalence as well as the antibiotic sensitivity of *Staphylococcus aureus* in chevon sold at the different wet markets in Dhaka City. A total of 120 samples of raw chevon were collected from some selected areas. The cultural characteristics, staining and biochemical properties were used to isolate and identify the *S. aureus* bacteria. The highest and lowest Total Viable Count (TVC) in the supplied sample were $\log_{10}$9.22 CFU/gm and $\log_{10}$9.04 CFU/gm, respectively. The overall prevalence of *S. aureus* in Dhaka City was 47.5%. The highest prevalence was recorded at BNP Bazar (65%) of the Dhaka City. Isolates were investigated for antibiotic sensitivity profile using a Kirby-Bauer disc diffusion assay against five common antibiotics used in goats. The *S. aureus* showed the highest sensitivity to gentamicin (57.9%), followed by ciprofloxacin (56.14%), and the highest resistance pattern was shown against amoxicillin (100%), followed by ampicillin (92.98%), and tetracycline (63.15%). These bacterial contaminations in the chevon may be mitigated following proper hygienic management, proper boiling or cooking, and public health awareness.

Keywords: *Staphylococcus aureus*, detection, prevalence, antibiotic sensitivity

INTRODUCTION

Goats were the first animals that humans domesticated (Saeid *et al.*, 2008). The world's goat population is currently around one billion, which is less than cattle (1.5 billion) and sheep (1.2 billion). On the other hand, Asia accounts for 54.4 % of the world's goat population (FAOSTAT, 2020). The goat is one of the most popular and commonly raised meat animals in Asian countries (Mazhangara *et al.,* 2019). In Bangladesh, there are about 26.6 million goats, of which most of them are Black Bengal Goats (DLS, 2020). Goat meat, often known as chevon, is the meat of domestic goats (*Capra hircus*). Because of its unique taste and lack of religious barriers goat meat has occupied an acceptable and sustained place in the diet as a source of animal protein among diverse red meats. Meat is highly important in maintaining the human body's strength to produce energy, health, and vigor (Das and Saikia, 2017).

Many researchers had isolated and identified *Staphylococcus aureus* (*S. aureus*) bacteria from raw chevon. The *S. aureus* cells are Gram-positive and appear in a spherical shape. They are often in clusters resembling a bunch of grapes when observed under a light microscope after Gram staining. The name 'Staphylococcus' was derived from Greek, meaning a bunch of grapes (staphyle) and berry (kokkos). The diameter of the cells ranges from 0.5 to 1.0 μm (Foster, 1996). The *S. aureus* is a commensal and opportunistic pathogen that causes a wide spectrum of infections, superficial skin infections, fatal and invasive diseases (Abebe 2020). Because of a combination of "toxin-mediated pathogenicity, invasiveness, and antibiotic resistance" this ubiquitous bacterium is a significant pathogen. The *S. aureus* is a desiccation-resistant organism with the ability to thrive in potentially dry and stressful habitats, such as the human nose and on the skin and inanimate surfaces such as clothing surfaces (Chaibenjawong and Foster, 2011).

Antimicrobial resistance (AMR) is another common reason for antimicrobial therapy failure. It occurs when microbes evolve mechanisms that protect them from the effects of antimicrobials (WHO, 2014). The introduction of new antibiotics to counter this pathogen has frequently been closely followed by the emergence of resistant strains. Most notably, isolates of *S. aureus* resistant to β-lactams have

[1]MS student, [2] Lecturer, [3]Associate Professor, [4*]Corresponding author (mam1982@sau.edu.bd) & Assistant Professor, Dept. of Microbiology and Parasitology, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh

become frequent, and many of these are also resistant to β-lactamase-resistant penicillin (Schito, 2006). Methicillin-resistant *S. aureus* (MRSA) connected with livestock is on the rise, and there is a considerable chance that it will spread zoonotic diseases. Professionals in the agricultural sector are particularly at risk for infection (Guardabassi *et al.,* 2013), and probably the community through the food chain (Kluytmans, 2010).

Chevon is one of the world's most important meat sources, especially for the Indian subcontinent (Mazhangara *et al.,* 2019). In Bangladesh, the goat contributes to a major part of its economy. The economic aspect of goat disease, as well as their mortality and morbidity due to bacterial infection, is of great concern to livestock owners and the government. Due to a lack of awareness and research, bacteria specially *Staphylococcus aureus* present in chevon and mutton and the consequences of these on human health remain unknown. The region related recent research data were not available in Bangladesh for developing the control and prevention program as well as further research. On the above circumstances, the present study was conducted with the objectives of identification and occurrences of the *Staphylococcus aureus* in raw chevon along with an assessment of antibiotic resistance pattern of the isolates in the Dhaka City.

MATERIALS AND METHODS

The present study was conducted during the period of January 2021 to June 2021. The samples were collected from the different retail shops of the Kacha Bazar in Dhaka City. Then collected samples were brought to the Laboratory of the Department of Microbiology and Parasitology, Sher-e-Bangla Agricultural University for further analysis. A total of 120 raw chevon (goat meat) samples were collected from six different markets in Dhaka City namely Krishi market, Geneva camp, Taltola bazar, BNP bazar, Agargaon kacha bazar, and Mohammadpur town hall market. The net weight of the each sample was 500 gm. The samples were promptly stored in the icebox, and transferred to the Departmental Laboratory of this University.

The stock culture of the collected chevon was prepared using phosphate buffer solution (PBS). At first, the stock culture was made by mixing of the 1 ml of PBS with 1 ml of pure culture in nutrient broth and storing it at -20^{0}C. The 10-fold dilution was made for total viable count (TVC). Then the bacteria were cultured on nutrient broth and incubated at 37^{0}C for 24 hours. The bacteria were detected based on cultural properties on different culture media (Nutrient agar, Blood agar, Mannitol salt agar). Morphological characterization was done using gram staining method. The biochemical tests of isolates were also done for observing the biochemical properties of the isolates. Antibiotic sensitivity profiling of the isolated bacteria was shown using disc diffusion methods. The procedure suggested by Carter (1986) and Thaker *et al.* (2013) was followed throughout the experiment for isolation and identification of bacteria.

Antibiotic discs

The antibiotics susceptibility pattern was determined using commercially available antibiotic discs (OXOID Limited, Canada). After placing the discs on the plate, the plates were inverted and incubated at 37^{o}C for 16 to18 hours. The diameter of the full inhibitory zones (including the diameter of the disc) was measured and recorded in millimeters after incubation. Without opening the lid, measurements were taken with a ruler on the underside of the plate. The zones of growth inhibition were compared to the Clinical and Laboratory Standards Institute's zone-size interpretive (CLSI, 2007). According to CLSI, zone diameter interpretation standards, antimicrobial testing findings were classified as sensitive, intermediate, or resistant on Table 1.

Statistical analysis

Data were entered into the Microsoft Office Excel 2021 spreadsheet. The recorded data were analyzed using SPSS software (version 20.0). The means value and standard deviations (mean±SD) were determined. The P (< 0.05) value was calculated using chi-square test.

Table 1. Drugs with their disc concentration for the Enterobacteriaceae family

Name of Antibiotic	Disc conc. (µg /disc)	Zone Diameter Interpretive Standard (mm)		
		Resistant	Intermediate	Susceptible
Gentamicin (GM)	10	≤13	14-17	≥18
Tetracycline (TE	30	≤14	15-18	≥19
Amoxicillin (AMX)	10	≤13	14-17	≥18
Ampicillin (AMP)	10	≤13	14-16	≥17
Ciprofloxacin (CIP)	5	≤15	16-20	≥21

RESULTS AND DISCUSSION

The results presented below demonstrated the isolation and identification of the *S. aureus* bacteria from raw chevon samples at surrounding area of the Dhaka City. The results also indicated the prevalence and antibiotic sensitivity resistant pattern of the isolates to different antibiotics.

Determination of TVC

Table 2. The TVC of supplied chevon sample sold at different wet markets in Dhaka City

Name of themarkets	TVC logcfu/ml (Mean±SD)	P-value
Krishi Market	9.06± 0.02	0.01
Geneva Camp	**9.23 ± 0.01**	0.01
Taltola Bazar	9.12± 0.02	0.01
BNP Bazar	9.18± 0.01	0.01
Agargaon Bazar	9.13± 0.02	0.01
Town Hall market	**9.02 ± 0.03**	0.01

The assessment of total viable bacterial counts using aerobic plate count was shown in Table 2**.** The average microbial load on fresh meat from several markets ranged from $\log_{10}9.02 \pm 0.03$ CFU/gm to $\log_{10}9.23 \pm 0.01$ CFU/gm. Geneva camp had the greatest bacterial load ($\log_{10}9.23 \pm 0.01$ CFU/gm), followed by the lowest observation ($\log_{10}9.02 \pm 0.03$ CFU/gm) in Town Hall Kacha Bazar. According to Mukhopadhya *et al.,* (2009), the presence of a high number of microorganisms (APC $>10^7$cfu/cm^2) accelerates the deterioration of meat. In a TVC column were found to be statistically significant (P=0.01).

In another study conducted by Haque *et al.* in 2008, they found a $\log_{10}$ 6.03 CFU/gm in slaughter yards and $\log_{10}$ 6.53 CFU/gm in meat stall samples respectively in Mymensingh town. The different TVC values in various time intervals were observed in another study conducted by Parvin *et al.,* in 2017. She observed TVC values of 5.17±0.28 log CFU/gm (0 hrs), 6.64±0.05 log CFU/gm (2 hrs), and 8.47±1.27 log CFU/gm (5hrs) respectively. In Tripura of India, another study was conducted by Shapna *et al.* (2018) and found a TVC of 6.84±0.42 log CFU/gm, which was significantly lower than the current study. This discrepancy could be attributed to differences in season, environmental variation, management, biosecurity of the slaughter house or different study methods.

Cultural properties in different media

After 24 hours of aerobic incubation at 37^0C, the nutrient broth revealed the growth of bacteria as indicated by the turbidity. In this current study, *Staphylococcus* species produced turbidity in nutrient broth. The *Staphylococcus* species produced gray to whitish colored colonies in nutrient agar plates after 24 hours of aerobic incubation at 37^0C. In blood agar media, the large, creamy white, beta-hemolytic colonies were found. The growth revealed golden yellow colored colony in mannitol salt agar (Fig. 1). The findings of this research were consistent with the report of MCL and Sborough (2005); and Cheesbrough (2006).

Table 3. Morphological and cultural properties of *Staphylococcus* species from chevon

Feature	Appearance
Nutrient agar	Gray, white, or yellowish colony
Blood agar	White to golden yellow colony
Mannitol salt agar	Yellow colour colony
Staining properties	Gram positive, cocci arranged in grapes likeclusters

Gram's staining properties of the *Staphylococcus* species

The bacterial smears were examined under microscope which revealed Gram-positive, cocci shaped and arranged in grapes like clusters.

Biochemical properties of the *Staphylococcus* species

The biochemical properties of the *Staphylococcus* species were observed and showed in Table 4. These bacteria fermented all the five basic sugars and produced only acid. It showed a positive reaction in the cases of catalase, coagulase tests and MR-VP tested but negative results were found in the case of Indole reaction. The coagulase test was used to distinguish pathogenic *S. aureus* from non-pathogenic *S. aureus*. The biochemical properties of these bacteria were also supported by Cheesbrough (2006) and OIE Manual (2000).

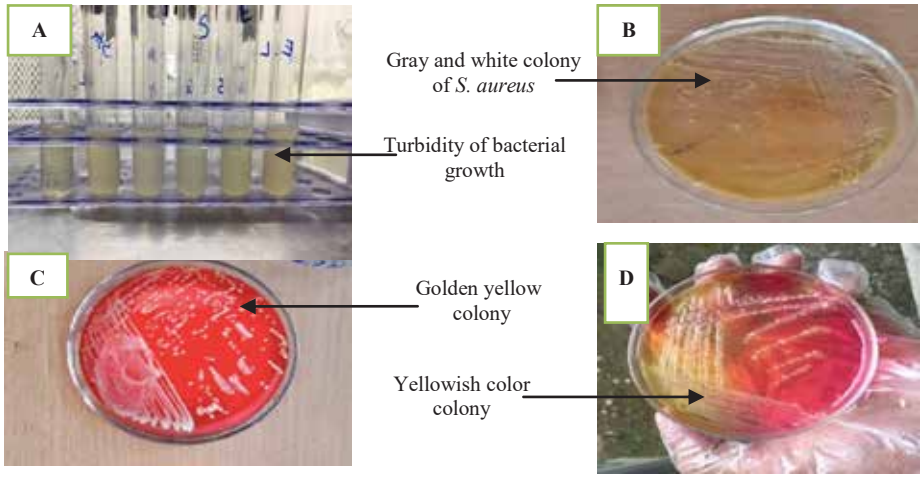

Fig. 1. Turbidity of bacterial growth was seen in nutrient broth (A); Gray and white colony of *S. aureus* in Nutrient agar (B); Golden yellow colony in Blood agar (C) and Yellowish color colony in Mannitol salt agar

Table 4. Biochemical properties of *Staphylococcus aureus*

Fermentation properties with five basic sugars					Indole test	VP Test	MR Test	Catalase test	Coagulase Test
DX	ML	L	S	MN					
A	A	A	A	A	−	+	+	+	+

Legends: DX= Dextrose; ML = Maltose; L =Lactose; S = Sucrose; MN = Mannitol; A = Acid production; + = Positive reaction; - = Negative reaction.

Occurrence of isolated bacteria

Occurrence of *Staphylococcus aureus* found in this study area in wide range (Table 5). The overall occurrence of these bacteria in the Dhaka City was 47.5%. The highest (65%) outbreak was recorded in

the BNP Bazar. lowest (35%) observation was found in both Krishi market and Taltola Bazar. The researcher, Das and Saikia (2017) found 43.33% prevalence in goat meat in Assam, which was slightly lower than the current study. It might be due to environmental or managemental variation.

Table 5. Occurrences of the *Staphylococcus aureus* from meat samples in different markets

Location	No. of Sample	No. of positive sample	Occurrence (%)
Krishi Market	20	7	35
Geneva Camp	20	12	60
Taltola Bazar	20	7	35
BNP Bazar	20	**13**	65
Agargaon Kacha Bazar	20	10	50
Town Hall Market	20	8	40
Total	**120**	**57**	**47.5**

Antibiotic sensitivity profiling of *Staphylococcus aureus*

A total of 57 positive samples of *Staphylococcus aureus* from chevon samples were detected based on cultural properties, staining properties and biochemical properties. The cultural sensitivity test (CS test) was done for knowing the antibiotic sensitivity pattern (Fig. 2 and Table 6). All 57-sample were resistant to amoxicillin. The gentamicin and ciprofloxacin were comparatively sensitive drugs against these bacteria. All isolated bacteria showed 100% resistant to amoxicillin, followed by ampicillin (92.98%), gentamicin (63.15%), and almost similar resistant against tetracycline (57.9%), and ciprofloxacin (56.14%)**.**

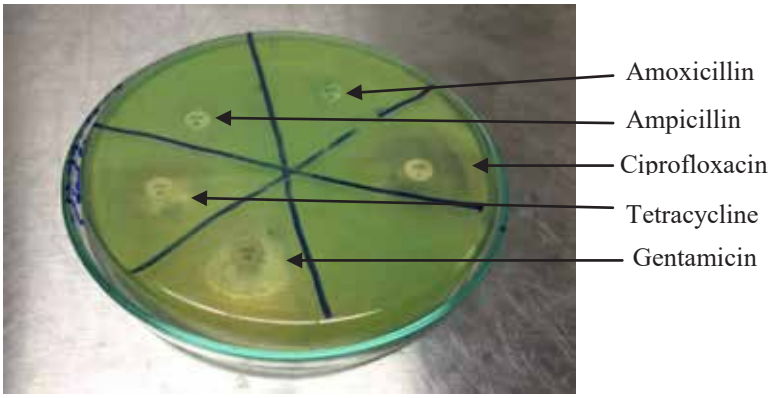

Fig. 2. Antibiotic sensitivity test of *Staphylococcus aureus*

Earlier observations by Hassan *et al.,* (2021) was that Tetracycline (100%) and Ampicillin (90%) resistant to *S. aureus* and 100% sensitive to ciprofloxacin. The scientist Bantawa *et al.,* (2019) in Nepal found 100% amoxicillin resistant. Isolates from raw chevon were sensitive to gentamicin (63.15%) followed by ciprofloxacin (56.14%). The results strengthen the earlier observations of Zehra *et al.,* (2019) who found 54.86% to gentamicin and 38.2% sensitive to ciprofloxacin on meat samples in Panjab, which was slightly lower than the current study. The discrepancy in antibiotic sensitivity was slightly lower probably due to genetic variation of the pathogen, environmental variation, or study methods.

Table 6. Antibiotic sensitivity pattern of *Staphylococcus aureus* isolated from chevon

SN.	Antibiotics used	Resistant	Intermediate	Susceptible
1	Amoxicillin	57 (100%)	-	-
2	Ampicillin	53 (92.98%)	4 (7.02%)	-
3	Gentamicin	7 (12.28%)	17 (29.82%)	33 (57.89%)
4	Tetracycline	36 (63.15%)	12 (21.05%)	9 (15.8%)
5	Ciprofloxacin	6 (10.53%)	19 (33.33%)	32 (56.14%)

CONCLUSION

The current study was conducted from January to June 2021 to detect the *Staphylococcus aureus* along-with antibiotic sensitivity pattern of these bacteria from raw chevon in different wet markets of Dhaka North City Corporation. A total of 120 samples were collected from 6 different wet markets. The prevalence of *Staphylococcus aureus* contamination in the raw chevon was 47.5%. The highest TVC ($\log_{10}$ 9.22±0.01 CFU/ml) was found in the Geneva Camp and the lowest was recorded in Town Hall Kacha Bazar ($\log_{10}$9.02±0.03 CFU/ml). The amoxicillin showed 100% resistant. The gentamicin and ciprofloxacin were found as moderate sensitive against these bacteria. Some variation in the results from previous findings might be due to the environmental or managemental variation, types of the cultural media procedures and genetic variation of the bacteria.

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ENHANCING ROOTING PERFORMANCE OF STEM CUTTING OF GARDENIA (*Gardenia jasminoides*) USING ROOT PROMOTING TREATMENTS

M. A. H. Saddam[1], M. G. Kibria[1], M. Eddris[1], H. Hasan[1] and M. H. Kabir[2*]

ABSTRACT

The experiment was conducted with *Gardenia jasminoides* to find out the suitable root promoting treatments of stem cutting both in the winter and summer season. The treatments of the experiment were T_0 = Control, T_1 = Mixed plant growth regulators (1000 ppm IBA + 1000 ppm NAA), T_2 = Wounding to cutting base and T_3 = Wounding to cutting base + Mixed plant growth regulators. The experiment was laid out in Randomized Complete Block Design with three replications. Among the treatments, T_3 was found superior in terms of days required for shooting, number of roots per cutting, number of shoots per cutting, percentage of rooting, percentage of survival, etc, both in the winter and summer season. The results of T_3 were closely followed by T_1 and T_2. On the other hand, the results from T_0 treatment were found lowest in all parameters. However, 78.33% rooting in the summer and 67.93% rooting in the winter were recorded from T_3, whereas it was only 43.66% in the summer and 37.66% in the winter for T_0 treatment.

Key words: Gardenia, plant growth regulators, wounding, propagation, season

INTRODUCTION

Gardenia (*Gardenia jasminoides*) belongs to the family Rubiaceae, native to the tropical and subtropical regions of Africa, Asia, Madagascar and Pacific Islands, is a flower plant. It is evergreen bushy shrub and widely grown in subtropical regions as an ornamental plant for their flowers are heavily perfumed at night. Propagation by cutting is commonly used in the commercial production of ornamental flowers. Cuttings of some species root readily without an auxin treatment, while cuttings of other species benefit from auxin treatment through enhanced promotion of rooting; benefits may be dependent upon the species and cultivar, condition of the cutting wood, time of year, and other factors (Hartmann *et al.,* 2002).

Gardenia is generally propagated by stem cutting. Cutting is easy but some problems arise when cuttings are planted in soil. Some cuttings become dried, wilted and some become rotten. As a result, propagation percentage is reduced. Rooting hormones are very necessary for easy to root and improve the quality of root system developed, decrease rooting time and improve the percentage of cutting rooted (Salman, 1988). There are now several commercial synthetic forms of rooting hormones available for nursery industry, such as IBA or NAA or a mixture of both (Blazich, 1988). Wounding to cuttings base is a common practice in commercial production of rooted cuttings. Wells (1962) stated that wounding was used for first, to speed up the rooting processes, second, to increase the number and quality of roots, and third, to improve attachment points between roots and the cuttings. Al-Noaimy (1999) found by wounding the terminal cuttings of *Cotoneaster prostrate* taken at November to March (except those taken at December) treated with a mixture of IBA and NAA at concentration 1000 mg/L for both by quick-dip method gave the best result for rooting percentage. Many investigators emphasized that the time of the year have a dramatic influence on rooting performance of stem cuttings.

Root-promoting chemicals for plant propagation commonly contain indole-3-butyric acid (IBA), 1-naphthaleneacetic acid (NAA), or a combination of the two, and are available in liquid, talc, tablet, and gel formulations. Root initiation with the use of growth regulators occupies a significant position in the

[1] MS Student, [2] *Corresponding author & Professor, (kabirsau@yahoo.com), Dept. of Horticulture, Sher-e-Bangla Agricultural Univeristy, Dhaka, Bangladesh

field of propagation. All the growth regulators are not equally suitable for rooting performances. Among the growth regulators IBA is the most commonly and widely used rooting hormone to achieve high percentage of rooting success for the ornamental species (Kundu *et al.*, 1987). Other exogenous hormones which regulate plant growth arc IAA, NAA, 2, 4-Dichloro phenoxy acetic acid (2, 4-D), Indole Propionic Acid etc. Activity of growth regulators depends upon the amount of hormone applied and a particular concentration of growth regulator may be more effective for root initiation. In our country, rooting in the winter season is little bit harder than summer season. The performance can be improved with the application of some root promoting treatments. Root promoting chemicals can enhance rooting performance of plants in the winter season as well. In the present study, some plant growth regulators applied individually, and also in combination with wounding treatment to cutting base to improve the rooting performance of gardenia both in the summer and winter season.

MATERIALS AND METHODS

A field experiment was carried out at the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka. The experiment was conducted in two season, in winter from December 2020 to March 2021 and in summer from mid March 2021 to mid June 2021. There were four treatments namely, T_0 = Control, T_1 = Mixed plant growth regulators (1000 ppm IBA + 1000 ppm NAA), T_2 = Wounding to cutting base and T_3 = Wounding to cutting base + Mixed plant growth regulators. The experimental area was divided into three equal blocks containing 8 plots in a block. There were 24 plots in total. The experiment was laid out in Randomized Complete Block Design with three replications. To provide wounded treatment, Basal parts i.e. proximal end of the cuttings were wounded with surgical blade. These cuttings were collected from mature branches of one year old stem, about 15 cm long having 2-3 nodes depending on the species. All the leaves were cut off and 20 cuttings were used in each treatment. The lower cuts of the stems were made slanting below the nodes and the upper cuts were horizontal above the nodes. The prepared cuttings were then dipped in the treatment solution for 24 hours, immerging 2.5 to 5 cm of their basal portion before planting in the field.
Cuttings were planted in the beds on the 1st December, 2020 in winter and on the 15th March, 2021 in summer at a spacing of 10 cm x 10 cm. The recorded data on different parameters of the crop were statistically analyzed using Statistix 10 software program and levels of significance of the treatment means were evaluated by LSD test at 5% probability. The mean for the treatments was calculated and analysis of variance for each of the characters was performed by F- test.

RESULTS AND DISCUSSION

Days to shoot initiation
Significant variation among the treatments had been observed in days to shoot initiation of stem cutting of gardenia (Table 1). The maximum days to shoot initiation in winter (35.66) was found from the

Table 1. Effect of different root promoting treatments on days to shoot initiation, number of shoot per cutting and length of shoot per cutting

Treatment	Days to shoot initiation		Number of shoot per cutting		Length of shoot(cm) per cutting	
	Winter	Winter	Summer	Summer	Winter	Summer
T_0	35.66 a	34.33 a	2.08 c	2.75 c	0.69 c	1.32 c
T_1	34.00 bc	33.33 b	3.01 b	3.33 b	1.20 ab	1.68 b
T_2	34.33 b	33.00 b	3.08 ab	3.25 b	1.05 b	1.51 bc
T_3	33.00 c	31.00 c	3.33 a	3.58 a	1.30 a	2.61 a
$CV_{(\%)}$	1.68	1.08	5.29	3.92	8.37	8.11
$LSD_{(0.05)}$	1.0843	0.6685	0.2867	0.2385	0.1672	0.2717

(In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, T_0 = Control, T_1 = Mixed plant growth regulators (1000 ppm IBA + 1000 ppm NAA), T_2 = Wounding to cutting base and T_3 = Wounding to cutting base + Mixed plant growth regulators)

control which was similar to that of T_2 and T_1 treatments while the minimum days to shoot initiation (33.00) was recorded from T_3. The maximum days to shoot initiation in summer (34.33) was found from T_0 (control) treatment which was identical to T_1 and T_2 treatments while the minimum days to shoot initiation (31.00) was recorded from T_3 treatment. That means T_3 enhanced the shooting of gardenia in the both season. NAA, IBA and wounding application resulted in earlier completion of physiological processes in rooting and sprouting of cuttings both in the winter and summer

Number of shoot per cutting

Growth regulators exhibited a significant influence on number of shoot per cutting in both winter and summer (Table 1). The maximum shoot per cutting in winter (3.33) was measured from T_3 which was statistically similar to that of T_2 and T_1 while the minimum shoot per cutting in winter (2.08) was recorded from the control. Similarly, the maximum shoot per cutting in summer (3.92) was also measured from T_3 which was statistically similar to that of T_1 and T_2 while the minimum shoot per cutting in summer (2.75) was recorded from the control. The best result was found from NAA, IBA or wounding treated cutting due to the increased mobilization and utilization of the stored carbohydrates in the cutting.

Length of shoot per cutting

Shoot length of stem cutting of gardenia showed statistically significant differences for different growth in winter and summer. In winter, the maximum length of shoot (1.30cm) per cutting was recorded from T_3 treatment which was statistically identical with T_2, while the minimum length of shoot (0.69 cm) was obtained from T_0 (control) treatment. In summer, the maximum length of shoot (2.61 cm) per cutting was recorded from T_3 treatment which was statistically similar with T_1 and T_2, while the minimum length of shoot (1.32 cm) was obtained from T_0 (control) treatment (Table 1). Increased shoot length might be due to the increased mobilization and utilization of the stored carbohydrates in the cutting.

Percentage of shooting

Considering the percentage of shooting of stem cutting of gardenia, significant variation was found in different root promoting treatments in winter and summer (Fig. 1). In winter, the maximum percentages of shooting (33.33 %) was observed in T_3 which was statistically similar to that of T_2 and T_1, whereas the minimum percentage of shooting was obtained in T_0 (20.83 %) treatment. In summer, the maximum percentages of shooting (33.83 %) was observed in T_3 which was statistically identical to T_1 and T_2 treatment whereas minimum percentage of shooting was obtained in T_0 (27.50 %) treatment.

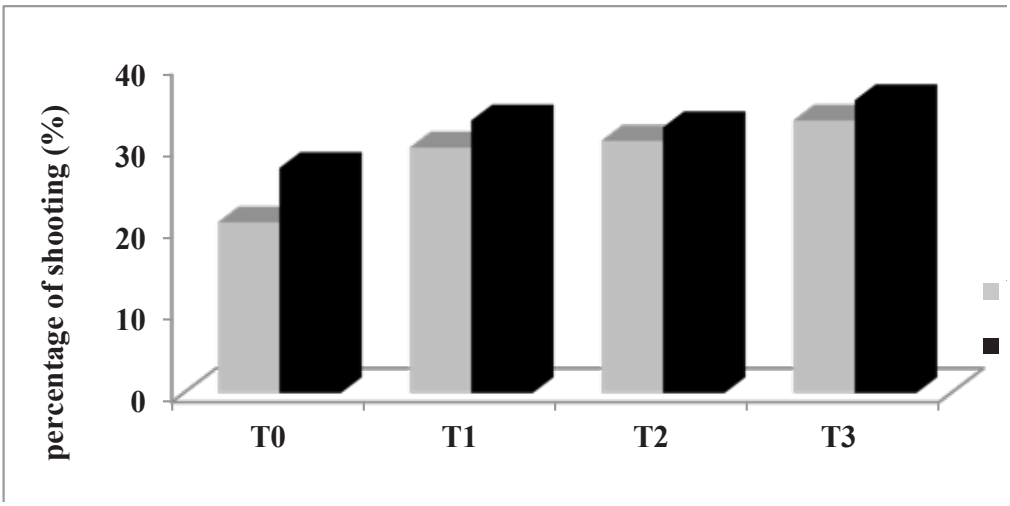

Fig. 1. Effect of different root promoting treatments on percentage of shooting

(Here, T_0 = Control, T_1 = Mixed plant growth regulators (1000 ppm IBA + 1000 ppm NAA), T_2 = Wounding to cutting base and T_3 = Wounding to cutting base + Mixed plant growth regulators)

Number of roots per cutting

Root enhancers exhibited a significant influence on number of root per cutting both in winter and summer (Table 2). In winter, the maximum number of root per cutting (6.79) was measured from T_3 treatment which was statistically identical to that of T_2 treatment while the minimum number of root per cutting (4.16) was recorded from T_0 (control) treatment. Considering summer season, the maximum number of root per cutting (7.83) was also obtained from T_3 treatment while the minimum number of root per cutting (4.51) was recorded from T_0 (control) treatment. Root promoting treatments enhance rooting performances both in winter and summer season. It might be due to the effect of PGR and wounding to cutting base. Similar result was also observed by Singh *et al.* (2013) in citrus.

Table 2. Effect of different root promoting treatments on number of roots per cutting, length of root per cutting and number of new shoot at 30 DAT in polybag

Treatment	Number of roots per cutting		Length of root per cutting (cm)		Number of new shoot at 30 DAT in polybag	
	Winter	Summer	Winter	Summer	Winter	Summer
T_0	4.16 c	4.51 c	2.77 c	3.24 c	2.50 c	2.91 c
T_1	6.16 b	6.47 b	3.80 b	5.36 b	3.25 b	3.50 ab
T_2	6.38 ab	6.58 b	3.85 b	5.34 b	3.25 b	3.41 b
T_3	6.79 a	7.83 a	4.81 a	6.25 a	3.58 a	3.83 a
CV $_{(\%)}$	5.18	8.26	7.81	6.37	5.74	6.34
LSD $_{(0.05)}$	0.5731	0.9875	0.5608	0.6055	0.3332	0.4076

(In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, T_0 = Control, T_1 = Mixed plant growth regulators (1000 ppm IBA + 1000 ppm NAA), T_2 = Wounding to cutting base and T_3 = Wounding to cutting base + Mixed plant growth regulators)

Percentage of Rooting

Significant variation among the rooting treatments had been observed in percentage of rooting of stem cutting of gardenia in winter and summer season (Fig. 2). The maximum percentage of rooting in winter (67.93 %) was found from T_3 which was similar to T_2 and T_1 whereas the minimum percentage of rooting (37.66 %) was recorded from T_0 treatment. Similar result was also noticed in the summer season where the maximum percentage of rooting (78.33 %) was recorded in T_3 treatment. On the other hand the minimum percentage of rooting (43.66 %) was recorded from T_0 (control) treatment. That means, by the application of rooting treatments the nursery man can propagate gardenia in winter as well.

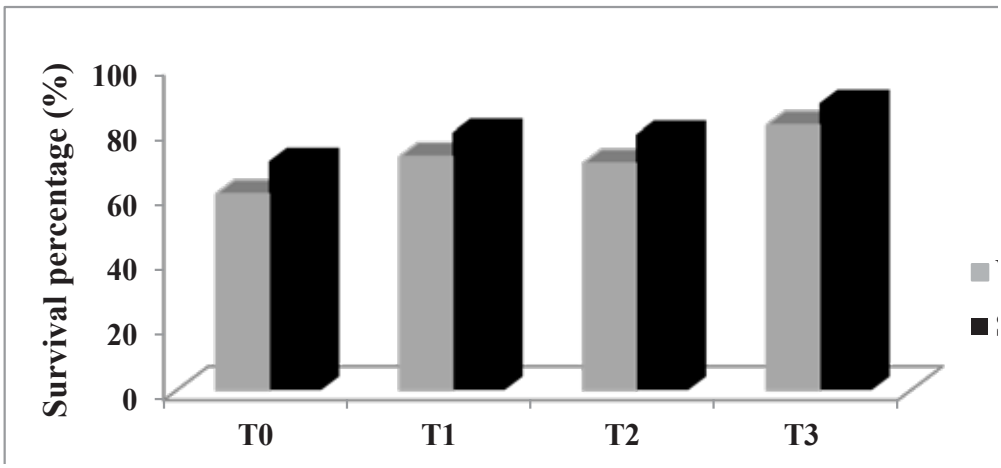

Fig. 2. Effect of different root promoting treatments on percentage of rooting

(Here, T_0 = Control, T_1 = Mixed plant growth regulators (1000 ppm IBA + 1000 ppm NAA), T_2 = Wounding to cutting base and T_3 = Wounding to cutting base + Mixed plant growth regulators)

Length of root

Rooting treatments exhibited a significant influence on length of root per cutting both in the winter and summer season (Table 2). The maximum length of root per cutting in winter (4.81 cm) was found in T_3 treatment which was statistically similar to that of T_2 and T_1 while the minimum length of root per cutting (2.77 cm) was recorded from the control. Similarly, in the summer, the maximum length of root per cutting (6.25 cm) was also noted on T_3 treatment which was statistically identical to that of T_1 and T_2 treatments while the minimum length of root per cutting (3.24 cm) was recorded from the control. Increased length of root was might be due to the effect of NAA, IBA and wounding to cutting base of gardenia. Similar result was also noted by Lal *et al.* (2007) in guava.

Number of new shoot at 30 days after transplanting in polybag

Number of new shoot at 30 days after transplanting in polybag is an important parameter for crop plant because of its physiological role in photosynthetic activities. Number of new shoot at 30 days after transplanting in polybag varied significantly due to different root promoting treatments (Table 2). At winter, the maximum number of new shoot at 30 days (3.58) was recorded from T_3, which was statistically similar with T_1 and T_2 treatments, while the minimum number of new shoot at 30 days (2.50) was obtained from T_0 (control). In the summer season, the maximum number of new shoot at 30 days (3.83) was recorded from T_3 which was statistically identical with T_1 and T_2 treatments, while the minimum number of new shoot at 30 days (2.91) was obtained from T_0 (control).

Survival percentage

Considering the survival percentage of stem cutting of gardenia, significant variation was found in different root promoting treatments (Fig. 3). In winter, the maximum percentage of survival (81.61%) was observed in T_3 which was statistically identical to T_1 and T_2 treatment whereas the minimum percentage of survival was obtained in T_0 (60.50 %) treatment. In summer, the maximum percentage of survival (88.42 %) was also observed in T_3 which was statistically identical to T_1 and T_2 treatments whereas minimum percentage of survival was obtained in T_0 (70.69 %) treatment.

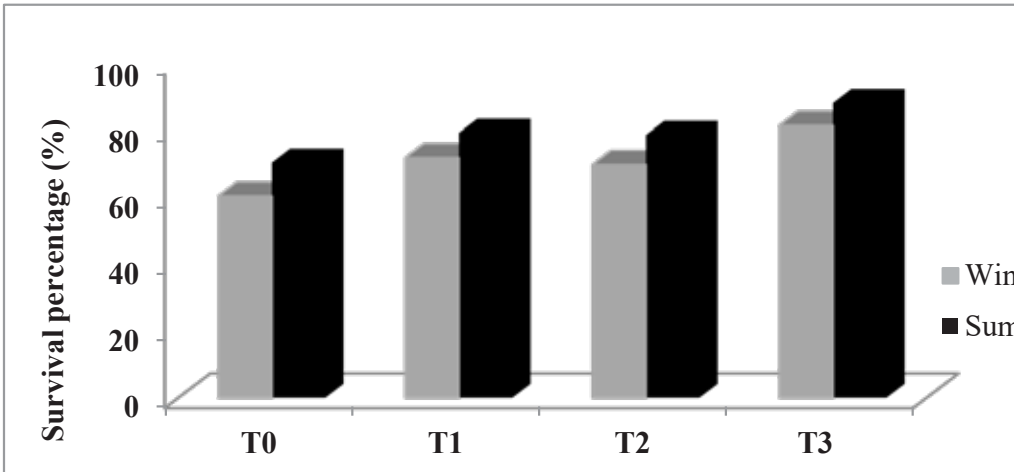

Fig. 3. Effect of different growth regulators on survival percentage

(Here, T_0 = Control, T_1 = Mixed plant growth regulators (1000 ppm IBA + 1000 ppm NAA), T_2 = Wounding to cutting base and T_3 = Wounding to cutting base + Mixed plant growth regulators)

CONCLUTION

On the basis of results of the present investigation, it can be concluded that performance of root promoting treatments was found significant than control treatment. Among the treatments, treatment T_3

(Wounding to cutting base + Mixed plant growth regulators) gave the best results both in winter and summer season for gardenia propagation through stem cutting.

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POTENTIAL OF MORINGA LEAF EXTRACT ON SEED PRIMING AND GROWTH PROMOTION OF CAULIFLOWER

J. Nesa[1], M. N. Touhid[2], S. J. Tripty[3], M. Z. A. Shishir[4] and K. Hossain[5*]

ABSTRACT

Moringa (*Moringa oleifera* Lam) leaf extract (MLE) enhances the germination percentage and seedling growth of cauliflower through its rich nutrient profile, essential compounds like vitamins, minerals, and amino acids. The study explores the potential of MLE as a novel agent for seed priming as well as growth promotion in cauliflower cultivation. This study provides insights into sustainable agricultural practices by using MLE for improving crop productivity. Experiment was conducted in controlled laboratory condition. Four treatments (T_0: Tap water as control, T_1: MLE prepared from 10 minutes boiling, T_2: MLE prepared from 20 minutes boiling, and T_3: Fresh MLE) were used in this experiment by following Completely Randomized Design (CRD) with four replications. In second stage of screening, the best selected treatment in the first stage of screening (T_1) was further evaluated (M_0: control, M_1, M_2, M_3) on growth promotion of cauliflower plant. Application of MLE prepared from 10 minutes boiling (T_1 treatment) showed the significantly highest germination percentage (100%), and mean daily germination (97.5%). Besides, treatment T_1 produced larger root (1.8 cm), accumulated higher fresh (0.244 g) and dry weight (0.043 g) of cauliflower seedlings compared to other treatments. In pot study, treatment M_3 (15 ml water:1 ml MLE−T_1) produced the highest plant height (30.9 cm), leaf number (15.0), leaf width (11.1cm), petiole length (8.7 cm) and dry weight (9.7 g) at harvest. Thus, MLE creates a conducive environment for optimal cauliflower seed germination and robust early seedling growth.

Keywords: *Brassica oleracea,* dry matter accumulation, moringa leaf extract, phytohormone, pre-sowing technique

INTRODUCTION

Cauliflower is an important winter vegetable in Bangladesh which has many health benefits such as aiding blood circulation and digestion. Cauliflower scientifically known as *Brassica oleracea* Lam under Brassicaceae family. Cauliflower is the 24th powerhouse of fruits and vegetables which is a cruciferous vegetable that is naturally high in fiber, vitamin B and water (Ware, 2023). In general, cauliflower is not difficult to grow, but it is sensitive to extreme temperatures. Different climatic hazards such as, heavy rainfall, drought, flood etc. cause crop failure (BBS, 2014). To survive in such situation, vigorous and healthy seedlings are needed. Vigorous seedlings possess robust physiological mechanisms that enable them to better withstand adverse environmental conditions such as extreme temperatures, drought, salinity, and various other stressors. Vigorous and healthy seedlings can be obtained by adopting seed priming technique (Biswas *et al.,* 2023*;* Devika *et al.,* 2021).

Seed priming is a pre-sowing treatment improves seed performance which change metabolic concentration and physiological process by application of synthetic and natural compounds. Seed priming shows the tremendous success in seed germination and seedling establishment thus adapting in abiotic stresses. Priming seeds supports germination even in challenging conditions, improves crop performance, and ultimately increases crop yield (Marthandan *et al.,* 2020). Seed priming plays role to initiate pre-germination activities without allowing the radicle to emerge, followed by the restoration of seeds to their initial moisture content through drying. These hydration- dehydration process influence metabolic activities within the seed, preparing it for germination without the actual sprouting of the root (Yadav *et al.*, 2011). According to Espanany *et al.* (2016) and Tu *et al.* (2022) cauliflower seed priming reduce germination time, increasing of seed vigour, and promote more uniform germination.

[1, 2 &4] M.S. Student, [5*]Corresponding author & Professor, Dept. of Agroforestry and Environmental Science, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207 [3]MS Student, College of Agricultural Sciences, International University of Business, Agriculture and Technology, Dhaka-1230, Bangladesh

There are different types of seed priming such as hydro-priming, chemical priming, osmo-priming, hormonal priming and redox priming which play an important role to promote plant in different adverse climatic conditions. Moringa Leaf Extract (MLE) as phytohormone may be used for seed priming. Moringa leaves contain a variety of active compounds including cytokinin, antioxidants, amino acids, flavonoids, carotenoids, and vitamins (El Sheikha *et al.,* 2022). MLE is rich in hormones and nutrients and perhaps a cost effective priming agent for cauliflower seed. Besides, MLE is being used as plant growth enhancer due to its affordability, safety, ease of preparation, and environmentally friendly nature. MLE promotes plant growth, increases leaf area, bolsters plant resistance to pests and diseases, and produce larger and more abundant fruits (Fuglie, 2001). Seed priming with MLE helps to regulate hydration process which enables seed to initiate germination more effectively and exhibits improved resistance to different stresses (Jisha, 2013). However, to best of our knowledge, no work has been done on cauliflower seed priming as well as plant growth promotion by using MLE. Moringa leaf extract as a seed priming agent perhaps enhance the germination rate, seedling vigor, and overall growth parameters of cauliflower plants (Ahmed and El-Mahdy, 2022). Therefore, this study had been undertaken to assess the bio-efficacy of Moringa leaf extract on seed priming of cauliflower seeds, establishment and growth promotion of cauliflower plants.

MATERIALS AND METHODS

Moringa (*M. oleifera*) leaf extract (MLE) were evaluated on cauliflower seed germination and seedling development at Agroforestry Field Laboratory, Department of Agroforestry and Environmental Science, Sher-e-Bangla Agricultural University, Dhaka (23° 46′N, 90° 22′E) from 1st October, 2023 to 18th January, 2024.

Seed materials: Seeds of cauliflower (*Brassica oleracea*) cv. BARI Fulkopi-2 were collected from Bangladesh Agricultural Research Institute, Gazipur. Before starting of experiment, seeds were surface sterilized in 1% sodium hypochlorite solution for 3 min, then rinsed with sterilized water and air-dried.

Extract preparation:

Fresh young Moringa leaf was collected from Agroforestry Field Laboratory, SAU, Dhaka. In this experiment, three types of extract were used.

Moringa Leaf Extract (MLE) prepared from 10 minutes boiling: MLE was prepared by following the method of Han *et al.* (2022) with some modification. Fresh leaf was chopped into small pieces of approximately 2 cm. Chopped leaf was thoroughly washed with tap water to remove dirt, sand, and other debris. In short, 100 g of chopped leaf was added into 500 mL of distilled water, and boiled for 10 min. Then the decoction was cooled at room temperature. Two fold muslin cloth was used to separate the Moringa leaf extract from the solid leaves, and were kept as crude or stock solution at 4 ^{0}C until required for further studies.

MLE prepared from 20 minutes boiling: Same procedure was followed as described previously except boiling time. Here, it was 20 minutes.

MLE prepared without boiling: MLE was prepared by following the method of Hoque *et al.* (2020) with some modification. Here, 200 gm fresh, cleaned, and chopped moringa leaves was added with 1000 ml water. The mixture was grinded for 3 minutes by using a grinding machine (HAVELLS Power Hunk, 800W Motor, 2100 RPM). The mixture was strained out four times by using cheese cloth to separate Moringa extract from solid particles. The extract was stored in a clean, airtight container at 4^{0}C for further use.

Evaluation of MLE on seed priming of cauliflower

Seed priming. Four treatments namely T_0= Tap water as control, T_1= MLE prepared from 10 minutes boiling, T_2= MLE prepared from 20 minutes boiling, and T_3= Fresh MLE were used in this experiment. A total of 100 cauliflower seeds were soaked into each extract according to the treatments for 6 hours at room temperature and drained the primed seed on paper towels for 24 hours and re-dried near to original weight (Sundstrom *et al.,* 1987).

Germination test. Four replicates of 20 seeds each were placed in 9 cm diameter petri dishes at room temperature. Five mL of MLE (treatment wise) was applied in each Petri dish, while distilled water was applied for normal conditions. A seed was scored germinated when coleoptile and root lengths reached 2 - 3 mm. Counts of germinating seeds were made every 6 h, starting on the first day of imbibition, and terminated when maximum germination was achieved.

Measurements and definitions

Several traits were evaluated to determine the role of different MLE on cauliflower seed priming.

Germination percentage (%) = (Number of Germinated Seeds/Total Number of Seeds) ×100.

Germination Initial Time (GIT, day): **is the period** it takes for a seed to begin the process of germination after being sown under specific environmental conditions, Number of days of first germinated seed.

Maximum Germination Time (MGT, day): MGT is the longest period within which a seed is expected to germinate under ideal conditions. It is the duration beyond which a seed is considered non-viable or unable to germinate, Number of days until the highest germination seeds.

Germination Duration Time (GDT, day): GDT = MGT – GIT, The interval from GIT to MGT.

Mean Daily Germination (MDG, %): It is calculated by dividing the total number of germinated seeds by the number of days it took for germination to occur.

MDG (%) = GP/MGT.

Mean Germination Time (MGT, day): It is calculated by recording the number of germinated seeds at regular intervals and then determining the time it takes for half of the seeds to germinate, the count days until reached to 50% of germinated seeds.

Speed of germination rate: Speed of Germination Rate (SGR) =1/Germination Time, Where, SGR is the Speed of Germination Rate, typically measured in units of per day (e.g., seeds per day).

Seedling Vigour Index (SVI): The vigour level of each treated seed lot was calculated according to Kim *et al.* (1994) as percentage normal emergence multiplied by seedling shoot height and divided by 100 (Adebisi, 2004).

Shoot length (cm) and root length (cm): Measured by measuring scale.

Fresh and dry weight (gm): Measured by weighting balance.

Evaluation of MLE on growth promotion of cauliflower: The best selected MLE (T_1= MLE prepared from 10 minutes boiling) was further evaluated to investigate its potentials on growth promotion of cauliflower.

Crop husbandry

Planting trays (42 × 21 × 19 cm) with drainage holes were surface sterilized in 2.5% (w/v) Sodium hypochlorite (NaOCl), rinsed with distilled water, and used in seedling establishment tests. Each tray was filled with 12.5 kg of soil mixture which was prepared by mixing soil and cowdung (3: 1, w/w). Thirty cauliflower seeds were sown in soil mixture at a depth of 1 cm, placed in three circles, with 10 seeds in each circle. Basal doses of N, P and K fertilizers were applied at 0.84g, 0.84g and 0.68g/tray in the form of urea, triple super phosphate (TSP) and muriate of potash (MoP) according to the treatments tested (Table 1). Soil moisture was maintained at field capacity. Each treatment consists of one planting tray. Data on plant growth promotion were recorded at intervals of ten days and were continued up to 50 days. Two additional splits of total 0.84g and 0.68g/tray urea and muriate of potash (MoP) were top dressed at 15 and 35 days after seeding (DAS). Soil moisture was maintained at field capacity by daily watering.

Fig.1. Evaluation of Moringa leaf extract (MLE) on cauliflower seedling growth promotion

Table1. Treatments for evaluating the effectiveness of MLE−T_1 on cauliflower growth promotion

Treatments	Details
M_0	Control, basal doses of fertilizers
M_1	Basal doses of fertilizers plus MLE−T_1 (5 ml water:1 ml MLE; v/v)
M_2	Basal doses of fertilizers plus MLE−T_1 (10 ml water:1 ml MLE; v/v)
M_3	Basal doses of fertilizers plus MLE−T_1 (15 ml water:1 ml MLE; v/v)

Measurements and definitions

Plant height (PH), distance from ground level to the tip of the longest leaf, were measured in cm from 5 randomly selected plants at 10 (PH10), 20 (PH20), 30 (PH30), 40 (PH40), 50 (PH50) days after seeding (DAS).

Leaf number (LN) were counted at different growth stages, and designated as 10 (LN10), 20 (LN 20), 30 (LN 30), 40 (LN 40), 50 (LN 50) days after seeding (DAS), respectively.

Petiole length (PL), distance from ground level to the tip of the longest leaf, distance from leaf base up to the base of leaf blade, were measured in cm from 5 randomly selected plants at, 40 (PL40), 50 (PL50) days after seeding (DAS).

Leaf breadth (LB), using a ruler measurement is taken from the outer edge of one side of the leaf to the outer edge of the other side, were measured in cm from 5 randomly selected plants at 40 (LB40), 50 (LB50) days after seeding (DAS).

Fresh and dry weights of plants, the growth performance of cauliflower was assayed on the basis of fresh and dry weights of plants determined after 50 days of seeding. The plants were carefully uprooted from the pots and thoroughly washed without damaging the roots to remove all adhering soil mixture. After recording the fresh weight, the plants were placed in an oven at 65 ^{0}C for 72 hours and dry weight was recorded.

Experimental design and data analysis

All experiments were conducted using completely randomized design (CRD) with four replications. The data were subjected to analysis of variance (ANOVA) and tested for significance using Least Significant Difference (LSD) using R-3.5.1 software (R Core Team, 2017).

RESULTS AND DISCUSSIONS

In this study, MLE was evaluated on cauliflower seed germination and growth promotion in two stages of screening where MLE performed significantly better over control treatments.

Germination percentage (GP)

Germination percentage is linked to seed vigor, which refers to overall health and robustness of the seeds. Significant differences of germination percentage of cauliflower seeds among the different treatments were recorded (Table 2). Germination percentages were 95, 100, 95 and 83.3% at T_0 (Control), T_1, T_2 and T_3 respectively at day 3. The highest germination percentage was found in T_1 treatment (100%) and the lowest germination percentage was found in T_3 treatment (83.3%). The second highest germination percentage was found in both T_0 and T_2 treatments which was 95.0%. Higher germination percentages post priming are an indicator of enhanced seed vigor.

Table 2. Effect of MLE on germination percentage of cauliflower seed priming

Treatment	Germination percentage (%)
T_0	95.0 b
T_1	100.0 a
T_2	95.0 b
T_3	83.3 c
LSD	2.718

Means within columns with the same letters are not significantly different at 5% level of probability

Remarks: T_0: Tap water as control; T_1: MLE prepared from 10 minutes boiling; T_2: MLE prepared from 20 minutes boiling; T_3: Fresh MLE

MLE contains vitamins, minerals, phytochemicals and natural antioxidants may enhance the overall physiological process involved in cauliflower seed germination. Our results were supported by the results of Goel *et al.* (2003) who reported that seed priming improved germination percentage and reduced deterioration of seeds under accelerated aging of cotton.

Germination initial time and maximum germination time

Monitoring germination initial time and maximum germination time in seed priming is essential for assessing the effectiveness of the priming treatment in terms of accelerating germination initiation, achieving uniform germination and optimizing the overall germination period. There were no significant differences of germination initial time among the treatments, but there were significant differences for maximum germination time of cauliflower seeds among the treatments (Table 3). Rapid GIT is beneficial in the field as it can lead to quicker and more uniform seedling emergence. In all treatments GIT was 1. Maximum germination time provides information about the overall germination period and the extent of synchronization in seed germination. The significantly lowest MGT was found in T_0 treatment (1 day), followed by T_1 and T_2 treatment with the values of 1.7 and 2 respectively. The highest MGT was found in T_3 treatment which was 2.7 day. Seed priming results in a shorter GIT and a more condensed MGT, indicating higher percentage of seeds germinate more quickly and synchronously. In this regards, treatment T_0 appeared as the best treatment closely followed by T_1 treatment in priming of cauliflower seeds.

Table 3. Effect MLE on Germination Initial Time (GIT) and Maximum germination time (MGT) of cauliflower seed priming

Treatment	Germination Initial Time (GIT, day)	Maximum germination time (MGT, day)
T_0	1.0	1.0 c
T_1	1.0	1.7 bc
T_2	1.0	2.0 ab
T_3	1.0	2.7 a
LSD	NS	0.769

Means within columns with the same letters are not significantly different at 5% level of probability

Remarks: T_0: Tap water as control; T_1: MLE prepared from 10 minutes boiling; T_2: MLE prepared from 20 minutes boiling; T_3: Fresh MLE

Germination Duration Time (GDT) and Mean Daily Germination (MDG)

Germination Duration Time (GDT) and Mean Daily Germination (MDG) were used to assess the efficiency of the priming treatment. A successful priming treatment might lead to a shorter GDT and a higher MDG, indicating quicker and more synchronized germination. There were significant differences of GDT and MDG on cauliflower seed among the treatments (Table 4). The lowest value of GDT was found in T_0 treatment where cauliflower seed were treated with water and the second lowest value of GDT was found in T_1 treatment which was 0.7 day. The highest value of GDT was found in T_3 treatment which was 1.7 day. As expectation, the highest MDG was found in T_1 treatment (97.5%) and

Table 4. Effect of MLE on Germination Duration Time (GDT) and Mean Daily Germination (MDG) of cauliflower seed priming

Treatment	Germination Duration time (GDT, day)	Mean daily Germination (MDG) (%)
T_0	0.0 c	95.0 ab
T_1	0.7 bc	97.5 a
T_2	1.0 ab	92.0 b
T_3	1.7 a	81.1 c
LSD	0.769	2.879

Means within columns with the same letters are not significantly different at 5% level of probability

Remarks: T_0: Tap water as control; T_1: MLE prepared from 10 minutes boiling; T_2: MLE prepared from 20 minutes boiling; T_3: Fresh MLE

the least MDG was found in T_3 treatment which was 81.1%. Hydropriming is a technique for initiating germination that involves soaking of seeds in water followed by drying. Seed priming of Rice with

MLE recorded earlier and uniform crop stand, improved yield and quality attributes than hydropriming (Kamran, 2011).

Mean Germination Time (MGT) and Speed of Germination Rate (SGR)

Table 5 showed that there was significant differences of Mean Germination Time (MGT) and Speed of Germination Rate (SGR) of cauliflower seed among treatments. The highest MGT value was found in T_3 treatment which was 1.9 day and the second highest value of MGT was found in T_2 treatment which was 1.5 day. The lowest value of MGT was found in T_0 treatment (control) which was 1 day. In seed priming, a shorter MGT is generally desirable as it indicates quicker and more synchronized germination which may lead to a more uniform stand of seedlings in the field. The highest values of SGR was found in T_0 treatment (control) which was 1 seed/day but the second highest values of SGR was found in T_1 treatment which was 0.7 seed/day. The lowest values of SGR was found in T_3 treatment which was 0.4 seed/day. An increased SGR implies that priming treatment has accelerated the initiation and progress of germination. In our study, T_0 appeared the best treatment in terms of MGT and SGR followed by T_1 treatment. Application of MLE often results in a shorter MGT and a higher SGR, demonstrating that seeds are germinating more quickly and uniformly (Ahmed and El-Mahdy. 2022).

Table 5. Effect of MLE on Mean Germination Time (MGT) and Speed of Germination Rate (SGR) of cauliflower seed Priming

Treatment	Mean Germination Time (MGT, day)	Speed of Germination Rate (SGR, seed/day)
T_0	1.0 c	1.0 a
T_1	1.3 bc	0.7 b
T_2	1.5 ab	0.5 bc
T_3	1.9 a	0.4 c
LSD	0.425	0.293

Means within columns with the same letters are not significantly different at 5% level of probability

Remarks: T_0: Tap water as control; T_1: MLE prepared from 10 minutes boiling; T_2: MLE prepared from 20 minutes boiling; T_3: Fresh MLE

Shoot length (cm) and root length (cm)

There were no significant differences of shoot length (cm) and root length (cm) of cauliflower seedling among treatments (Fig. 2). The highest shoot length was recorded in the seedling belong to T_3 treatment with the value of 3.2 cm and the lowest shoot length was found in the seedlings of T_0 with the value of 3.0 cm. Treatments T_1 and T_2 produced intermediate type of shoot (3.1 cm).

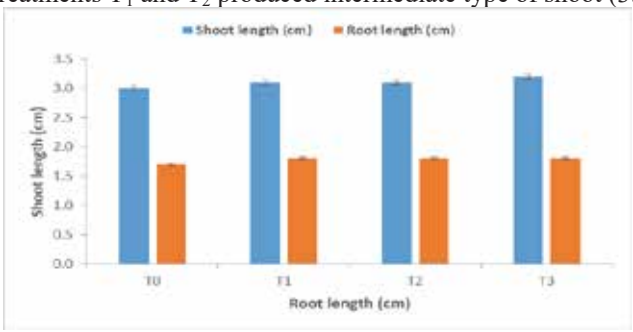

Fig. 2. Effect of MLE on Shoot length (cm) and Root length (cm) of cauliflower seedling

Means within columns with the same letters are not significantly different at 5% level of probability

Remarks: T_0: Tap water as control; T_1: MLE prepared from 10 minutes boiling; T_2: MLE prepared from 20 minutes boiling; T_3: Fresh MLE

In case of root, the least length of root was recorded in the seedlings of T_0 treatment where other treatments (T_1, T_2 and T_3) produced root of 1.8 cm length. All the treatments contain MLE produced longer shoot and root length compared to hydropriming. Our research results were in line with the

findings of Afzal *et al.*(2006) reported that shoot length improved due to seed priming in wheat. MLE is rich in zeatin, ascorbates, phenolic and minerals like Ca, K and Fe which increase crop growth (Anjorin *et al.,* 2010). An increase of 94% in radish and 65% in bean because of MLE application (Foidle, 1999)

Germination Vigor Index (GVI)

Germination Vigor Index (GVI) reflects the quality and speed of seed germination. Higher values indicate better seed vigor in terms of both the rate and uniformity of germination. The significantly highest GVI were observed in the seeds treated with MLE compared to hydro-priming seeds (Table 6). Results showed that the significantly highest GVI was recorded in T_3 treatment (168.5mg) where T_2 (142.5mg) and T_1 treatments were statistically same. The least GVI was recorded in T_0 treatment (95.0mg). MLE, when used in seed priming, plays a crucial role in enhancing seed germination and early seedling growth. The extract contains bioactive compounds, cytokinins and antioxidants, which stimulate enzymatic activity and protects seed from oxidative stress, promoting overall seed vigor. Additionally, the presence of nutrients like vitamins and minerals in MLE contributes to improve seedling establishment and resilience during the early stages of plant development.

Table 6. Effect of MLE on Germination Vigor Index (GVI) of cauliflower seed priming

Treatment	Germination Vigor Index (GVI) (mg)
T_0	95.0 b
T_1	133.3 ab
T_2	142.5 a
T_3	168.5 a
LSD	43.081

Means within columns with the same letters are not significantly different at 5% level of probability

Remarks: T_0: Tap water as control; T_1: MLE prepared from 10 minutes boiling; T_2: MLE prepared from 20 minutes boiling; T_3: Fresh MLE

Fresh weight (g) and dry weight (g)

Table 8 represents fresh and dry weight (g) of cauliflower seedling and showed that there were significant differences in fresh and dry weight in between the treatments. The data clearly demonstrates that when cauliflower seed was primed by MLE, there were a noteworthy increment in fresh and dry weight of cauliflower seedling. The significantly highest fresh weight (0.244g) was recorded in T_1 treatment (Figure 3) and T_0 recorded the significantly lowest (0.222g) fresh weight.

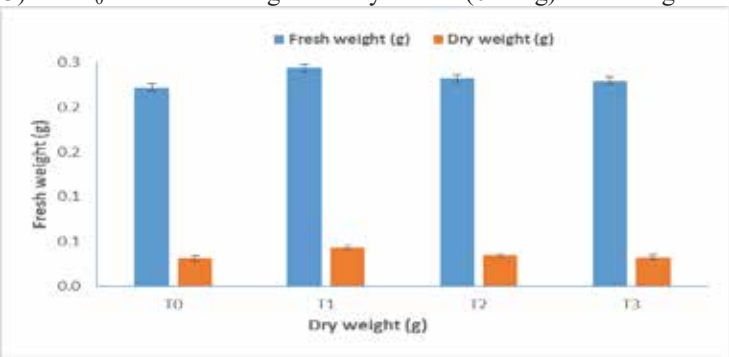

Fig. 3. Effect of seed priming by different MLE on cauliflower seedling on fresh weight (gm) and dry weight (gm) of cauliflower seedling

Means within columns with the same letters are not significantly different at 5% level of probability

Remarks: T_0: Tap water as control; T_1: MLE prepared from 10 minutes boiling; T_2: MLE prepared from 20 minutes boiling; T_3: Fresh MLE

As expectation, similar trends were also recorded in dry weight of cauliflower seedlings. Results showed that maximum dry weight (0.043g) was recorded in T_1 treatment followed by, T_2 and T_3 treatments and the significantly lowest dry weight (0.031g) was found in the seedlings of T_0 treatment.

Similar results was found by Basra *et al.* (2006) and stated that seedling fresh and dry weights increased due to seed priming in case of rice. Yeasmin *et. al.*(2011) stated that MLE as foliar application in wheat increase grain weight, biological yield, grain yield and harvest index.

Moringa Leaf Extract (MLE−T_1) on plant growth promotion of Cauliflower

Moringa leaf extract (MLE), rich in bioactive compounds like phenolics, flavonoids, and vitamins, serves as an effective seed priming agent, enhancing seed germination rates and vigor due to its phytohormonal and antioxidant properties. Furthermore, its application as a plant growth promoter stimulates root and shoot development, improving nutrient uptake efficiency and overall plant biomass production, thus contributing to sustainable agricultural practices.

Plant height (PH)

The effects of moringa leaf extract (MLE) on the plant height (cm) of cauliflower seedlings at various days after seeding (DAS) are showed in Table 7. At 10 DAS, the M_3 treatment had the maximum plant height (6.0 cm), whereas the T_1 and T_2 treatments had the lowest plant heights. Plant height was significantly the highest in T_1 treatment at 20, 30, and 40 DAS, measuring 9.6, 18.6, and 25.8 cm, respectively. While T_2 treatment had the lowest plant height, measuring 9.1, 16.5, and 24.0 cm, respectively. Plants treated with MLE produced the longest plants in structure throughout the experiment compared to control plants. There was no significant variations between these treatments at 50 DAS. Our research results were in line with the past research experience (Hoque *et al.* 2022). They found foliar application of MLE at two weeks interval significantly enhanced plant height of cabbage. Moringa leaf extract (MLE) applied to cauliflower plants can potentially enhance their growth and height due to its nutrient-rich composition, containing substances like cytokinins and auxins known to promote plant growth. Regular application of MLE may stimulate root development, improve nutrient uptake, and ultimately contribute to increased plant height and overall vigor in cauliflower crops.

Table 7. Effect of MLE on plant height (cm) of cauliflower seedling at different days after seeding (DAS)

Treatment	Plant height (cm)				
	10 DAS	**20 DAS**	**30 DAS**	**40 DAS**	**50 DAS**
M_0	5.7ab	9.5ab	17.8b	23.8b	29.2
M_1	5.5b	9.6 a	18.6 a	25.8a	30.9
M_2	5.5b	9.1c	16.5c	24.0b	30.0
M_3	6.0a	9.2bc	18.4ab	24.2b	30.9
$LSD_{(0.05)}$	0.437	0.314	0.677	0.558	NS

Means within columns with the same letters are not significantly different at 5% level of probability

Remarks: **M_0**= Control, **M_1**=5 ml water: 1ml MLE, **M_2**=10 ml water: 1ml MLE, **M_3**=15 ml water: 1ml MLE

Leaf number (LN)

Moringa leaf extract (MLE) significantly affected the number of leaves of cauliflower plants throughout the experiment except at 10 DAS (Table 8). At 10 DAS, maximum number of leaves were recorded in the plants belong to M_0 treatment. Thereafter, treatment M_3 produced the significantly

Table 8. Effect of MLE on number of leaf of cauliflower seedling at different days after seeding (DAS)

Treatment	Leaf number				
	10 DAS	**20 DAS**	**30 DAS**	**40 DAS**	**50 DAS**
M_0	4.0	4.0c	8.0b	9.0ab	13.0b
M_1	3.7	4.2b	8.5a	9.3a	13.3b
M_2	3.7	4.0c	8.5a	8.8b	14.0ab
M_3	3.7	4.3a	8.3ab	9.3a	15.2a
$LSD_{(0.05)}$	NS	0.160	0.420	0.479	1.571

Means within columns with the same letters are not significantly different at 5% level of probability

Remarks: **M_0**= Control, **M_1**=5 ml water: 1ml MLE, **M_2**=10 ml water: 1ml MLE, **M_3**=15 ml water: 1ml MLE

highest number of leaves throughout the study period except at 30 DAS. Treatment M_1 was statistically at pair with M_3 treatment at 30 and 40 DAS. At harvest, the significantly highest number of leaves

were produced in the plants under M_3 treatment (15, 2) which was closely followed by the plants belong to M_2 treatment (14.0). Plants receiving control treatment produced the least number of leaves (13.0). Applying MLE to plants has been shown to increase leaf production due to its rich nutrient content, including essential vitamins and minerals that support plant growth (Abdalla, 2013; Abohassan and Abusuwar, 2018). The MLE contains compounds such as cytokinins, which can promote cell division and leaf formation, potentially leading to an increase in the number of leaves produced by the plant. Regular application of MLE may contribute to lush foliage and higher leaf counts, enhancing the overall health and productivity of plants.

Petiole length (cm) and leaf width (cm) −

Data on the petiole length (cm) and leaf breadth (cm) of cauliflower seedlings are shown in Table 9. At 40 DAS, petiole length was non-significant in between the treatments where the least petiole length was recorded in M_3 treatment (6.2cm). However, at 50 DAS, plants receiving M_3 treatment produced the significantly longest petiole with the value of 8.7cm, closely followed by M_1 (7.7cm) and T_0 (7.3cm), respectively. Leaf width were significantly different due to the application of MLE both at 40 and 50 DAS (Table 3). Treatment M_3 produced the significantly widest leaf at 50 DAS with the value of 11.1cm. Where, treatment M_1 produced the second widest leaf (9.7cm) closely followed by M_2 and M_0 treatment, respectively. Regular application of Moringa leaf extract can enhance the development of wider leaves and longer petioles, contributing to increased surface area for photosynthesis and improved nutrient transport within the plant (Brockman and Brennan, 2017). Moringa leaf extract, enhance wider leaves and longer petioles.

Table 9. Effect of MLE on petiole length (cm) and leaf width (cm) of cauliflower seedling at different days after seeding

Treatment	Petiole length (cm)		Leaf width (cm)	
	40 DAS	50 DAS	40 DAS	50 DAS
M_0	6.6	7.3 ab	8.0ab	9.5b
M_1	6.5	7.7 ab	8.5a	9.7b
M_2	6.2	6.7 b	7.6b	9.6b
M_3	6.2	8.7 a	8.1ab	11.1a
LSD $_{(0.05)}$	NS	1.730	0.540	1.299

Means within columns with the same letters are not significantly different at 5% level of probability

Remarks: **M_0**= Control, **M_1**=5 ml water: 1ml MLE, **M_2**=10 ml water: 1ml MLE, **M_3**=15 ml water: 1ml MLE

Fresh weight (g) and dry weight (g)

Changes in fresh weight indicates alterations in water uptake, nutrient absorption, and overall metabolic activity of the plant. Unlike fresh weight, which can fluctuate due to changes in water content, dry weight provides a more stable measure of plant biomass and productivity. MLE significantly affected the fresh and dry weight of cauliflower plants (Table 10). Both fresh and dry weight were increasing throughout the experiment. At 40 DAS the significantly highest fresh was found in the plants treated with control plants (43.2g) closely followed by M_3 treatment (41.4 g). But, at harvest control plants produced the second least fresh weight (75.0g) where treatment M_3 produced the significantly highest fresh weight (93.7 g) which was statistically at par with treatment M_3 (89.3 g). Dry weights of cauliflower plants were non-significant receiving both control and MLE treatment. However, at harvest the significantly highest dry weight were found in the plants receiving M_3 treatment closely followed by M_1, and M_2 treatments, respectively. The significantly lowest dry matter was accumulated in the plants belong to control treatment. Moringa leaf extract (MLE) application to cauliflower plants may result in increased fresh and dry weights due to its nutrient-rich composition, containing essential elements such as nitrogen, potassium, and phosphorus which are vital for plant growth and development (Mashamaite *et al.,* 2022). The extract's biostimulant properties, including its ability to enhance nutrient uptake and promote metabolic processes, can potentially lead to improved biomass accumulation in cauliflower crops.

Table 10. Effect of MLE on fresh weight (g) and dry weight (g) of cauliflower seedling at different days after transplanting

Treatment	Fresh weight (g)		Dry weight (g)	
	40 DAS	50 DAS	40 DAS	50 DAS
M_0	43.2a	75.0 b	4.7	7.0b
M_1	32.2b	93.7a	4.1	9.3a
M_2	35.6ab	71.0 b	4.5	9.0a
M_3	41.40a	89.3 a	5.0	9.7a
$LSD_{(0.05)}$	8.89	9.35	NS	1.37

Means within columns with the same letters are not significantly different at 5% level of probability
Remarks: **M_0=** Control, **M_1**=5 ml water: 1ml MLE, **M_2**=10 ml water: 1ml MLE, **M_3=1**5 ml water: 1ml MLE

Moringa Leaf Extract (MLE) enhanced seed germination and early seedling growth of cauliflower. Initially, three different types of MLE were tested in this study where treatment T_1 (MLE prepared from 10 minutes boiling) appeared as the best agent for cauliflower seed priming. Treatment T_1 showed the significantly highest germination percentage (100%), mean daily germination (97.5%), root length (1.8 cm), fresh (0.244 g) and dry weight (0.043 g) of cauliflower seed and seedling. In second stage of screening, MLE i.e., treatment M_3 (15 ml water: 1ml MLE−T_1) accumulated the significantly highest dry matter (9.7 g) at harvest, also produced the significantly highest plant height (30.9 cm), leaf number (15.2), leaf width (11.1cm), and petiole length (8.7cm) of cauliflower plant. Thus, MLE (treatment M_3) may be used for seed priming and plant growth promotion in cauliflower cultivation.

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ADOPTION OF IMPROVED RICE CULTIVATION PRACTICES BY THE FARMERS OF CHAR-LAND OF GOMOTI RIVER

M. M. R. Talukder[1], M. H. Bhuiyan[2] and M. S. Ali[3*]

ABSTRACT

The main purpose of the research work was to determine the extent of adoption of selected rice cultivation practices by the farmers of char-land of Gomoti River and to explore the relationships between selected characteristics namely, age, level of education, family size, farm size, annual income, organizational participation, extension media contact, innovativeness, attitude towards modern agricultural technology and agricultural knowledge of the farmers and their composite adoption of selected rice cultivation practices (dependent variable). Data were collected from randomly selected one hundred farmers of Luter-char union under Daudkandi upazilla of Comilla district with the help of an interview schedule. Appropriate scales were developed in order to measure the variables. Pearson Product Moment Coefficient of Correlation test was used to ascertain the relationships between the concerned focus and causal variables of the research work. Majority (53 percent) of the farmers had high adoption while 29 percent had medium adoption and 18 percent had low adoption of improved rice production practices. Among the selected characteristics, age, farm size, annual income, extension media contact, innovativeness, attitude towards modern agricultural technology, problems and agricultural knowledge showed significant and positive relationships with their adoption of selected rice production practices. The policy makers may consider these characteristics to increase the adopter of improved rice production practices.

Keywords: Adoption, rice production, char land, improved practices

INTRODUCTION

The total char land of Bangladesh is one million hectares. This land has been created through the formation of lands by accretion of sediments along the riverbanks and/ or riverbeds of four big rivers – Padma, Meghna, Jamuna and Brahmaputra and their more than 500 branch rivers and tributaries. People of char lands mainly depend on agriculture including fisheries and livestock-rearing (Roy, 2019). They cultivate various crops such as ground nut, mungbean, watermelon etc. However, beside these crops they also cultivate rice and vegetables in some areas.

The majority of the farmers of char-land of Bangladesh are illiterate. They have little communication facilities with developed areas. Reasonably they do not have well exposure with modern agricultural technologies except some HYV of rice varieties such as BR-3, BR-8. BR-28 and BR-29 (Karim, 2014). Indeed only the HYV of rice seeds can not ensure high production. Cultivation of HYV of rice consists of a package of technologies such as quality seeds, raising of seedling, balance dose of fertilizers, insect and disease control, etc. Unless the farmers of char-land adopt the entire package of rice production technologies the yield is supposed to be below the national average. The per hectare rice production in char-land is estimated to be below three tons per hectare against national average five ton per hectare (BBS, 2021). As the char people mostly depend on agriculture for their livelihood and the crop production is low, therefore, it is assume that they are very poor and live hand to mouth. There is an urgent need to adopt improved rice production technology along with HYV of rice by the people of char-land to improve their livelihood.

According to Rogers (2003), "Adoption is a decision to make full use of an innovation as the best course of action available". Ray (1995) also said that when an individual takes up a new idea as the best course of action and practices it, the phenomenon is known as adoption. The adoption of selected rice production practices by the farmers of char-land must be in the line of definition. The success of rice production technologies depends on its dissemination among the potential users, which ultimately

[1]M.S. Student, [2&3*]Professor & Correspondng authors, Dept. of Agricultural Extension and Information System, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh

is measured by the level of its adoption (Haque *et. al.,* 2016). It is assumed that notable improvements can take place in rice production system among the farmers of char- land if farmers adopt the package of technologies properly.

Generalization from studies conducted at home and abroad regarding the adoption of innovations may not be always applicable due to considerable variation in attributes of the innovations and for various other factors. It will be necessary to have a clear understanding of the present status of adoption of selected rice production practices by the farmers. Therefore, there is necessary to conduct a study on adoption among especial community such as farmers of char-land of Gomoti-river.

i. To identify the rice production practices used by the farmers of char-land of Gomoti River.
ii. To describe some selected socio-economic characteristics of the farmers.
iii. To determine the extent of adoption of selected rice production practices used by the farmers.
iv. To explore the relationships between the selected characteristics of the farmer's and their extent of adoption of selected rice production practices.

MATERIALS AND METHODS

Locale of the study

Luter-char a char-land of Gomoti River was purposely selected as locale of the study. The char-land is situated in Daudkandi upzilla under comilla district just five kilometers away from the upzilla head quarter.

Population and sample of the study

An update list of all farm family heads using only selected rice production practices of the selected village was prepared with the help of Sub-Assistant Agricultural Officer (SAAO). The list comprised a total of 496 farmers in the study area. These farmers constituted the population of this study. Twenty (20 percent) of the population of the village was randomly selected as sample of population by using a table of Random Numbers (Kerlinger, 1973). Thus, the total sample size of this study area was about one hundred (100) farmers.

Variables and their measurement

The respondents' selected 10 characteristics viz. age, education, family size, farm size, annual income, organizational participation, innovativeness, extension media contact, attitude towards technology, and agricultural knowledge are selected as causal variables. Adoption of selected rice production practices is selected as focus variable. It was calculated by asking farmers how many Boro rice technologies they adopted for how many years in how much land. The land area used for certain technology (mentioned in the first part of result and discussion) is considered to be the extent of adoption (e), whereas the area that could be used for the technology is considered to be potentiality of adoption (p). The extent of adoption (e) was divided by potentiality of adoption (p) against each of the technologies. This is called Adoption Quotient (AQ). Thus adoption of selected rice production practices score of a respondent could range from 0-100, while 0 indicating no adoption and 100 indicating highest adoption. A summary of measuring techniques of these variables are given below--

Table 1. Measurement techniques of focus variable and farmers characteristics

IV and dv	Measuring techniques
Age	Actual years
Education	0 for illiterate and 1 for each of schooling
Family size	Total number of members in the farmers family
Farm size	Total land possessed by the farmers (hectare)
Annual family income	Taka (Bangladeshi currency)
Organizational participation	0 for not involved and 1 for each year of involvement

IV and dv	Measuring techniques
Innovativeness	Use a technology earlier (score)
Attitude towards improved technology	Five point Likert scale
Knowledge on rice technology	Score comes from question asking
Extension media contact	Five point scale from regularly to no contact (Score)
Adoption of improved practices	Adoption quotient formula (Score)

Collection of data

For the purpose of data collection, an interview schedule was prepared. It was prepared keeping the objectives of the study in mind. The schedule contained both open and closed from questions. Direct simple questions were included in the schedule to collect data on the selected dependent and independent variables. Appropriate scales were developed to measure the selected factors of the respondents. The draft schedule was prepared in Bengali and pre-tested before using it for collection of data. Fore pre-test purpose, ten farmers taking from the selected village of the study area were interviewed by using the draft interview schedule. Based on the pre-test experience, necessary corrections, additions, alternations and rearrangements were made in the schedule. Thus, the schedule was prepared for final use.

Data were collected personally by the researcher himself through face to face visit to all the selected farmers of Luter-char village of Daudkandiupazilla to obtain valid and pertinent information. The researcher made all possible efforts to explain the purpose of the study to the farmers. Rapports were established with the farmers prior to interview and the objectives were clearly explained by using local language to the extent possible. At the time of data collection, the researcher was also aware of side talking and tried to avoid that problem tactfully. The researcher sought the help of the local supervisors for this purpose. Excellent co-operation and co-ordination were obtained from all the respondents.

Processing and analysis of data

The collected raw data were examined thoroughly. For this, the researcher made a scrutiny of the completed interview schedule to make sure that they were entered as complete as possible and well arranged to coding and tabulation. In case of qualitative data, appropriate scoring technique was followed to convert the data into quantitative forms. These were then tabulated according to the objectives of the study. For describing the various independent and dependent variables, the respondents were classified into various categories and arranged in simple table for description.

The collected data were compiled, coded tabulated and analyzed in accordance with the objectives of the study. The statistical measures such as range, mean, standard deviation, percentage distribution and rank order were used to describe both the dependent and independent variables. Tables were also used in presenting data for clarity of understanding. In order to explore the relationships of the selected characteristics of the farmers with their adoption of modem agricultural technologies, the Pearson's Products Moments Correlation Co-efficient was computed. Correlation matrix were also computed to determine the inter relationship among the variables.

RESULTS AND DISCUSSION

Identification and selection of rice cultivation practices

The term rice cultivation practices referred to the practices related to rice production, namely, cultivation of modern variety of rice, use of green manure, use of compost, use of granular urea, use of mixed fertilizer, use of power tiller, use of weedicide, methods used for controlling diseases and insects in rice field etc. In a broad sense, rice production practices refer to the production technologies of rice by judicious use of the resources of nature and different innovations.

For identifying rice production practices by the farmers, the researcher asked farmers about their use of production practices in rice cultivation. Later, their responses were cross checked by the DAE personnel (SAAO) and model farmers. After thorough discussion with these stakeholders, the following practices were identified. These practices were followed by the farmers of the study area.

1. HYV Boro rice varieties (BR3/ BR8/ BRRI dhan 28/ BRRI dhan 29)
2. Integrated Pest Management
3. Recommended Doses of Fertilizers.

Socio-economic profile of the farmers

Ten characteristics of the farmers were selected to find out their relationship with the adoption of selected rice production practices. The selected characteristics included their age, level of education, family size, farm size, annual income, organizational participation, extension media contact, innovativeness, attitude towards modern agricultural technology and agricultural knowledge. The summary of these characteristics of the farmers have been Table 2.

Table 2. Summary profile of the farmers selected socio-economic characteristics

Item	Possible range	Observed range	Mean	SD
Age (years)	--	17-80	50.46	14.24
Education (score)	--	0-11	1.80	3.07
Family size (number of person)	--	2-18	6.66	2.67
Farm size (ha)	---	0.13-2.83	0.87	0.56
Annual family income (BDT)	--	12000-724360	109647	87810
Organizational participation (score)	0-11	0-5	3.90	1.01
Innovativeness (score)	0-50	1-15	6.19	4.06
Attitude towards improved technology (score)	0-32	18-30	23.86	2.92
Knowledge on rice technology (score)	0-50	4-30	16.82	6.12
Extension media contact (score)	0-72	0-17	7.62	3.25

Adoption of selected rice production practices

In this study only three important dimensions were taken into consideration for determining adoption of Boro rice production practices. The three dimensions were: 1. Area of selected Boro rice varieties. 2. Use of IPM practices for controlling pests & disease of Boro rice and 3. Recommended doses of fertilizers.

According to the measurement procedure of adoption of selected Boro rice production practices mentioned in methodology chapter. The adoption score of these three technologies ranged from 22-89 against the possible range of 0-100. The average adoption was 58.54 with a standard deviation of 18.02. Based on the adoption score, the farmers were classified into three categories: "low adopters" (up to 40), medium adopters" (41-60) and "high adopters" (61 and above). Majority (53 percent) of the farmers fell under the high adopter's category, while 29 percent had medium adopters and only 18 percent had low adopters. Thus, an overwhelming majority of the farmers had medium to high adoption. For clarity of understanding, a bar diagram has been presented in Fig. 1.

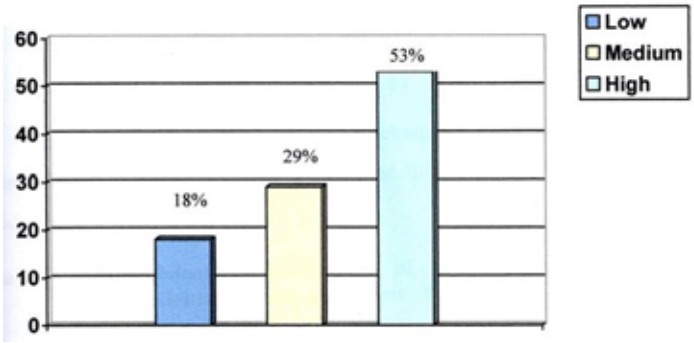

Fig. 1. Bar-graph showing adopter categories of selected rice production practices

Relationships between farmers' characteristics and adoption of selected rice production practices

Here the relationships with ten selected characteristics of the farmers and their adoption of selected rice production practices were presented. The selected characteristics constituted underlying variables and the adoption of selected rice production practices by the farmers considered as focus variable. Pearson's product moment correlation co-efficient "r" has been used to test the hypothesis concerning the relationship between two variables. The analysis showed that out of 10 selected characteristics seven characteristics such as age, farm size, annual income, extension media contact, innovativeness, attitude towards technology and knowledge on agriculture had significant relationship with the adoption of selected rice production technologies. The summary of the results of the correlations co-efficient relationships between the selected characteristics of the respondents and their adoption of selected rice production practices is shown in Table 3.

Table 3. Co-efficient of correlation of the selected characteristics of the farmers and their adoption of selected rice production practices

Focus variable	Causal variables	Computed value of `r'	Table value of `r' at 98 degree 0f freedom	
			0.05%	0.01%
Adoption of selected rice production practices	Age	0.202*	0.196	0.257
	Level of education	0.009^{NS}		
	Family size	-0.034^{NS}		
	Farm size	0.220*		
	Annual income	0.204*		
	Organizational participation	-0.092^{NS}		
	Extension media contact	0.225*		
	Innovativeness	0.197*		
	Attitude towards technology	0.202*		
	Agricultural knowledge	0.227*		

^{NS}Not significant, * significant at 0.05 level

The relationship between the age and adoption was positive direction and a low relationship was found between the two variables. The co-efficient of correlation between the concerned variable was significant at 0.05 level of probability. Based on the above findings, the researcher concluded that age of the farmers had a significant and positive relationship with their adoption of selected rice production practices. This meant the higher age of the farmers the higher was their adoption in respect of selected rice production practices. Singh and Rajendra (1990) and Hossain *et al.* (1992) observed the similar findings in their studies.

From the above observations, it might be concluded that there was significant positive relationship between farm size of the farmers and their adoption of selected rice production practices. The finding is quite rational because adoption of selected rice production practices is relatively costly. Hence, large farmers get more scope than the small farmers as they can invest money for adoption of selected rice production practices. Many researchers (Pal, 1995; Islam, 2002; Islam, 2003) observed the similar significant and positive relationship between these two variables.

On the basis of the observations, the researcher concluded that the annual income of the farmers had a positive significant relationship with their adoption of selected rice production practices. This means that the farmers having higher annual income were likely to have more adoption of selected rice production practices. Khan (1993), Aurangozeb (2002) and Islam (2003) found the similar results.

Table 3 explored that extension media contact of the farmers had significant and positive relationship with their adoption of selected rice production practices. It means that higher extension media contact of the farmers was more likely to have more adoption of selected rice production practices. Hussen (2002), Rahman ((2001) and Aurangozeb (2002) observed the similar significant and positive relationship between these two variables.

Considering the findings, the researcher concluded that innovativeness of the farmers had a significant and positive relationship with their adoption of selected rice production practices. Innovative farmers have more tendencies to adopt technology than the laggards. The finding is consistent with the studies conducted by Podder (1999) and Islam (2002).

The researcher also concluded that the attitude towards modern agricultural technology of the farmers had significant and positive relationship with their adoption of selected rice production practices. Favorable attitude helps to form a positive mind for adopting an innovation. In this aspect, the finding is realistic.

From the above observations, it might be concluded that there was significant positive relationship between agricultural knowledge of the farmers and their adoption of selected rice production practices. The finding is quite rational, because adoption of selected rice production practices is relatively intellectual. Hence, an intelligent farmer can accept technology earlier than the non-intelligent farmers. Many researchers (Bashar, 1993, Islam, 2002) observed the similar significant and positive relationship between these two variables.

CONCLUSION

The adoption of selected rice production practices of the farmers was remarkable, as nearly 82 percent of the farmers had medium to high adoption. However, to meet the ever-growing demand of food, economic facts, and environmental problems, there is a need to further enhance the rate and extent of adoption of selected rice production practices among the farmers. Particularly, both the Government Organization (GO) and Non-Government Organization (NGO) workers should provide appropriate technical and field management information to all farmers through continued extension education and support services. The study found a significant and positive relationship between farmers' seven characteristics such as age, farm size, annual income, extension media contact, innovativeness, attitude towards technology and knowledge on agriculture with the adoption of selected rice production technologies. The policy makers may consider these characteristics to increase the adoption of improved rice production practices. Department of Agricultural Extension (DAE) should take initiative to motivate farmers with younger age, having lower media contact, lower agricultural knowledge, unfavorable attitude towards technology adoption to accept improved rice production practices.

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GENETIC AND NON-GENETIC FACTORS ASSOCIATED WITH DISEASE PREVALENCE OF GOATS

B. Yadav[1], A. N. M. I. Rahman[2*] and M. Islam[3]

ABSTRACT

The purpose of the study was to ascertain the prevalence of diseases of the goats at the Central Veterinary Hospital, Dhaka, Bangladesh. The diseases were identified by laboratory results, clinical indicators, and complaints from the patients' owners. The risk factors of the disease prevalence were associated with breed, varieties or type, age, and sex of the animals. Overall disease prevalence of goats was found around PPR (40%), Pneumonia (11%), Mastitis (6%), Worm infestation (14%), Bloat (17%), Urolithiasis (8%) and Miscellaneous (4%). The prevalence was relatively higher in Black Bengal (56.92%), followed by Jamunapari (23.07%) and Jamunapari and Black Bengal crosses (20%). The study revealed that PPR prevalence was significantly ($P<0.05$) influenced by breed. Disease occurrence in morphological variant groups has no significant effect. The infection rate of goats was highly variable in 7-24 months of age (50.76%) followed by 0-6 months (27.69%) and over 24 months (21.53%). It was found that bloat disease has significant ($P<0.05$) effects on the age of the animals. Male goats have higher (7.69%) Urolithiasis cases compared to female goats. The results of this study is important to understand the prevalence of goat diseases in this region concerning different genetic and non-genetic risk factors which will facilitate the implementation of appropriate preventative measures against those diseases.

Keywords: Prevalence, disease, goat, breed, age.

INTRODUCTION

Goat is one of the most indispensable small ruminants in Bangladesh due to their high rates of prolificacy, short generation intervals, and the ease with which the goats and their products can be marketed. According to the Food and Agricultural Organization (FAO), goat meat and skin makeup roughly 38% and 28% of all livestock meat and skin output in Bangladesh (Sarker and Islam, 2011). To enhance national health, goat supplies the primary dietary animal protein in the form of meat. In Bangladesh, Black Bengal goat (BBG) accounts for around 90% of the country's total goat population. Other goat breeds include Jamunapari, and crosses between BBG and Jamnapari, according to Amin *et al.,* (2001) and Husain, (1993). Goats play a significant role in Bangladesh's rural economic development and poverty reduction. Goats are known as "poor man's cows" because they may be raised with relatively minimal capital input by impoverished farmers, laborers, and miserable women who cannot afford to raise cattle. Moreover, there are varieties of coat color variants in the BBG. Husain, (1993) reported that about 80% of BBG is black in color and others being solid white, solid brown, mixed grey or spotted. Chowdhury, (2002) also reported BBG to be mostly black comprising 69% of the total goat population and the rest being white stripe on black (13%), brown (5%), solid white (4%), black with white patches or brown with white or brown with black (9%). About 90% of all goats in Bangladesh are BBGs, which are raised for their high fertility rate, propensity for procreation, early sexual maturity, ability to adapt quickly to hot environments, and superior quality meat and skin (Hussain, 1993; Amin *et al.,* 2001). Currently, there are about 26.7 million goats (DLS, 2023) in Bangladesh. However, numerous infectious and non-infectious diseases are commonly occurring in goats which is considered as a severe threat to existing animals in Bangladesh. In this country, urolithiasis, parasitism, and infectious diseases such as PPR, goat pox, pneumonia, etc. are prevalent ailments that can kill young or adult goats. Diseases are the main obstacle to goat production. According to Hussain, (1993), infectious diseases can negatively impact Bangladesh's national

[1]Internship student, Internship Program 2021, Faculty of Animal Science & Veterinary Medicine, [2*]Correspondence author & Associate Professor, Dept. of Animal Nutrition, Genetics and Breeding, [3]Associate Professor, Dept. of Microbiology and Parasitology, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh

economy in addition to causing farmers to suffer significant losses. Unhealthy management practices and unfavorable environmental conditions contribute to the incidence of many diseases in Bangladesh (Ndegwa *et al.,* 2001). Considering the above fact, the present study was conducted to find out the incidence, frequencies, as well as some common genetic and non-genetic risk factors associated with goat diseases and disorders at Central Veterinary Hospital (CVH), Dhaka, Bangladesh.

MATERIALS AND METHODS

Study region and period

The study was conducted at Central Veterinary Hospital (CVH), Dhaka district, Bangladesh during the period from July to August 2022. The necessary information and data were collected directly from the goat owner and the registered record book of the veterinary hospital where all diseased goats were brought for treatment.

Sample size and data collection

During this study period, a total of 77 goats were recorded to visit this hospital. Among those, 65 goats were diagnosed with the disease. The prevalence was measured according to the breed, variety, age, and sex of the goats which were studied. Data were collected by face-to-face interaction with the responded goat owner, repeated questioning, and observation of goat and recorded based on the basic information about owner's, number of animals, breed, age, sex, source of purchase, body weight, disease condition, vaccination, anthelmintic, purchase ready feed, supplied amount, feed supplement, frequency of feeding, feeding routine, favorite feed, housing system, rearing system, watering system, amount of water per day, problems and suggestions.

Clinical evaluation and determination

Following a visual examination of the patient, palpation, percussion, auscultation, needle puncture, and an analysis of the animals' stride and posture were used to check various body parts and systems of each sick animal. Based on the merits of each case, the general clinical examination was carried out taking into account the owner's complaint, the disease history, the symptoms, and common laboratory procedures such as microscopic inspection (Rosenberger, 1979). Thus, each of these ill animals had their temperature, pulse, and respiration rate noted. For viral disease diagnosis, close inspection were performed properly followed by the protocol of Raquib *et al.,* (2020). Presenting signs of abnormalities were observed such as a sharp rise of temperature 104°F–106°F, occulonasal discharge, diarrhea and respiratory distress. Rectal temperature was recorded with the thermometer in every case. Respiratory distress was identified with the help of stethoscope and the lung and tracheal sounds were observed and recorded. When it comes to parasite disorders, some were presumed to be diagnosed based on the patient's medical history, clinical signs and symptoms, and study of their feces (Blood and Radostits, 1989). A thorough inspection of the feces was done to identify any live or dead worms as well as tapeworm segments. Any discernible ectoparasites were looked for on the animal's body. The keys and descriptions provided by Wall and Shearer, (1997) were used to identify ectoparasites. Percentages of the prevalence of disease was calculated by using the formula of Raquib *et al.,* (2020). Briefly referring to the number of cases of a disease that are present in a particular population at a given time.

Statistical analysis

Each patient's data was gathered and entered into Microsoft Excel (Microsoft Office Excel-2013, USA). Using the Minitab19 software (Minitab Ltd., UK), the Pearson's Chi-square test was used to evaluate all of the study's data. A significance level of $p<0.05$ was assigned to differences.

RESULTS AND DISCUSSION

Overall occurrence of diseases in goat

The highest prevalence was found in PPR which was almost (40%), followed by bloat (17%), worm infestation (14%), pneumonia (11%), urolithiasis (8%), mastitis (6%) and miscellaneous (4%) respectively. The prevalence of the different diseases in goat are presented in Fig. 1. Numerous species,

including bacteria, fungi, parasites, protozoa, rickettsia, and viruses, are thought to be the cause of goat diseases. Poor management practices and low-quality diets can also increase the risk of metabolic disorders, which can result in lower productivity and even mortality (Unigwe *et al.,* 2016). The current study found 40% incidence of PPR in goats among the viral illnesses, which is greater than previous investigations that found 13.72% and 13.74% prevalence of PPR in goats (Poddar *et al.,* 2018, Raquib *et al.,* 2020). However, Balamurugan *et al.,* (2014) found the prevalence of PPR was almost 45.2% in northeastern India. The resemblance could stem from comparable animal husbandry practices and regional distribution.

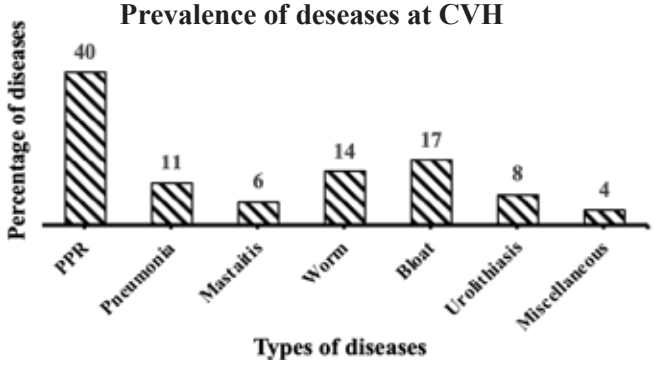

Fig. 1: Overall disease prevalence of goat studied at CVH.

In this study, among the bacterial diseases, pneumonia was recorded to be prevalent in around 11% of goats whereas it was observed 17.11% in Ethiopia (Mekibib *et al.,* 2019). Other studies reported a slightly lower prevalence 9.6% and 8.28% pneumonia in goats in Magura and Sylhet respectively (Karim *et al.,* 2014). It was reported that, the highest prevalence rate of pneumonia was recorded during winter (3.62%) (Sarder *et al.,* 2006). Since seasonal variation was not considered in this study; hence, the increased pneumonia rate in this study might be due to poor husbandry practices, infection of the lungs and a small sample number with diseased conditions.

Mastitis refers to an inflammation of the mammary glands due to a bacterial infection. Udder damage, often caused by mastitis, is one of the leading causes of culling in goat operations (Scharko, 2008). The findings of the present study showed 6% prevalence of Mastitis in goats. Hoque and Samad, (1997) stated that 10.14% mastitis cases in goats in the central Veterinary Hospital, Dhaka out of 1243 clinical cases. Other studies reported 1.6% mastitis in goat (Karim *et al.,* 2014), but in Eastern Algeria the prevalence of mastitis in goat was 3.55% which was Lower than the present study (Gabli *et al.,* 2019). Seasonal variation and breed types influence the mastitis prevalence in goats. The data variation of mastitis in this study is possible to influence by the breed and seasonal variation and geographic location along with scientific management of rearing systems.

Worm parasites pose a significant threat to the health of small ruminants. Parasites can damage the gastrointestinal tract, and result in reduced reproductive performance, reduced growth rates; less productive animals in terms of meat, fiber, and milk; and even death (Kate *et al.,* 2006). The present study showed that the prevalence of worm infestation was recorded almost 14% in goat. Proper deworming practices is recommended to maintain the animal health. The patient records considered in this study found lack of deworming practices regular interval hence animals become sick and come for treatment in the CVH.

Bloat is mainly a dietary in origin and occurs most frequently in ruminants in Bangladesh (Sutradhar *et al.,* 2000). The present study recorded almost 17% prevalence of bloat which was higher than earlier studies of Karim *et al.,* (2014) found 2.6% bloat case in goats at Upazila Veterinary Hospital, Mohammadpur, Magura. Location, availability of feed with its component and frequency of offering is highly related to bloat disease. The location of the present study is city area and the availability of feed

is rare. The highest prevalence rate of bloat in this study was seems to be considered due to improper feed management.

The overall prevalence of urolithiasis in goats was 8%. Hossain *et al.,* (1986) reported urolithiasis (5.3%) at the Veterinary Teaching Hospital of the Bangladesh Agricultural University from 1980 to 1984, which was little higher to this study. Mclntosh, (1978) recorded urolithiasis as a disease where dietary factors played a significant role. Rahman *et al.,* (1975) reported 8.6% urolithiasis in goats. The present study support the previous statement of the similar results regarding urolithiasis of goats.

Breed and variety wise disease prevalence of goat

The highest disease prevalence was observed in BBG (56.92%) and the least in crossbred (20%) as shown in Table 1. PPR prevalence has significant variation among the breeds (P<0.05). The morphological variants of BBG were solid black, Black with toggenberg, Black with dutch belt spotting, silver bezoar and brown bezoar. Morphological variants of BBG did not show any differences of disease prevalence. In BBG, the highest prevalence was found in PPR (26.15%). The breed and variety-wise disease prevalence of goats are presented in Table 1 and 2. Results shows that among the

Table 1. Breed-wise prevalence of clinical diseases of goat

Breed / Disease	Jamunapari No. (%)	Black Bengal No. (%)	Crossbred No. (%)	*P value*
PPR	6 (9.23)	17 (26.15)	3 (4.61)	0.002*
Pneumonia	1 (1.53)	3 (4.61)	3 (4.61)	0.565
Mastitis	-	3 (4.61)	1 (1.53)	0.223
Worm	2 (3.07)	5 (7.69)	2 (3.07)	0.368
Bloat	2 (3.07)	7 (10.76)	2 (3.07)	0.103
Urolithiasis	2 (3.07)	1 (1.53)	2 (3.07)	0.819
Others	2 (3.07)	1 (1.53)	-	0.368
Total	15 (23.07)	37 (56.92)	13 (20)	
Overall	65 (100%)			

*Statistically significant (P<0.05)

Table 2. Coat colour variants and disease prevalence of Black Bengal goat

Variety / Disease	Solid black No. (%)	Black with Toggenberg pattern No. (%)	Black with Dutch belt spotting No. (%)	Silver bezoar No. (%)	Brown bezoar No. (%)	*P value*
PPR	6 (9.23)	3 (4.61)	5 (7.69)	-	3 (4.61)	0.070
Pneumonia	2 (3.07)	-	-	-	1 (1.53)	0.255
Mastitis	1 (1.53)	1 (1.53)	-	-	1 (1.53)	0.736
Worm	3 (4.61)	-	1 (1.53)	-	1 (1.53)	0.199
Bloat	4 (6.15)	1 (1.53)	-	-	2 (3.07)	0.092
Urolithiasis	-	-	-	1 (1.53)	-	ND
Other	-	-	-	-	1 (1.53)	ND
Total (n=37)	16 (24.61)	5 (7.69)	6 (9.23)	1 (1.53)	9 (13.84)	

*Statistically significant (P<0.05)
ND: Not done

bacterial diseases, pneumonia are a common and serious disease in goats. The prevalence of pneumonia was considerably higher in BBG and crossbred (4.61%). Moreover, the prevalence of worm infestation was considerably higher in BBG (7.69%), Jamunapari (3.07%) and crossbred (3.07%). In North east India, the prevalence of PPR was detected as 45.2% which is higher than this study. This variation may be due to different geographical location and management system (Balamurugan *et al.,*

2014). Previous study showed that the prevalence of PPR was highest in winter (20.00%) and lowest in summer (8.40%) season (Raquib *et al.,* 2020). In this study the breed wise variation of PPR might be due to age factor, location and management issues.

Age-wise occurrence of diseases in goats

The no. of 65 goats was observed in which 18 were in 0-6 months, 33 were in 7-24 months and 14 were in over 24 months of age (Table 3). The most percentage was detected in 7-24 months (50.76%), and the least in over 24 months (21.53%). Bloat was significantly differ ($P<0.05$) among the age group of goats. This study illustrated that adult goats were more susceptible to disease prevalence than the young. Other studies represented that the young was more susceptible PPR than adult goat (Raquib *et al.,* 2020; Nath *et al.,* 2014; Sarker and Islam, 2011). However, a non-significant difference was observed among the other diseases of different age groups. The young animals might be more susceptible because of undernourishment, lack of immunity and poor husbandry. In this study, improper feeding management might be caused the metabolic disorder of adult animals.

Table 3. Age-wise prevalence of clinical diseases of goat

Age / Disease	0-6 Month No. (%)	7-24 Month No. (%)	>24 Month No. (%)	*P value*
PPR	8 (12.3)	14 (21.53)	4 (6.15)	0.054
Pneumonia	3 (4.61)	4 (6.15)	-	0.156
Mastitis	-	2 (3.07)	2 (3.07)	0.368
Worm	5 (7.69)	3 (4.61)	1 (1.53)	0.264
Bloat	1 (1.53)	8 (12.3)	2 (3.07)	0.020*
Urolithiasis	-	1 (1.53)	4 (6.15)	0.074
Other	1 (1.53)	1 (1.53)	1 (1.53)	1
Total	18 (27.69)	33 (50.76)	14 (21.53)	
Overall	65 (100%)			

*Statistically significant ($P<0.05$)
ND: Not done

Sex-wise occurrence of diseases in goats

In this study, goats were classified in male and female categories to find out sex sex-wise disease occurrence of goats. Among observed samples, 26 were male and 39 were female (Table 4). The highest percentage of disease occurrence was observed in females (60%) compared to male goats (40%). In males, the highest disease occurrence rate was PPR (13.84%), and the lowest in pneumonia (1.53%**).** In female**,** the highest occurrence rate was in PPR (26.15%). Male goats have higher (7.69%)

Table 4. Sex-wise prevalence of clinical diseases of goat

Sex / Disease	Male No. (%)	Female No. (%)	*P value*
PPR	9 (13.84)	17 (26.15)	0.117
Pneumonia	1 (1.53)	6 (9.23)	0.059
Worm	3 (4.61)	6 (9.23)	0.317
Bloat	5 (7.69)	6 (9.23)	0.763
Urolithiasis	5 (7.69)	-	ND
Others	3 (4.61)	-	ND
Total	26 (40)	39 (60)	
Overall	65 (100%)		

*Statistically significant ($P<0.05$)
ND: Not done

urolithiasis cases compared to female goats in the study area. Seasonal variation was observed in the prevalence of urolithiasis of goat by Raquib *et al.,* (2020) where it was estimated 3.82% in summer season followed by rainy (3.80%) and winter season (2.31%). Raquib *et al.,* (2020) also reported, earlier stage of age group (0-12 months) was found to be more (3.89%) susceptible than 13-24 months (1.85%) and above 24 months (3.39%) age group. Alternatively, other study reported higher prevalence of urolithiasis in goat (44.4%) in Magura, Bangladesh (Karim *et al.,* 2014). In this study, males patient have higher prevalence of urolithiasis seems supplied feed was not appropriate for the male animals. However, urolithiasis is a disease in which small calculi (often called 'stones' or 'crystals') form in the urinary tract and is likely linked to or certainly effected by diet. Urinary calculi or stones are caused by the precipitation of minerals. In goats, phosphate salts, often apatite (calcium phosphate) or more frequently struvite (magnesium ammonium phosphate hexahydrate), make up the calculi (Gutierrez *et al.,* 2000). Moreover, wethers are particularly vulnerable because their urethras the tubes that empty the bladder are often smaller than those of bucks. Although bladder stones can occur in does as well, they typically fit through the short, straight female urethra with ease. In this study the higher urinary stones in male goats support the previous statement for wethers and buck in the study area.

CONCLUSION

It was observed that goats came for treatment at veterinary hospital were mostly infected by viral, bacterial, worm infestation, and nutritional diseases. PPR, bloat, and urolithiasis is mostly found in the Dhaka city area. Disease prevalence also varied with some genetic and non-genetic factors such as breed, variety, age, and sex of the animals. It has been observed that the experimental study's duration and sample size are insufficient to fully examine the spectrum of illnesses and disorders. Therefore, more thorough research should be done to accurately ascertain the prevalence of diseases and abnormalities in goats in the studied area. However, these findings will assist to know about breed-wise, sex-wise, age-wise, and varieties-wise diseases of goat and will assist to application suitable way of prevention procedure against goat disease.

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Compliance with ethical statements
Conflict of interest: The authors declare that they have no conflict of interest.

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EFFECT OF SULPHUR AND ZINC FERTILIZERS ON THE GROWTH AND YIELD OF CHILI (BARI Morich 4)

N. J. Suny[1], H. Siddika[2] and M. A. Khan[3*]

ABSTRACT

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Dhaka, during the Rabi season from November 2021 to April 2022 to study the effect of sulphur (S) and zinc (Zn) fertilizer on green chili production (cv. BARI Morich 4). The experiment consisted of two factors, viz., Factor A: 3 levels of Sulphur (S_0: 0 kg ha^{-1}, S_1: 20 kg ha^{-1}, S_2: 30 kg ha^{-1}) and Factor B: three levels of zinc (Zn_0: 0 kg ha^{-1}, Zn_1: 2 kg ha^{-1} and Zn_2: 4 kg ha^{-1}). Two-factor experiments with Randomized Complete Block Design (RCBD) were followed with 9 treatment combinations and replicated three times. Vegetative growth, yield contributing characters, and yield were measured during the experiment. The growth and yield of BARI Morich 4 were significantly affected by different levels of S. The highest plant height (66.12 cm), number of leaves plant^{-1} (96.13), number of branches plant^{-1} (15.50) and the highest number of fruits plant^{-1} (104.57), flowers plant^{-1} (111.18), fruit length (7.10 cm), fruit diameter (0.56 cm), individual fruit weight (1.73 g), average fruit weight plant^{-1} (177.27 g), fruit yield ha^{-1} (28.21 t) were obtained from S_1 treatment. Similarly, the growth and yield were significantly affected by different rates of Zn fertilizer application. The highest plant height (66.06 cm), number of leaves plant^{-1} (92.61), number of branches plant^{-1} (14.76) and the highest number of flowers plant^{-1} (109.24), fruits plant^{-1} (98.81), fruit length (6.93 cm), fruit diameter (0.58 cm), individual fruit weight (1.69 g), average fruit weight plant^{-1} (169.05 g), fruit yield ha^{-1} (27.35 t) were recorded from Zn_2 treatment. Considering the combined effect of S and Zn, growth contributing parameters and yield were affected and the tallest plant (74.83 cm), maximum number of leaves plant^{-1} (101.32), maximum number of branches plant^{-1} (16.74), highest number of flowers plant^{-1} (121.26), maximum number of fruits plant^{-1} (114.09), highest fruit length (7.79 cm), highest fruit diameter (0.63 cm), highest individual fruit weight (1.78 g), average fruit weight plant^{-1} (203.49 g) and fruit yield ha^{-1} (33.52 t) were recorded from S_1Zn_2. Meanwhile, the lowest values of the parameters were found in the control application of sulphur and zinc. Therefore, it can be concluded that 20 kg ha^{-1} of sulphur and 4 kg ha^{-1} of zinc were found beneficial for the growth and yield of green chili in the soils of Madhupur Tract.

Keywords: Green chili, growth, sulphur, yield, zinc

INTRODUCTION

Chili (*Capsicum annum* L.) is a vital spice crop in the Solanaceae family, ranked 3rd after tomato and potato in significance. It's widely grown in Bangladesh, covering a large area and serving as a cash crop. Among the 20 species in the Capsicum genus, only 5 are cultivated, with *Capsicum frutescence* and *Capsicum annum* being the most common worldwide (Khan, 2014). *Capsicum frutescence*, known as hot peppers, contains an extra amount of alkaloid capsaicin ($C_{18}H_{27}O_3$) responsible for spiciness (Udoh *et al.*, 2005). Chili is a globally recognized spice, cultivated extensively in temperate, tropical, and subtropical regions. Its ground powder and oleoresin are used in pharmaceutical preparations (Warrier, 1989). Bangladesh produces around 79,747 metric tons of Rabi chili annually from 426,157 acres of land, with prominent cultivation in districts like Bogura, Rangpur, Kurigram, Natore, Jamalpur, and Jashore (BBS, 2019). In Bangladesh, farmers typically choose local chili cultivars that yield poorly due to factors like outdated techniques and inadequate fertilization. Achieving higher yields requires adopting modern practices and maintaining nutrient balance through proper fertilizer application. It is realized that the productivity of crops is being adversely affected in different areas due to deficiencies of micronutrients (Bose and Tripathi, 1996). The application of micronutrients can enhance growth attributes by boosting photosynthesis and metabolic activity. This can elevate plant metabolites responsible for cell division and elongation, as suggested by (Hatwar *et al.,* 2003). Sulphur is a plant nutrient with a crop requirement similar to that of phosphorus. Sulphur is known as the fourth

[1&2]M.S. Student, [3*]Correspondence author & Professor, Dept. of Soil Science, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh

major plant nutrient (Jamal *et al.*, 2010). Sulfur (S) is one of the essential macro elements of plants and is regarded as the fourth key element after N, P, and K (Lewandowska and Sirko, 2008). Sulfur is essential for synthesizing crucial amino acids, increasing specific alkaloids like allyl propyl disulphide (43% S) and capsaicin – the main pungency compound in onion and sweet pepper. Additionally, sulfur aids plant defense against stress, and pests, and enhances chlorophyll and vitamin synthesis (Hasseneen, 1992). It has been observed when Sulphur is present in a critical amount of soil (less than 10 ppm), the plant growth, quality, and total production of the crop are adversely affected (Jones *et al.*, 1984). Zinc is crucial for successful green chili growth, impacting nitrogen metabolism, photosynthesis, protein quality, and resistance to environmental and biological challenges in plants (Potarzycki and Grzebisz, 2009). Zinc plays a crucial role in the activation of enzymes involved in sulphur metabolism, such as adenosine-5'-phosphosulfate reductase (APR). This enzyme catalyzes the reduction of adenosine-5'-phosphosulfate (APS) to sulfite, which is a key step in sulphur assimilation. Zinc deficiency can limit the activity of APR, impairing the plant's ability to utilize sulphur effectively. This can result in reduced synthesis of essential sulphur-containing compounds like cysteine and methionine. Sulphur availability in the soil can affect the solubility and bioavailability of zinc. Adequate sulphur levels can enhance zinc availability by maintaining an optimal soil pH and promoting the formation of soluble zinc-sulphur complexes. The research was conducted to find out the suitable doses of Sulphur and Zinc for the growth and yield of chili.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, during the period From November 2021 to April 2022. The soil of the experimented field belongs to the Tejgaon series under the Agro-Ecological Zone, AEZ-28 (Madhupur Tract). In this series general soil type is shallow deep red-brown terrace soil. A composite sample was made by collecting soil from several spots of the field at a depth of 0-15 cm before the initiation of the experiment. The collected soil was air-dried, ground, and passed through a 2 mm sieve and analyzed for some important physical and chemical parameters. Soil pH was determined by the glass-electrode pH meter method (Jackson, 1958) and the wet oxidation method was used for determining soil organic carbon (Walkley and Black, 1934). The available P and S were determined by sodium bicarbonate extraction (Olsen *et al.,* 1954) and Calcium chloride extraction method (Houba *et al.,* 2000). The morphological characteristics of the experimental field and initial physical and chemical characteristics of the soil are presented in Tables 1, and 2, respectively. Chili (cv. BARI Morich 4) was used as an experimental crop. The two factors experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. There were 27 unit plots altogether in the experiment. The size of each plot was 3.0 m × 1.75 m. The experiment consisted of three levels of S (S_0 = 0 kg ha^{-1}, S_1 = 20 kg ha^{-1}, S_2 = 30 kg ha^{-1}) and three levels of Zn (Zn_0 = 0 kg ha^{-1}, Zn_1 = 2 kg ha^{-1}, Zn_2 = 4 kg ha^{-1}). Gypsum and Zinc sulphate monohydrate ($ZnSO_4.H_2O$) were used as the source of sulphur and zinc respectively. There were nine treatment combinations such as S_0Zn_0, S_0Zn_1, S_0Zn_2, S_1Zn_0, S_1Zn_1, S_1Zn_2, S_2Zn_0, S_2Zn_1, S_2Zn_2. The N, P, K, and B nutrients were applied through Urea, Triple superphosphate (TSP), Muriate of Potash (MoP), and Boric acid respectively. The N, P, K, and B were applied according to Fertilizer Recommendation Guide, 2018. One-third of the whole amount of Urea, and the full amount of Cowdung as manure, TSP, MoP, and Boric acid were applied at the time of final land preparation. The remaining Urea was top dressed in two equal installments - at 20 days after transplanting (DAT) and 50 DAT respectively. In November 2021, a seedbed of 3 m × 1 m was prepared for green chili seedlings. The soil was well ploughed, cleared of weeds and debris, and enriched with cow dung at 10 t/ha. To prevent ant and cutworm attacks, Sevin 50WP was applied at 5 kg/ha. For seed-borne disease protection, seeds were treated with Vitavex-200 at 5 g per 1 kg of seeds. No chemical fertilizers were applied for the raising of seedlings. Healthy and 30 days old seedlings were transplanted into the experimental field on December 2021. Seedlings were transplanted in the plot and the distance maintained between row to row and plant to plant were 50 cm and 60 cm, respectively and a total of 15

plants were accommodated in each plot. After raising seedlings, various intercultural operations, such as gap filling, weeding, earthing up, irrigation pest and disease control, etc. were accomplished for better growth and development of the chili seedlings. Fruits were harvested at 6 to 7 days intervals during the early ripe stage when they attained marketable size. Harvesting was started in mid-March, 2022 and was continued up to mid-April, 2022. Five plants were selected randomly from each plot for data collection. The recorded data on various parameters were statistically analyzed using MSTAT-C statistical package program. The mean for all the treatments was calculated and an analysis of variance for all the characters was performed difference between treatment means was determined by Duncan`s Multiple Range Test (DMRT) according to Gomez and Gomez, (1984) at a 5% level of significance.

Table 1. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Agronomy farm, SAU, Dhaka
AEZ No. and name	AEZ-28, Madhupur Tract
General soil type	Shallow Red Brown Terrace Soil
Soil series	Tejgaon
Topography	Fairly leveled
Depth of inundation	Above flood level
Drainage condition	Well drained

Table 2. Physical and chemical properties of the initial soil of the experimental field

Physical properties	**Values**
%Sand (2-0.02 mm)	30%
%Silt (0.02-0.002 mm)	40%
%Clay (<0.002 mm)	30%
Textural class	Clay loam
Particle density	2.57 g cc^{-1}
Chemical properties	**Values**
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.06
Available P(ppm)	20.0
Available S(ppm)	14.7

RESULTS AND DISCUSSION

Effect of S on the growth parameters of Chili

Different levels of S had significant effects on various growth parameters of Chili. Results showed that in terms of the S effect, the highest plant height, leaves $plant^{-1}$, and number of branches $plant^{-1}$ were recorded from S_1 (20 kg S ha^{-1}) treatment. On the other hand lowest plant height, leaves $plant^{-1,}$ and branches $plant^{-1}$ were found from the control treatment, S_0 (0 kg S ha^{-1}).

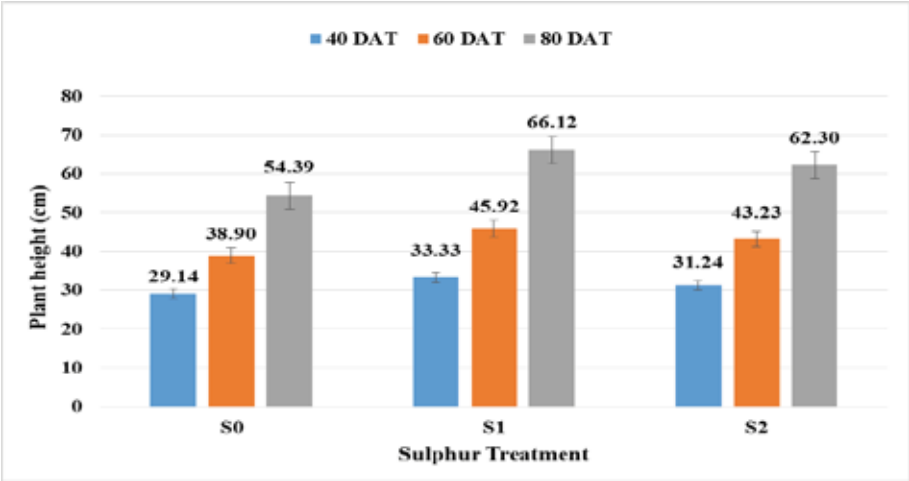

Fig. 1. Effect of sulphur on the plant height of chili at different DAT

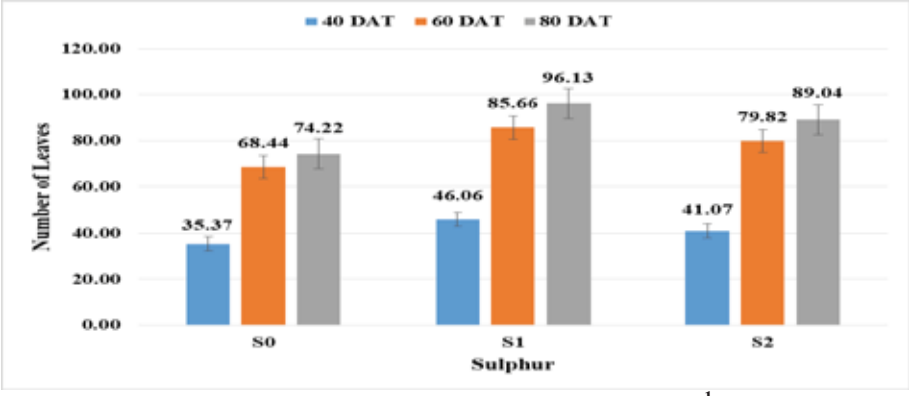

Fig. 2. Effect of sulphur on the number of leaves plant^{-1} at different DAT

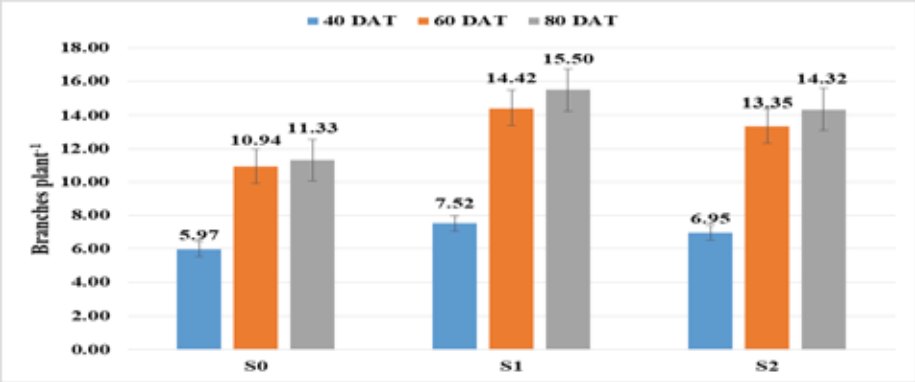

Fig. 3. Effect of sulphur on the number of branches plant^{-1} at different DAT

Effect of S on the yield contributing parameters and yield of Chili

Different levels of S had significant effects on various yield-contributing parameters of Chili. The highest number of flowers plant^{-1} (111.18), number of fruits plant^{-1} (104.57), fruit length (7.10 cm), fruit diameter (0.56 cm), individual fruit weight (1.73 g), average fruit weight plant^{-1} (177.27 g), and

fruit yield ha^{-1} (28.21 t) were recorded at S_1 (20 kg S ha^{-1}). In comparison, the lowest number of flowers plant^{-1} (92.45), fruits plant^{-1} (76.29), fruit length (6.04 cm), fruit diameter (0.41 cm), individual weight of fruits (1.51 g), average fruit weight plant^{-1} (119.99 g), and fruit yield ha^{-1} (18.54 t) were obtained from control treatment, S_0 (0 kg S ha^{-1}).

Table 3. Effect of different levels of sulphur application on yield contributing parameters and yield of chili

Treatment	Flowers plant^{-1}	Fruits plant^{-1}	Fruit length (cm)	Fruit diameter (cm)	Individual fruit weight (g)	Average fruits weight plant^{-1} (g)	Fruit yield (t ha^{-1})
S_0	92.45 c	76.29 c	6.04 b	0.41 b	1.51 b	119.99 c	18.54 c
S_1	111.18 a	104.5 a	7.10 a	0.56 a	1.73 a	177.27 a	28.21 a
S_2	102.67 b	96.48 b	6.62 a	0.53 a	1.64 a	159.75 b	25.41 b
Level of significance	**	**	*	*	*	**	**
SE(±)	0.66	0.79	0.15	0.01	0.02	2.90	0.15
CV %	8.14	12.29	9.31	13.58	5.72	7.39	5.04

In a column means having a similar letter(s) are statistically identical and those having a dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, S_0 = 0 kg ha^{-1}, S_1 = 20 kg ha^{-1}, S_2 = 30 kg ha^{-1},SE (±) = Standard Error ; CV (%) = Coefficient of variation

Effect of Zn on the growth parameters of Chili

Different levels of Zn had significant effects on various growth parameters of Chili. Results indicated that the highest plant height, number of leaves plant^{-1}, and number of branches plant^{-1} were obtained from Zn_2 (4.0 kg Zn ha^{-1}). On the other hand, the lowest plant height number of leaves plant^{-1}, and number of branches plant^{-1} were found from control treatment, Zn_0 (0 kg Zn ha^{-1}).

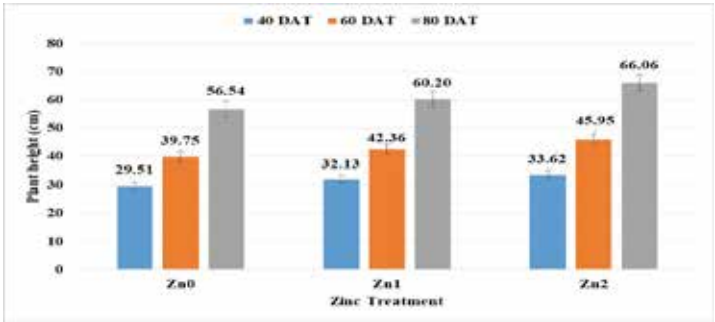

Fig. 4. Effect of Zinc on the plant height of chili at different DAT

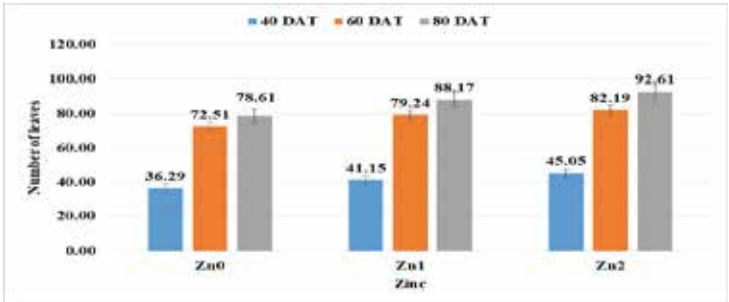

Fig. 5. Effect of zinc on the number of leaves plant^{-1} at different DAT

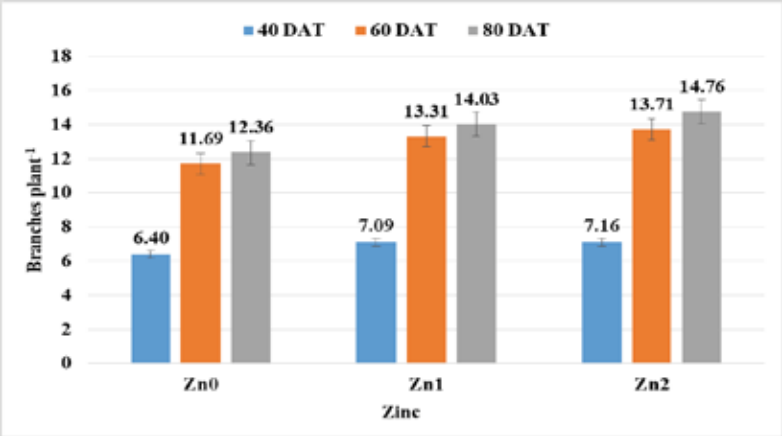

Fig. 6. Effect of zinc on the number of branches plant^{-1} at different DAT

Effect of Zn on the yield contributing parameters and yield of Chili

In the case of different levels of Zn fertilizer application, the highest number of flowers plant^{-1} (109.24), number of fruits plant^{-1} (98.81), fruit length (6.93 cm), fruit diameter (0.58 cm), individual fruit weight (1.69 g), average fruit weight (169.05 g), fruit yield ha^{-1} (27.35 t) were found at Zn_2 (4 kg Zn ha^{-1}). Whereas the lowest number of flowers plant^{-1} (94.64), number of fruits plant^{-1} (80.26), length of fruit (6.01cm), fruit diameter (0.43 cm), individual weight of fruits (1.48 g), average fruit weight (126.99 g), fruit yield ha^{-1} (19.88 t) were found from the control treatment Zn_0 (0 kg Zn ha^{-1}) (Table 4).

Table 4. Effect of different levels of Zinc application on yield contributing parameters and yield of chili

Treatment	Flowers plant^{-1}	Fruits plant^{-1}	Fruit length(cm)	Fruit diameter(cm)	Individual fruit weight (g)	Average fruits weight plant^{-1} (g)	Fruit yield (t ha^{-1})
Zn_0	94.64c	80.26b	6.01b	0.43b	1.48b	126.99c	19.88c
Zn_1	102.41b	98.26ab	6.45 a	0.52a	1.65a	160.97b	24.94b
Zn_2	109.24a	98.81a	6.93a	0.58a	1.69a	169.05a	27.35a
Level of significance	**	**	*	**	*	**	**
SE(±)	0.66	0.79	0.15	0.01	0.02	2.90	1.59
CV %	8.14	12.29	9.31	13.58	5.72	7.39	5.04

In a column means having a similar letter(s) are statistically identical and those having a dissimilar letter(s) differ significantly as per 0.05 level of probability. Zn_0 = 0 kg ha^{-1}, Zn_1 = 2 kg ha^{-1}, Zn_2 = 4 kg ha^{-1} SE (±) = Standard Error; CV (%) = Coefficient of variation

Combined effects of S and Zn Effect of S and Zn on growth parameters of Chili

In the case of, the interaction effect of S and Zn results signified that the highest plant height was observed from S_1Zn_2. Statistically identical results were observed from Sn_2Zn_2 at 40 and 60 DAT. On the other hand, the shortest plant height was recorded from the S_0Zn_0 treatment combination. The maximum number of leaves plant^{-1} was recorded from S_1Zn_2 which was closely followed by S_2Zn_2 at 60 and 80 DAT, whereas the minimum number of leaves plant^{-1} was observed from S_0Zn_0 followed by S_0Zn_1 at 40 and 60 DAT. The highest number of branches plant^{-1} was observed from S_1Zn_2 while the lowest number of branches plant^{-1} was recorded from S_0Zn_0 statistically similar to S_0Zn_1.

Table 5. Combined effects of S and Zn Effect of S and Zn on growth parameters of Chili

Treatment	Plant Height (cm)			number of leaves plant^{-1}			number of branches plant^{-1}		
	40 DAT	60 DAT	80 DAT	40 DAT	60 DAT	80 DAT	40 DAT	60 DAT	80DAT
S_0Zn_0	25.81 i	36.76 hi	51.51 i	32.24 h	64.52 h	68.57 hi	5.70 gh	10.36 g	10.48 gh
S_0Zn_1	29.08 h	37.38 gh	54.60 h	35.63 gh	70.27 g	72.46 h	5.99 g	10.64 fg	10.72 g
S_0Zn_2	32.95 de	41.40 e	59.43 ef	39.72 e	78.26 def	88.55 e	6.64 def	13.32 d	14.18 e
S_1Zn_0	33.04 cde	43.77 de	61.91 d	42.74 d	80.32 cd	93.54 d	6.82 de	13.78 cd	14.63 de
S_1Zn_1	33.30 cd	46.54 c	64.09 bcd	43.55 cd	83.68 bc	94.86 cd	7.16 c	14.43 bc	15.57 cd
S_1Zn_2	35.39 a	50.76 a	74.83 a	53.37 a	92.34 a	101.32 a	8.82 a	15.52 a	16.74 a
S_2Zn_0	29.69 gh	38.54 fgh	57.05 g	36.90 g	75.47 ef	78.70 fg	6.28 fg	11.39 f	12.42 f
S_2Zn_1	32.53 def	40.47 ef	58.70 efg	38.22 f	77.52 de	81.63 f	6.57 ef	11.82 ef	12.78 f
S_2Zn_2	34.02 ab	48.55 ab	66.30 bc	45.07 b	87.12 ab	98.51 ab	7.38 bc	14.88 ab	15.92 bc
Level of significance	*	*	*	*	*	*	*	**	**
SE (±)	1.04	2.38	1.58	1.37	1.27	1.40	0.43	0.30	0.30
CV (%)	5.98	9.15	4.52	2.85	6.16	2.69	8.66	4.34	4.07

In a column means having a similar letter(s) are statistically identical and those having a dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, S_0 = 0 kg ha^{-1}, S_1 = 20 kg ha^{-1}, S_2 = 30 kg ha^{-1} and Zn_0 = 0 kg ha^{-1}, Zn_1 = 2 kg ha^{-1}, Zn_2 = 4 kg ha^{-1}, SE (±) = Standard Error ; CV (%) = Coefficient of variation

Effect of S and Zn on yield contributing parameters and yield of Chili

In the case of, the interaction effect of S and Zn results revealed that the highest number of flowers plant^{-1} (121.26), fruits plant^{-1} (114.09), fruit length (7.79 cm), fruit diameter (0.63 cm), fruit weight (1.78 g), highest average fruit weight (203.49 g), and the highest fruit yield ha^{-1} (33.52 t) was recorded in the treatment combination of S_1Zn_2. On the other hand, the lowest number of flowers plant^{-1} (88.07), number of fruits plant^{-1} (66.26), fruit length (5.90 cm), fruit diameter (0.37 cm), fruit weight (1.51 g), average fruit weight (99.96 g), and fruit yield ha^{-1} (15.59 t) was observed from S_0Zn_0 treatment.

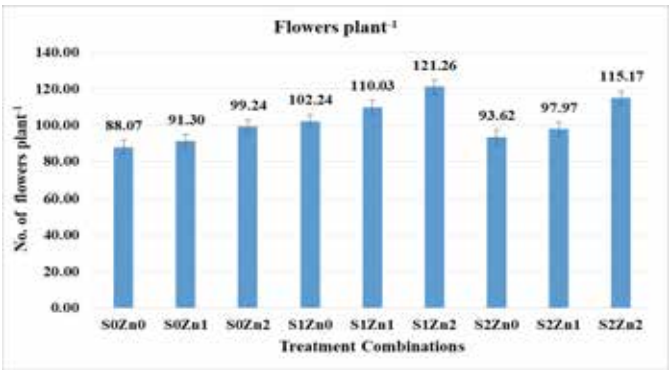

Fig. 7. Combined effect of S and Zn on the number of flowers plant^{-1} of chili

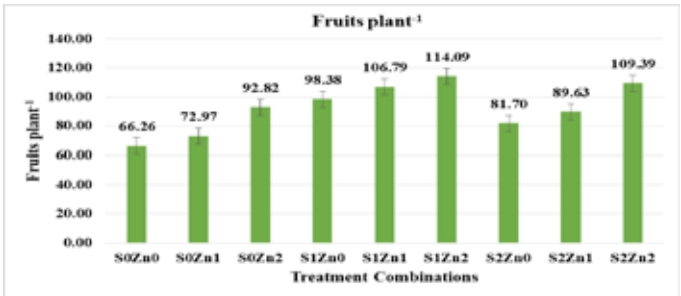

Fig. 8. Combined effects of S and Zn on the number of fruits plant^{-1} of chili

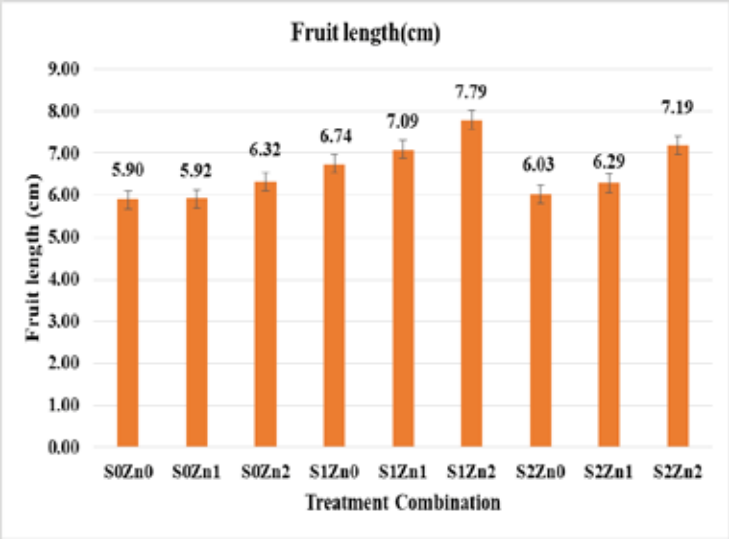

Fig. 9. Combined effects of S and Zn on the number of fruit lengths of chili

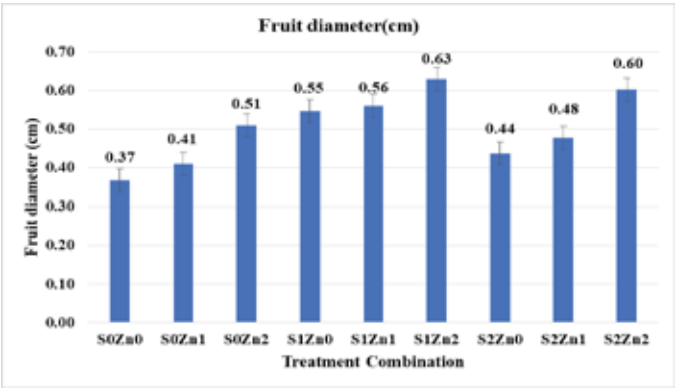

Fig. 10. Combined effects of S and Zn on the number of fruit diameter of chili

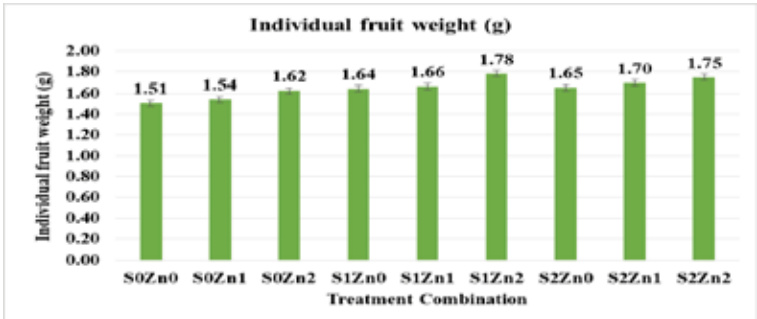

Fig. 11. Combined effects of S and Zn on individual fruit weight of chili

Table 6. Combined Effect of S and Zn on average fruit weight plant^{-1} and fruit yield ton ha^{-1}

Treatment	Average fruit weight plant^{-1} (g)	Fruit yield (t ha^{-1})
S_0Zn_0	99.96 i	15.59 h
S_0Zn_1	112.51 h	17.83 gh
S_0Zn_2	150.62 ef	23.43 de
S_1Zn_0	157.72 de	24.91 cde
S_1Zn_1	177.69 cd	27.69 bc
S_1Zn_2	203.49 a	33.52 a
S_2Zn_0	130.39 g	20.62 ef
S_2Zn_1	147.50 efg	22.21 e
S_2Zn_2	191.15 ab	30.70 ab
Level of significance	**	**
SE	5.03	.27
CV (%)	7.39	5.04

In a column means having a similar letter(s) are statistically identical and those having a dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, S_0 = 0 kg ha^{-1} , S_1 = 20 kg ha^{-1}, S_2 = 30 kg ha^{-1}, Zn_0 = 0 kg ha^{-1} , Zn_1 = 2 kg ha^{-1} , Zn_2 = 4 kg ha^{-1}, SE (±) = Standard Error; CV (%) = Coefficient of variation

CONCLUSION

The individual effect of S and Zn on the growth and yield of chili plants were found significant in this study. In the case of sulphur (S) application, S_1 treatment (20 kg S ha^{-1}) was found suitable dose which gave the highest yield (28.21 t ha^{-1}). In the case of zinc (Zn) application, Zn_2 treatment (4 kg Zn ha^{-1}) was a suitable dose that gave the highest yield (27.35 t ha^{-1}). Finally, for the interactive effect of sulphur (S) and zinc (Zn), the S_1Zn_2 treatment combination (20 kg S ha^{-1} with 4 kg Zn ha^{-1}) was found most suitable dose which gave the highest yield (33.52 t ha^{-1}).

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THE EFFECT OF GALLS FORMED BY TRICHILOGASTER ACACIAELONGIFOLIAE ON THE VEGETATIVE GROWTH OF INVASIVE ACACIA LONGIFOLIA SUBSPECIES LONGIFOLIA IN AUSTRALIA

M. R. Islam[1*], W. Wright[2], G. Palmer[3] and H. Hira[4]

ABSTRACT

A study was conducted to observe the effectiveness of galls by *Trichilogaster acaciaelongifoliae* on the vegetative growth of *Acacia longifolia* subspecies *longifolia* at six study locations in the Greater Grampians (GGr) Bioregion of Victoria, Australia during a study period from September 2014–December 2016. The results of this study have showed that galls formed by *Trichilogaster acaciaelongifoliae* on *Acacia longifolia* subspecies *longifolia* plants have negative impacts on vegetative growth of *Acacia longifolia* subspecies *longifolia* growing in the native home range of the weed, however it is not sufficient to reduce the invasive spread of the plant. An integrated weed management approach is required to control the invasive weed *Acacia longifolia* subspecies *longifolia*.

Keywords: Infestation intensity, phyllodes, sub-branches, environmental weed, biological control

INTRODUCTION

Trichilogaster acaciaelongifoliae (Froggatt) (*T. acaciaelongifoliae*) is a hymenopteran wasp, origin in Australia found in the galls on *Acacia longifolia* subspecies *longifolia* (*A. l. longifolia*) (Dennill *et al.,* 1999). Haiden *et al.* 2012 explains that galls develop because a stimulus from the insect alters normal physiological processes within the plant. The redirection of resources associated with the formation of galls impair vegetative growth of the host plant (Fernandes *et al.,* 2012). For example, in a case study from South Africa, *Trichilogaster signiventris* causes the development of galls on vegetative parts of *Acacia pycnantha.* Normal growth of the plant is hampered by the redirection of plant resources (Dorchin *et al.,* 2006).

Among the numerous examples of negative effects on plant growth, due to the formation of galls is a study by Klöppel *et al.* (2003), which showed that galls formed by the cynipid wasp, *Aulacidea subterminalis*, have a significant impact on growth of the grassland weed *Hieracium pilosella*. The negative effects of galls on plant growth and reproduction have been successfully used to help control pest plants in some instances. The eurytomid wasp *Eurytoma attiva* (Burks) has been successfully used to control black sage, *Cordia curassavica* Jacq. (R & S) in Mauritius as it damages the reproductive parts of the plant and prevents reinvasion of the weed in areas that have been difficult to manage the weed. This gall-forming wasp has also been used successfully in Malaysia and Sri Lanka to control the black sage (Cock *et al.,* 1985).

Biological control of weeds can be an effective strategy for long-term restoration of native ecosystems (Richardson and Kluge, 2008; Wilson *et al.,* 2011). *T. acaciaelongifoliae* has been applied as a biological control agent to manage introduced, invasive *A. l. longifolia* populations in South Africa (Hoffmann *et al.,* 2002), where both the wasp and the plant are introduced.

A. l. longifolia is regarded as a significant environmental weed in its native distribution in several Australian states (Luke *et al.,* 2008; Thomson, 2016; Milkins, 2017), where it co-occurs naturally with *T. acaciaelongifoliae,* While it is apparent that the wasp is not acting to control *A. l. longiofolia* in these areas- (since populations of the plant continue to spread) (Milkins, 2017), it is not understood whether this is because galls formed by the wasp do not negatively affect the plant in its native home range.

[1*]Correspondence author & Associate Professor, Dep. of Entomology, Sher-e-Bangla Agricultural University and PhD Fellow, Environmental Science, Federation University Australia, [2]Professor, Conservation Biology, [3]Senior Lecturer, [4]PhD Fellow and Research Associate, Environmental Science, Federation University Australia.

Therefore, the aim of this study is to test whether reduced vegetative growth in *A. l. longifolia* occurs due to galls formed by *T. acaciaelongifoliae* in the Australian context.

MATERIALS AND METHODS

Study area

Measurements of the growth of *A. l. longifolia* were made at six study locations in the Greater Grampians (GGr) Bioregion of Victoria, Australia during a study period from September 2014–December 2016, where PP1 = Public Property 1, PP2 = Public Property 2, PP3 = Public Property 3, PV4 = Parks Victoria 4, PV5 = Parks Victoria 5 and PV6 = Parks Victoria 6.

Data collection

The methods for data collection and analysis were derived by some modification of methods used by Impson *et al*. (2013) and Hartnett and Abrahamson (1979).

Infestation intensity

The intensity of infestation of *A. l. longifolia* plants by *T. acaciaelongifoliae* was assessed once, at the beginning of the study period in September 2014. The intensity of infestation was calculated by positioning a $25m^2$ quadrat (considering the plant density and plant canopy of *A.l. longifolia* in the study locations) pseudo-randomly within each of the six study locations and assessing the number of *A. l. longifolia* plants present within the quadrat, noting how many plants bore galls. Infestation intensity was calculated as the number of *A. l. longifolia* plants bearing galls divided by the total number of *A. l. longifolia* plants present in each (5x5) = 25 m^2 area; expressed as a percentage.

Vegetative growth

In order to understand the effects of the presence of galls on the growth of *A. l. longifolia*, three galled and three un-galled mature *A. l. longifolia* plants were selected at of the six study locations (*N*=36). One branch of each selected tree was tagged and several parameters were measured on these branches at monthly intervals throughout the study period to provide proxy measures of growth of *A. l. longifolia*. Each branch was considered to be comprised of many (usually 3-12) sub-branches and was chosen based on size (1.5 to 2.5 m long). Initially, the length of galled and ungalled branches were roughly equal in size. For several parameters, sub-branches were used instead of branches as this was more practical and provided a larger data set for analysis.

Branch and sub-branch length

Plant growth parameters measured were: Branch and sub-branch length: measured every month for the first year but only every second month for the second year of the study due to consistent trends of the data.

Phyllodes

Phyllodes serve the same function as the leaves of other plants (i.e. photosynthesis). As in other members of the *Acacia* genus, the petioles of *A. l. longifolia*, are flattened and widened to form leaf-like structures known as phyllodes (Plate 3). Anatomically, leaves comprise lamina, petiole and leaf base. In Acacias, the modified petiole performs as leaf. Number of phyllodes per sub-branch: measured every month throughout the first year of the study. The effect of galls on the vegetative of *A. l. longifolia* was assessed by comparing the parameters described above for galled and ungalled trees.

Data analysis

All data analysis was conducted using SPSS Statistics Version 22, with reference to Allen *et al.* (2014). A chi-squared test was performed to assess whether infestation intensity differed significantly across locations. Assumptions of independence and expected frequencies were checked and found not to have been violated (Allen *et al.,* 2014).

RESULTS AND DISCUSSION

Infestation intensity

Infestation of *A. l. longifolia* by *T. acaciaelongifoliae* was observed across all study locations at the beginning of the study period. The highest proportion of infested trees (83.3%) was found at location

PP1 (Table 1), a private property densely covered by *A. l. longifolia* plants known to be more than three years of age. The lowest proportion of infested trees (42.9%) was found at location PP2 (Table 1).

Table 1. Percent infestation of *A. l. longifolia* by *T. acaciaelogifoliae* in 25m^2 quadrats assessed at six study locations in the Greater Grampians Bioregion, Victoria, Australia in September 2014.

Locations	Total number of *A. l. longifolia* plants in 25 m^2	Number of *A. l. longifolia* plants infested by *T. acaciaelongifoliae* in 25 m^2	Percent infestation (%) of *A. l. longifolia* plants by *T. acaciaelongifoliae* in 25 m^2
PP1	18	15	83.3
PP2	14	6	42.9
PP3	9	5	55.6
PV4	15	9	60.0
PV5	12	9	75.0
PV6	11	6	54.5

The proportion of trees affected by *T. acaciaelongifoliae* was more than 50% at all four other study locations; and the chi-squared test indicated no significant differences in infestation intensity between the locations (p=1.00). With the exception of PP1, all locations were covered by a mix of *A. l. longifolia* and other native vegetation; locations PV4 and PV5 had been recently invaded by *A. l. longifolia* plants, following a fire in 2014 (Milkins, 2017) enhanced germination of the *A. l. longifolia* seeds. Its spread has impeded the germination and growth of other native plants in these locations. *A. l. longifolia* trees with more branches and more flower buds may provide greater opportunities for *T. acaciaelongifoliae* infestation (PP1) since these structures are thought to be preferred by the wasp for egg deposition. *T. acaciaelongifoliae* shows a preference for flower or twig buds on younger branches of *A. l. longifolia* plants for egg deposition (Islam, 2022). Such branches are more common at locations PV4 and PV5 (Plate 1).

(A) **(B)**

Plate 1. Abundance of younger branches of *A. l. longifolia* in the study locations PV4 (A) and PV5 (B).

The impact of galls on growth

The impact of galls formed by *T. acaciaelongifoliae* on the vegetative growth of *A. l. longifolia* was evaluated by measuring sub-branch length (growth rate) per branch and numbers of phyllodes per sub-

branch at six different locations throughout the study period and comparing these measures for galled and ungalled branches.

Plate 2. Sub-branches of *A. l. longifolia* with galls (inset photo of gall at a month of age) formed by *T. acaciaelongifoliae* (white colour) and without galls (red colour) in the study location in the Greater Grampians Bioregion, Victoria, Australia.

The effects of galls on the length of sub-branches

Initially, the average length of galled and ungalled branches of *A. l. longifolia* were roughly equal in size (Plate 2), however, the average length of ungalled branches increased over the time compare to galled branches (Fig. 1).

The average length of galled sub-branches (mean length, M=94.98 cm; standard deviation, SD=13.63 cm) were significantly shorter than ungalled sub-branches (mean length, M=117.37 cm; standard deviation, SD=25.9 cm) of *A. l. longifolia* at the end of the study F(1, 24)=47.39, p<.005, partial η^2 =.66. The partial η^2, indicates that the presence of galls has a large effect on the length of galled sub-branches (Fig.1) at different locations. However, there were no significant effects of location on the length of sub-branches F(5, 24)=1.87, p=.137, partial η^2 =.281 and no significant interaction between treatments (galled/ungalled) and locations *F*(5, 24)=0.364, *p*=.868, partial η^2 =.071.

Not surprisingly, time (the months of the study period) explains a great deal of the variation in the lengths of both galled and ungalled sub-branches (galled and ungalled) of *A. l. longifolia*. All sub-branches increased in length over time *F*(17, 408)=2202.55, *p*<.001, partial η^2 =.99), however galled branches increased at a slower rate than ungalled branches F(1, 24)=47.39, p<.005, partial η^2 =.66). A slower growth rate in galled sub-branches is implied by a significant combined effect of time and the presence of galls on the length of sub-branches F(17, 408)=563.01, p<.001, partial η^2 =.96. The effect

size of changes in the length of the sub-branches over time was almost five times higher (η^2 =.77) in ungalled branches than galled branches (η^2 =.15) of *A. l. longifolia* (Fig. 1).

Seasonal differences in growth were also evident; and were also influenced by the presence of galls. Mean lengths of galled sub-branches did not differ significantly from their initial lengths (measured in September 2014) until after January 2015 when season growth began (Post hoc comparisons using the LSD test with α=.05; M=90.95 cm, SD=11.31 cm).

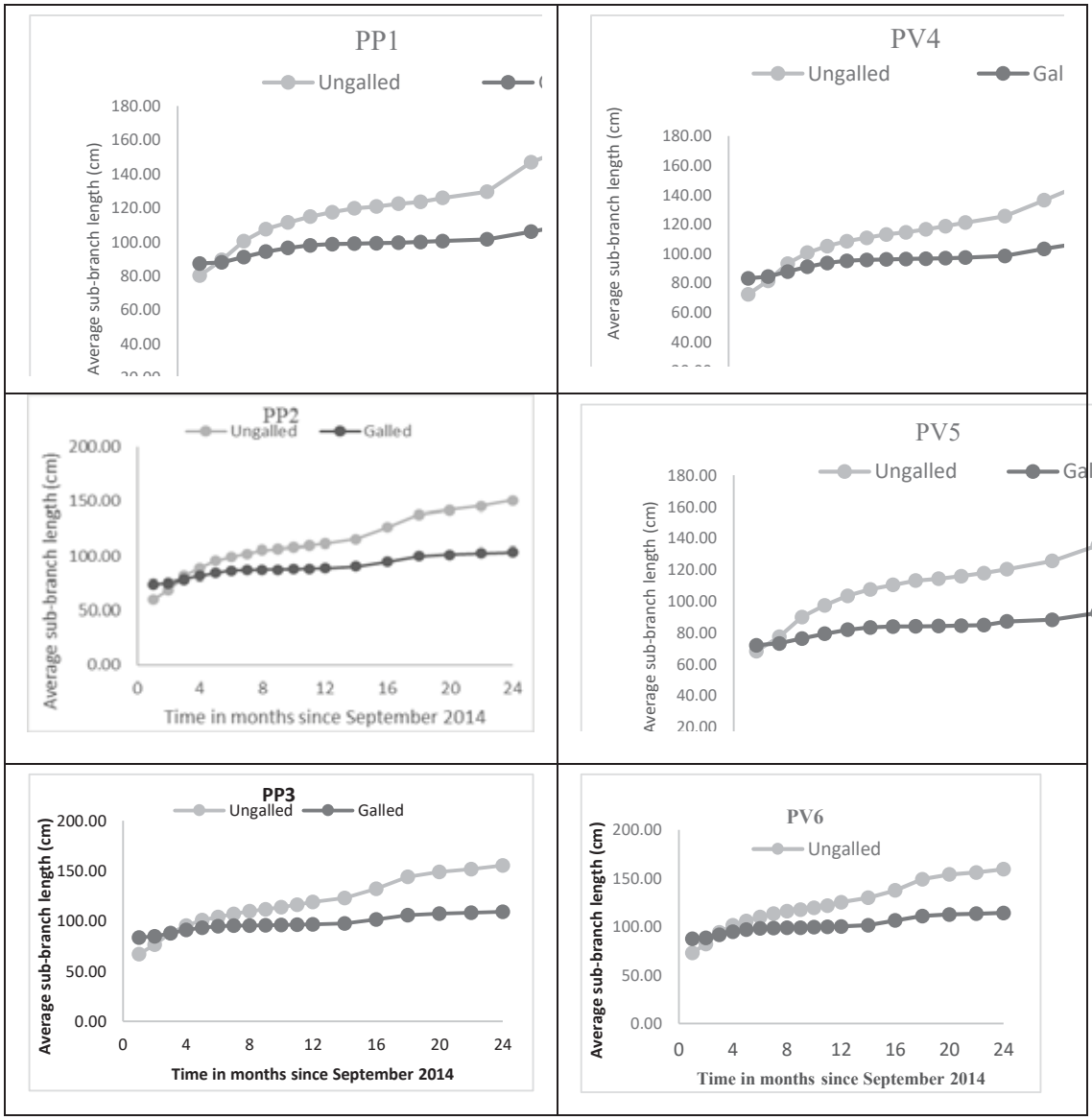

Fig. 1. Monthly variations in the average length of sub-branches of *A. l. longifolia* with galls formed by *T. acaciaelongifoliae* and of un-galled sub-branches during a two-year period from September 2014 to August 2016 at six different study locations (1-6, PP= private property, PV= Parks Victoria and indicates the Grampians National Park) in the Greater Grampians Bioregion, Victoria, Australia..

The galls produced by *T. acaciaelongifoliae* reduced the vegetative growth of *A. l. longifolia*. Although galled sub-branches consistently showed lower growth rates than ungalled sub-branches, the extent of the difference in growth rate between galled and ungalled sub-branches varied across the six locations. Location PP1 supported older stands of *A. l. longifolia* compared to other locations (although there were some younger *A. l. longifolia* present). The initial (measured in September 2014) average length, of galled sub-branches at location PP1 was 87.59cm (Fig. 1). These galled sub-branches increased their average length by only 26.57 cm over the two-year study period (Fig. 1). On the other hand, the initial average length of un-galled sub-branches at location PP1 was 72.89 cm. These branches grew at a rate of approximately three times higher than galled branches in the same location, reaching an average length of 159.40 cm by August 2016 (Fig. 1).

The greatest differences in length between galled and ungalled sub-branches were found at locations PV5 and PV4, (57.6 cm and 53.90 cm) respectively, where younger *A. l. longifolia* were the most common. It is possible that the age of the plant may influence the rate of sub-branch growth; this was not tested here, and there was no bias in the age of plants selected for galled and ungalled groups in this study. Galled branches grow more slowly than those without galls and the reduced growth rate observed in galled branches is likely to be due to galls acting as nutrient sinks (Dennill, 1985). Such effects have also been shown for other insect-plant relationships. For example, Shaw *et al.* (2009) showed that a psyllid, *Aphalara itadori* Shinji reduced vegetative growth of *Fallopia japonica* (Houtt) in the UK. *Fallopia japonica* is an invasive weed in the UK, North America and greater Europe.

The effect of galls on number of phyllodes

The number of phyllodes per sub-branch of *A. l. longifolia* did not differ significantly across the six study locations ($F(5, 24)=0.77$, $p=.58$, partial $\eta^2=0.14$).

Plate 3. Phyllodes on the sub-branch of *A. l. longifolia* act as leaves in the photosynthetic process.

There was no significant interaction between treatment (presence/absence of galls) and locations ($F(5, 24)=.79$, $p=.56$, partial $\eta^2 = 0.14$); however the presence of galls had an effect on the number of phyllodes per sub-branch of *A. l. longifolia* $F(1, 24)=322.64$, $p<.001$, partial $\eta^2=0.93$. Considering all measurements made over a one year period, the average number of phyllodes per sub-branch of *A. l. longifolia* was 1.7 times higher in ungalled sub-branches (M=26.44, SD=1.38) compared to galled sub-

branches (M=16.00, SD=2.91). More phyllodes per ungalled sub-branch allowed more photosynthesis and the production of more energy resources for further growth of the plant (Plate 3).
Initially, the difference between the mean number of phyllodes per sub-branch for galled and ungalled sub-branches of *A. l. longifolia* was four, increasing to 28 after one full year of study (Fig. 2).
The number of phyllodes per sub-branch increased over time for both galled and ungalled plants. Post hoc comparisons using the LSD test revealed, for ungalled plants, differences between the initial number of phyllodes per sub-branch (measured in September 2014; M=26.44, SD=1.38) and the number of phyllodes per sub-branch measured in April 2015 (M=37.00, SD=2.72). During this period, *A. l. longifolia* starts growing rapidly in response to weather factors. However, there was no significant difference between the initial number of phyllodes (M=19.00, SD=4.24) on sub-branches of galled *A. l. longifolia* compared to the number measured in April 2015 (M=16.00, SD=2.91) (Fig. 2). The gall inducing wasps emerge from galls and galls dessicate during this period. After the month of April, the number of phyllodes increase in both cases due to weather factors, however it was comparatively low in number in galled branches than ungalled branches. Thus galled sub-branches did not increase their capacity for photosynthesis over time compared to ungalled sub-branches.
A combined effect of the presence of galls and time on the number of phyllodes per sub-branch of *A. l. longifolia* was found $F(11, 264)= 0.375$, $p<.001$, partial $\eta^2 =0.85$. There is a difference in the average number of phyllodes over time. The highest number of phyllodes was found in the month of August 2015, which was followed by July and June 2015. However, there was no significant interaction between time and locations $F(55, 264)= 0.38$, $p=1.00$, partial $\eta^2 = 0.07$; nor was there a significant interaction among time, treatments and locations $F(55, 264)= 0.64$, $p= 0.98$, partial $\eta^2 =0.12$ on the number of phyllodes of *A. l. longifolia*. The number of phyllodes per sub-branch of *A. l. longifolia* was affected by the presence of galls , as was the rate of increase in the number of phyllodes over time. It is likely that a reduced number of phyllodes in galled sub-branches has follow-on effects, possibly including reductions in other growth parameters, and in reproductive success.

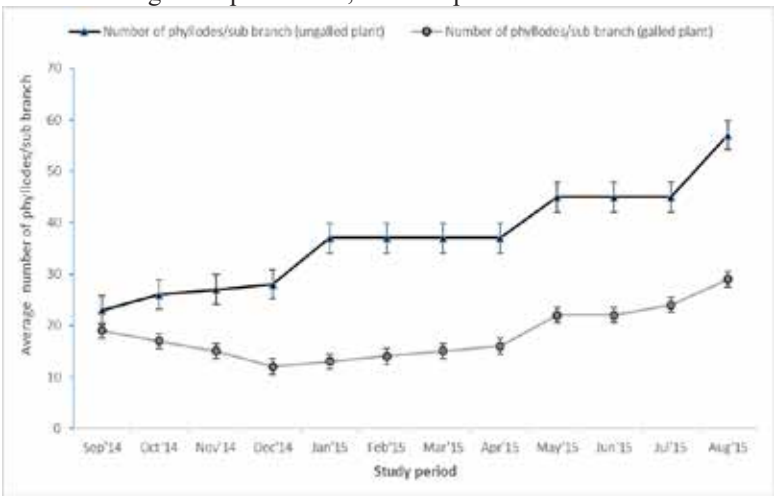

Fig. 2. Number of phyllodes on galled (*T. acaciaeloguifoliae)* and ungalled sub-branches of *A. l. longifolia* from September 2014-August 2015.

Initially, the difference between the mean number of phyllodes per sub-branch for galled and ungalled sub-branches of *A. l. longifolia* was four, increasing to 28 after one full year of study (Fig. 2). The average number of phyllodes per sub-branch was significantly affected by the presence of galls over the time of study period. There was some indication of seasonal variability in the average number of phyllodes per sub-branch.

The average number of phyllodes per sub-branch on galled *A. l. longifolia* plants decreased gradually from September 2014 to December 2014. The number of phyllodes per branch on galled branches then remained similar from January 2015 until April 2015 (Fig. 2). At this time of year, the adult insects emerge from the galls; and the galls start to desiccate; and are no longer redirecting the plants' resources. The number of phyllodes per galled sub-branch increased in May 2015 but remained lower than in ungalled sub-branches. The number of phyllodes per sub-branch on ungalled sub-branches increased steadily over the period of the study (Fig. 2).

The initial average number of phyllodes per sub-branch in September 2014 was 23 (ungalled) and 19 (galled). These numbers increased to 57 (ungalled) and 29 (galled) per sub-branch in August 2015 after one year (Fig. 2). The galls have the potential to accumulate nutrients, which would otherwise be directed into the formation of phyllodes. Dennill (1985) observed similar results in South Africa, suggesting that galls have an adverse effect on the number of phyllodes. Galls formed by *Dryocosmus kuriphihs,* a cynipid wasp, are known to significantly reduce the vegetative growth of the chestnut tree in Japan (Kato and Hijii, 1997).

However, some galls (by *T. acaciaelongifoliae*) bearing branches (*A. l. longifolia*) in the study location still able to grow and produce a number of flowers and seeds, which invades more areas in the following year. Performance of biological control agent can vary by spatial and temporal changes with abiotic and biotic conditions such plants resources, soil ferltility, weather factors, increased resistance of the weed, natural enemies (such as bird, predatory insects, parasitoids) of the biocontrol agent (Denno *et al.,* 2002, Stiling and Moon, 2005, Hovick and Carson, 2015). So that reliance only on *T. acaciaelongifoliae* as a biological control of *A. l. longifolia* is not effective in Australia. The high abundance and persistence of *A. l. longifolia* seeds in the soil seed bank is likely to further reduce the effectiveness of *T. acaciaelongifoliae* as a sole control agent. Impson *et al.* (2013) also found similar results when considering the use of the gall-forming midge *Dasineura rubiformis* (Cecidomyiidae) to control *Acacia mearnsii* (black wattle) and recommended the use of the midge as part of an integrated appraoch to weed control. Thus an integrated management including *T. acaciaelongifoliae* might be effective to control *A. l. longifolia* in the native range.

CONCLUSION

This research has demonstrated that galls formed by *T. acaciaelongifoliae* on *A. l. longifolia* plants reduce vegetative growth of *A. l. longifolia* growing in the native home range of both species, although this does not appear to be sufficient to reduce the invasive spread of the plant. It is concluded that effective control of the invasive weed *A. l. longifolia* will require an integrated weed management approach and recognise that while insufficient as a sole control agent, the role of *T. acaciaelongifoliae* in reducing vegetative and reproductive growth is likley to be an important component of an integrated approach.

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FACTORS INFLUENCING CLINICAL CASES OF CATS AT CENTRAL VETERINARY HOSPITAL (CVH), BANGLADESH

P. Chaudhary[1], M. Islam[2*], A. N. M. I. Rahman[3] and M. R. Adnan[4]

ABSTRACT

Cats are becoming more common as pets in Bangladesh, yet they may get infected with various pathogens and can harbour zoonotic infections. This study aimed to look into the prevalence of clinical cases and management practice of pet cats at the Central Veterinary Hospital (CVH) in Bangladesh. From July to December of 2022, a six-month cross-sectional prospective study was conducted on 153 pet cats that were brought to the CVH. Clinical ailments were identified by the patient owners' complaints, disease histories, and clinical examinations. According to the survey, feline panleukopenia (FP) was the most prevalent clinical case in cats (30.06%), followed by accidental injuries (17.64%), dermatitis (15.03%), laminitis (11.76%), parasitic (8.49%), feline calicivirus infection (6.53%), myiasis (5.88%), and urolithiasis (4.57%). Cross-breed cats had the lowest incidence of clinical cases (7.84%), whereas local cats had the highest prevalence (38.56%). The age group of ">24 months" had the highest prevalence of clinical cases compared to others. Male and female cats had comparable rates of clinical cases (43.79% vs. 56.20%). Furthermore, the prevalence of FP was significantly higher in local cats, in cats of "6-24 months" of age, and female cats compared to others. About half of the pets did not receive an anthelmintic or vaccination. Local breeds had a significantly larger percentage of unvaccinated cats; however, parsian and exotic breeds had the opposite scenarios. The study's findings provide significant new information regarding the most prevalent clinical cases in cats and their vaccination and deworming status needed to keep cats from becoming sick.

Keywords: Clinical cases, deworming, pet cats, prevalence, risk factors, vaccination

INTRODUCTION

Cats are popular pets worldwide and significant members of many civilizations (Hall *et al.,* 2016; Dawson *et al.,* 2019). They are valued family members who support their owners' well-being and the physical, social, and mental development of their children in many homes (Dohoo *et al.,* 1998; Robertson *et al.,* 2000). Having a pet typically entails specific responsibilities, such as providing housing, managing illnesses, and being accountable for pet ownership, which can have detrimental effects on public health if neglected (William *et al.,* 2002). Since cats are raised in environments similar to those of people, there is a chance that they could spread a variety of zoonotic illnesses. The most prevalent health risks are cat bites and allergies to pets, but domesticated cats can also spread a wide range of ailments, including bacterial, fungal, parasitic, and viral illnesses (Plant *et al.*, 1996; Geffray, 1999). In order to guarantee that our pets enjoy comfortable and healthy lives, the animal health industry is at the forefront of pet health care and is always creating innovative products. This covers immunization, deworming, treatments for fleas and ticks, dental care, and skin care. If we choose to live with a cat in our house, we must practice good hygiene and make sure they are free of ticks, worms, and fleas. It will guarantee not only the health of our cat but also our own well-being and the absence of parasites in our home. Despite the fact that Bangladesh has been connected to the existence of multiple serious zoonotic diseases contracted from cats, inland reports on this topic are rather scarce. As a result, research on feline illnesses is required, especially in Dhaka, the city with the highest pet population. Although research on clinical diseases in pets has been carried out across Bangladesh (Tarafder and Samad, 2010; Mahmud *et al.,* 2014; Parvez *et al.,* 2014; Yadav *et al.,* 2017), relatively little is known about the prevalence of these conditions in cats in Dhaka city and the risk factors that are associated with them. Therefore, the current study's objective was to determine the

[1]Internship student (17-08212), Internship Program 2021, Faculty of Animal Science & Veterinary Medicine, [2*]Correspondence author & Associate Professor, Microbiology and Parasitology, [3]Associate Professor, Dept. of Animal, Nutrition, Genetics and Breeding, [4]MS Fellow, Dept. of Microbiology and Parasitology, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.

prevalence of clinical illnesses and the risk factors that go along with them in cats that were taken to the Central Veterinary Hospital (CVH) in Dhaka to obtain medical assistance.

MATERIALS AND METHODS

Research area and duration

153 pet cats that were taken to the Central Veterinary Hospital (CVH) in Dhaka from July to December of 2022 were used in the study. Every cat, together with its breed, age, sex, and owners' complaints, was entered into the patient registration book.

Methods of diagnosis of diseases

An assessment of the health status of the pet animals, the amount of feed supplied, the feeding habits, the rearing of the pet animals, and the difficulties with the pet animals was used in a retrospective study to determine the illness prevalence and management practices in cats. When patients came to the hospital, their pet owners provided pertinent information about their animal using a pre-structured questionnaire survey. Based on categories, a closed-ended questionnaire was created.

Following a visual examination of the patient, palpation, percussion, auscultation, needle puncture, and an analysis of the animal's gait and posture were used to check various body parts and systems of each sick animal. The general clinical examination was carried out based on the merits of each case, taking into account the owner's complaint, the disease history, the symptoms, and common laboratory procedures and techniques such as microscopic examination (Rosenberger, 1979). Consequently, each of these sick animals' temperature, pulse, and respiration rate were noted.

A close investigation was necessary to correctly observe the presenting evidence of a viral disease, which included respiratory distress, diarrhoea, occulonasal discharge, and a sudden rise in temperature of 102°F to 104°F. In each instance, the rectal temperature was measured using a thermometer. The stethoscope was used to identify respiratory distress and to record and observe lung and tracheal sounds. Presumptive diagnosis for some parasite infections was made using the patient's medical history, clinical signs and symptoms, and stool analysis (Blood and Radostits, 1989). To identify any live or dead worms or tapeworm segments, a thorough inspection of the faeces was conducted. We looked over the animal's body to see whether any ectoparasites were apparent. Ectoparasites were identified using Wall and Shearer's (1997) keys and descriptions.

Statistical analysis

The information pertaining to every patient was collected and input into Microsoft Excel (Microsoft Office Excel-2013, USA). All of the study's data were assessed using the Pearson's Chi-square test using the Minitab17 program (Minitab Ltd., UK). For differences, a significance threshold of $p \leq 0.05$ was used.

RESULTS AND DISCUSSION

Prevalence of clinical cases of pet cats at CVH

From July to December of 2022, a total of 153 clinical cases involving cats were documented at CVH in Dhaka, Bangladesh. The survey found that the prevalence of Feline Panleukopenia (FP) was highest in cat 46 (30.06%) ($p < 0.001$). As illustrated in Fig.1, the subsequent most common disease in cats was accidental injury 27 (17.64%), followed by dermatitis 23 (15.03%), laminitis 18 (11.76%), parasitic 13 (8.49%), feline calicivirus infection 10 (6.53%), myiasis 9 (5.88%), and urolithiasis 7 (4.57%). Similar studies were conducted in Bangladesh by Parvez *et al.* (2014), Sarker *et al.* (2015), Sultana *et al.* (2016), Yadav *et al.* (2017), and Chisty *et al.* (2020); however, the prevalence varied among studies. Sultana *et al.* (2016) and Chisty *et al.* (2020) reported the prevalence of FP of about 7.5% in Bangladesh, which was around 22.5% lower than the present study. The variation might be due to study period and carelessness of the pet's owner regarding vaccination. Accidental injuries was the second highest prevalent clinical cases in this study, which might be due to unconscious movement of the cats. Parasitic diseases also very common in cats. The present study is in agreement with the Sarker *et al.* (2015) who reported the prevalence of parasitic diseases in cats was 13.33%.

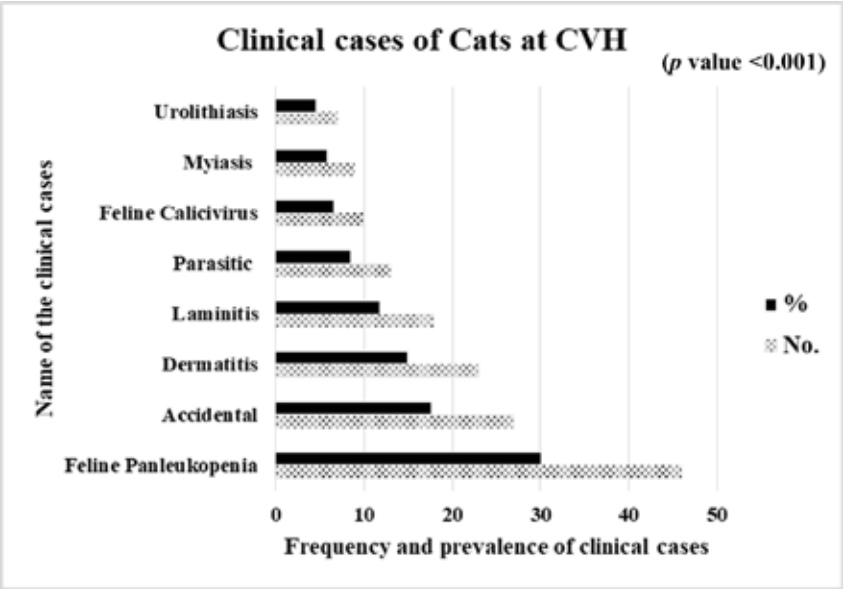

Fig. 1. Prevalence of clinical cases of cats according to diseases types at CVH.

Association of cases with breed, age, and sex of pet cats

The prevalence of clinical cases was highest in Local cats (38.56%) followed by Persian cats (26.14%), non-descriptive cats (15.03%), Exotic cats (12.41%) and lowest in Cross-breed cats (7.84%) as shown in Table 1 ($p < 0.001$). Likewise, Yadav *et al.* (2017) reported local breed (79.70%) were more prone to clinical cases. Furthermore, the prevalence of FP, dermatitis, and myiasis were significantly higher in Local cats compared to other breeds ($p \leq 0.05$). This finding indicates that breed has significant influence on the occurrence of clinical cases of pet cats.

Table 1. Association of clinical diseases of cats between disease types and breed.

Name of the clinical cases	Breed					*Chi square p value*
	Local	Exotic	Persian	Cross-breed	Non-descriptive	
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	
Feline Panleukopenia	18 (11.76)	7 (4.57)	12 (7.84)	5 (3.26)	4 (2.61)	0.054*
Accidental	9 (5.88)	3 (1.96)	6 (3.92)	3 (1.96)	6 (3.92)	0.32
Dermatitis	14 (9.15)	1 (0.65)	5 (3.26)	1 (0.65)	2 (1.30)	<0.001*
Laminitis	4 (2.61)	2 (1.30)	7 (4.57)	2 (1.30)	3 (1.96)	0.31
Parasitic	3 (1.96)	4 (2.61)	3 (1.96)	1 (0.65)	2 (1.30)	0.73
Felin Calicivirus	3 (1.96)	2 (1.30)	3 (1.96)	0	2 (1.30)	0.55
Myiasis	5 (3.26)	0	2 (1.30)	0	2 (1.30)	0.05*
Urolithiasis	3 (1.96)	0	2 (1.30)	0	2 (1.30)	0.27
Total	59 (38.56)	19 (12.41)	40 (26.14)	12 (7.84)	23 (15.03)	<0.001*

*Significant p ≤0.05

The prevalence of clinical cases of cats was highest in age group of ">24 months" (50.98%) followed by "6-24 months" (35.94%) and "<6months" (13.07%) as shown in Table 2 ($p < 0.001$). Furthermore, the prevalence of FP was higher in cats of "6-24 months" while accidental injuries, dermatitis, laminitis, and myiasis were higher in cats of ">24 months" ($p \leq 0.05$). The prevalence of clinical cases

of cats was similar between male and female (43.79% vs 56.20%) as shown in Table 3 (p = 0.125). Furthermore, the prevalence of FP was higher in female compared to male cats ($p \leq 0.05$). In contrast, previous study reported that clinical cases were more prevalent in male cats (58.65%), and in cats less than 6 months of age (51.13%) (Yadav *et al.,* 2017). The findings of this study further corroborate the significant influence of age and sex on the occurrence of individual clinical cases of pet cats especially FP.

Table 2. Association of clinical diseases of dogs between disease types and age.

Name of the clinical cases	Age			*Chi square p value*
	<6 months	6-24 months	>24 months	
	No. (%)	No. (%)	No. (%)	
Feline Panleukopenia	7 (4.57)	21 (13.72)	18 (11.76)	0.02*
Accidental	4 (2.61)	7 (4.57)	16 (10.45)	0.01*
Dermatitis	1 (0.65)	6 (3.92)	16 (10.45)	<0.001*
Laminitis	1 (0.65)	7 (4.57)	10 (6.53)	0.03*
Parasitic	4 (2.61)	4 (2.61)	5 (3.26)	0.92
Felin Calicivirus	3 (1.96)	5 (3.26)	2 (1.30)	0.49
Myiasis	0 (0)	3 (1.96)	6 (3.92)	0.049*
Urolithiasis	0 (0)	2 (1.30)	5 (3.26)	0.066
Total	20 (13.07)	55 (35.94)	78 (50.98)	<0.001*

*Significant p ≤0.05

Table 3. Association of clinical diseases of dogs between disease types and sex.

Name of the clinical cases	Sex		*Chi square p value*
	Male	Female	
	No. (%)	No. (%)	
Feline Panleukopenia	16 (10.45)	30 (19.60)	0.03*
Accidental	9 (5.88)	18 (11.76)	0.083
Dermatitis	16 (10.45)	7 (4.57)	0.060
Laminitis	7 (4.57)	11 (7.18)	0.34
Parasitic	5 (3.26)	8 (5.22)	0.40
Felin Calicivirus	3 (1.96)	7 (4.57)	0.20
Myiasis	4 (2.61)	5 (3.26)	0.73
Urolithiasis	7 (4.57)	-	ND
Total	67 (43.79)	86 (56.20)	0.125

*Significant p ≤0.05, ND: Not done

Management practices of pet cats

In this survey, various management practices were studied like vaccination and deworming status of cats. In this survey, out of 153 cats, 77 (50.33%) cats were vaccinated and 76 (49.67%) were unvaccinated (Table 4) (p = 0.936). Among breeds, the percentage of non-vaccinated cats was higher in local breeds while vaccination was more practiced in Parsian and Exotic breeds compared to others (p <0.05). Deworming is less practice in cat as compared to vaccination. In the present study, approximately 44% cats were dewormed regularly as shown in Fig. 2 (p = 0.125). Vaccination and deworming are the key to prevent viral and parasitic diseases, respectively (Bergmann *et al.,* 2018; Roussel *et al.,* 2019). Though the prevalence of vaccination and deworming were not differed significantly compared to their counter parts, non-vaccinated and non-dewormed cats were remaining in danger.

Table 4. Vaccination status of cat according to breed.

Breed	Vaccine status		*Chi square p value*
	Vaccinated	Non-vaccinated	
	No. (%)	No. (%)	
Local	13 (8.50)	46 (30.07)	<0.001*
Exotic	14 (9.15)	5 (3.27)	0.038
Persian	32 (20.92)	8 (5.23)	<0.001*
Cross-breed	8 (5.23)	4 (2.61)	0.25
Non- descriptive	10 (6.54)	13 (8.50)	0.53
Total	77 (50.33)	76(49.67)	0.936

*Significant p ≤0.05

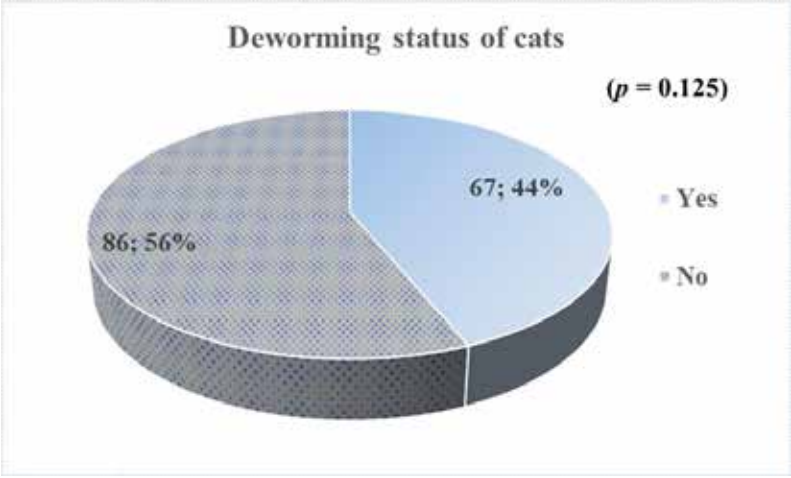

Fig. 2. Deworming status of cats of this study.

CONCLUSION

In conclusion, feline panleukopenia was the most prevalent clinical case in pet cats at CVH, Bangladesh. Breed, age, and sex influenced the prevalence of FP. Around half of the cat's owners were unaware of the vaccination and deworming of their cats. Therefore, proper vaccination, deworming, and hygienic management of pet cats are recommended to reduce clinical illness.

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STATUS OF INDISCRIMINATE USES OF ANTIBIOTICS IN LIVESTOCK AT NARAYANGANJ SADAR, NARAYANGANJ

A. I. Robin[1], H. Hossain[2], M. Taslima[3], M. S. Jahan[4] and M. R. Islam[5*]

ABSTRACT

Antibiotic overuse, the prevalence of diseases, and the emergence of medication resistance are the main reasons why rash antibiotic use has attracted significant attention worldwide. By assessing the prescribers' patterns of prescribing antibiotics for patients, this cross-sectional survey-based study aims to represent a true picture of antibiotic use in Narayanganj Sadar, Narayanganj. It was conducted by making specific interviews with 60 farmers using a self-designed standard questionnaire. As a result of this study, we know that 38.3% of animals received antibiotic prescriptions, and that young animals (those age under 2 years old) received these prescriptions more frequently (53.8%). According to this study, the majority of antibiotics were used to treat microbial infections about 18 out of 23 animals (78.3%). Contrary to goat species, cattle species utilized antibiotics at a rate that is 6.69% greater. All prescriptions are for ceftriaxone (22%), marbofloxacin (18%), ceftiofur (4%), and ciprofloxacin (4%), in addition to amoxicillin (26%) and penicillin (26%). The13% of farmers had no idea how an antibiotic worked, how long it had lasted, or how to use it. About 69.5% of animals received prescriptions from non-registered veterinarians. It was obvious that farmers were not sufficiently aware of the usage of antibiotics, lacked adequate education and did not practice regarding drug usage policies in all situations. The spread of bacterial resistance to antibiotics and other health issues are caused by this illogical use. Therefore, community base awareness regarding the discriminate and indiscriminate use of antibiotics in livestock production.

Keywords: Antibiotics, livestock, antibiotics resistance, drug policy, awareness

INTRODUCTION

Specifically, pathogenic microorganisms are destroyed or slowed down in their proliferation by antimicrobials (Merriam-Webster *et al.*, 2022). Due to our better understanding of the underlying causes of numerous infectious diseases, the term "antibiotic" is now frequently used to describe a chemical substance, produced by micro-organisms, which has the capacity to inhibit the growth of and even to destroy bacteria and other micro-organisms. (Bentley, 2003) In veterinary hospitals globally, antibiotics are currently the most commonly administered medications because to their considerable contribution to life expectancy increases (Faryna *et al.*, 1987). However, improper and overuse of antibiotics results in increased drug resistance (Park *et al.*, 2012; Snow *et al.*, 2001; Hiramatsu *et al.*, 1997) which poses a direct threat to future animal health (Wise, *et al.*, 1998).

The main factor contributing to bacterial antibiotic resistance is genetic mutation. Due to the indiscriminate use of antibiotics in veterinary medicine, a high incidence of microorganisms resistant to antibiotics exists (Padmaja *et al.*, 2009). The likelihood that resistance will emerge is influenced by the length of exposure. In a developing nation like Bangladesh, the general people and veterinary experts are unaware of the usage of antibiotics. Bangladesh has made significant progress in drug formulation since the implementation of the "Drug Control Ordinance-1982" for drug manufacturing. However, unjustified self-medication, careless prescription, and irrational antibiotic use not only raise the risk of the emergence of resistant organisms but also drive up the cost of treatment (Biswas *et al.*, 2014). Many veterinary professionals and doctors in Bangladesh frequently write unreasonable antibiotic prescriptions without considering the findings of the clinical test. Additionally, farmers are not fully cognizant enough to finish the prescribed antibiotic dosages, especially in cases of major infectious diseases. The research on antibiotic prescription patterns may indicate that veterinary professionals assess, monitor, and suggest potential changes to the practitioner's prescription practices to ensure that

[1]MS Student,[2&3]Lecturer, Dept. of Surgery and Theriogenology [4]Associate Professor, Dept. of Pharmacology and Toxicology [5*]Correspondence author & Associate Professor, Dept. of Surgery and Theriogenology, , Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.

patients receive effective and reasonable care (Shankar *et al.*, 2003). To address the issues brought on by the irrational use of antibiotics, it is vital to gather and disseminate knowledge on antibiotic usage. It is essential to create an antibiotic policy in veterinary hospitals and clinics and to ensure that individual prescribers follow best practices (Remesh *et al.*, 2013). A thorough and approved representative study may aid veterinarians in prescribing antibiotics sensibly and can raise the standard of patient care. The objectives of this survey-based research are to evaluate, investigate, and justify whether antibiotics are being prescribed irrationally or rationally for animals and to assess the prevalence of most prescribed antibiotics in Narayanganj Sadar under Narayanganj district in Bangladesh.

MATERIALS AND METHODS

Study design, setting and study population

This is a cross-sectional prospective study conducted in Narayanganj Sadar Upazilla, Narayanganj, Bangladesh, under the Dhaka Division. Over 40 days of data collection were involved. Age, species, class of veterinary practitioner, and disease pattern were taken into account in this study. Additionally, a patient who has been prescribed one or more antibiotics at any stage during the study period and is between the ages of fewer than 2 and over 7 years is referred to as an "antibiotic patient" ((BBS), 2013).

Data collection

A self-designed standard questionnaire was used to perform this cross-sectional survey, which involved directly interviewing 60 farmers or animal caretakers from the Narayanganj Sadar Upazilla Veterinary Hospital, various organized farms. After gathering information from farmers and animal caretakers, a random sample of consumers who went to pharmacies to buy prescription drugs was recorded.

Statistical analysis

The collected data were first transferred to Microsoft Excel and compiled to facilitate the needed tabulation. Utilizing Microsoft Excel, descriptive statistics were applied to the acquired data to fulfill objectives of the study. Results are represented as percentages.

RESULTS AND DISCUSSION

A total of 60 animals were chosen at random for the interview in this study. Of them, it was discovered that 23 animals (38.3%) had antibiotic prescriptions. According to the breakdown of ages, animals under 2 years were regarded as young where 7 animals (11.66%) were prescribed antibiotics among total animals under survey (60) (Fig.1). In age between 2-5 years animals, mentioned as adult animal, 11 animals (18.33%) were prescribed antibiotics which were the most frequent among them (Fig.1).

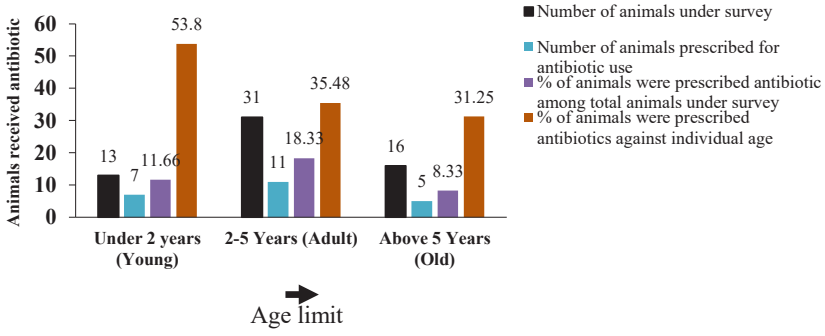

Fig. 1. Status of antibiotic user by age

On the other hand, 7 animals (53.8%) out of the 13 animals (under 2 years) who had their individual ages broken down had prescriptions for antibiotics, the highest percentage indicated in Fig. 1.
Due to our extensive coverage of dairy farms in various regions, of 60 animals 23 received antibiotic prescriptions, 20 out of 23 (87%) were cattle, and 3 out of 23 (13%) were goats as shown in Fig. 2.

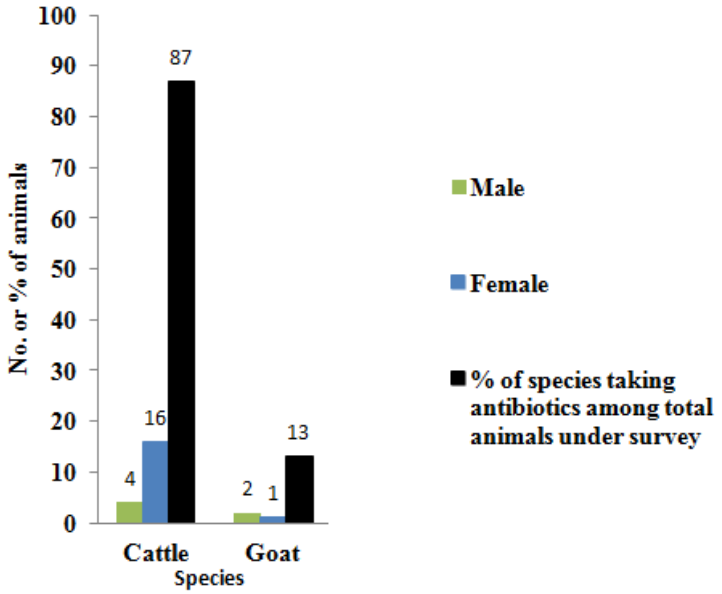

Fig. 2. Species & gender variability for antibiotic use

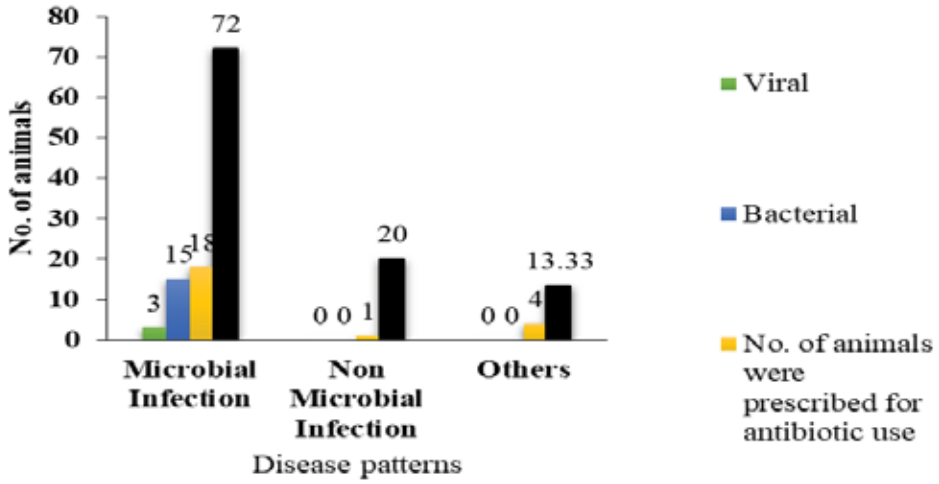

Fig. 3. Disease patterns for antibiotic use

In this analysis, the rate of antibiotic prescriptions to animals that was more susceptible to illnesses was found to be considerable. Although the doctors were irrationally recommending antibiotics, guidelines advise against prescribing them unless an infection has been identified. In this survey, no clinical testing was included in the prescriptions to identify positive microbiological infections. According to this study, the majority of antibiotics were used to treat microbial infections in 18 out of 25 animals (72%), where 3 cases out of 7 viral cases (42.8%) and 15 cases out of 18 bacterial cases (83.3%),

respectively, involved viral and bacterial infections. In situations of non-microbial infection, only 1 animal out of 5 (4.3%) received an antibiotic prescription, and in others cases, 4 out of 30 animals (13.33%) received antibiotics. These cases are demonstrated in Fig. 3. Additionally, in accordance with the established standards, antibiotics could not be the main mode of treatment for the majority of microbial and non-microbial conditions.

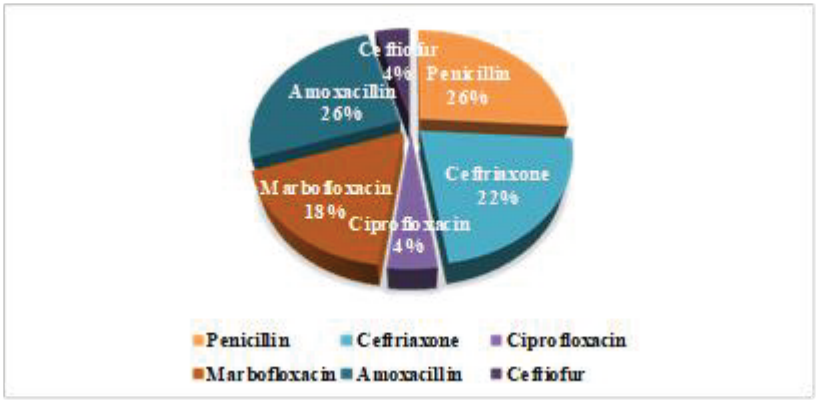

Fig. 4. Antibiotics frequently prescribed for patients

Based on our research, it was found that penicillin and amoxicillin together covered a staggering 26% of all antibiotic prescriptions (Fig. 4). The most common quinolone prescribed was marbofloxacin, which was high compared to other quinolones like ciprofloxacin, which was prescribed at a rate of roughly 4%. About 22% of ceftriaxone prescriptions were for the treatment of mastitis and other infections. This might result in increased cefixime and ceftriaxone resistance. Mastitis was the issue most closely associated with an antibiotic prescription (Biswas *et al.*, 2014). Excluding the registered veterinarians (30.4%), veterinary assistants (13%) and village doctors/quacks (39.1%), who are not authorized to provide antibiotics, have been observed oddly going against the recommended dosage for antibiotics. This is most likely the outcome of contested pharmaceutical firms' marketing strategies in Bangladeshi targeting country veterinary Para-professionals and quack veterinarians, along with a lack of awareness of the most recent treatment recommendations. In addition, antibiotics are frequently and illogically supplied to patients in order to provide them with temporary relief without taking into account the patient's illness condition or potential long-term complications. This occurs as a result of antibiotics being the

Table 1. Status of indiscriminate use of antibiotics based on different parameters

Parameters		Number	Percentages
Professional status of antibiotic prescribers	Registered Veterinarian	7	30.4
	Veterinary Paraprofessionals	3	13
	Quack	9	39.1
	Self	4	17.4
Status of the owner's concern about completion of course of antibiotic	Strongly agree	11	47.8
	Agree	9	39.1
	Disagree	3	13
Owners' perception to stop giving antibiotic	When get improved	4	17.4
	After giving all the doses as prescription	19	82.6
Conclusion of leftover antibiotics used by owners	Keep for further use	4	17.4
	Throw in garbage	19	82.6
Status of record keeping of antibiotics by owners	Never	12	52.2
	Sometimes	11	47.8

drug that prescribers and farmers by themselves use and abuse the most (17.4%) (Table 1). This type of unintentional prescription trend for antibiotics could hasten antibiotic usage and strengthen resistance (Kunin, 1990; Zara, 1991). Worldwide antibiotic abuse is also a result of
improper veterinary hospital practices (Stein, 1984; Aswapokee, 1990; Yang, 1993).
Unfortunately, 13% (3) of the owner disagreed with finishing the antibiotic course. Of all the prescribed (23) farmers, 39.1% (9) of the owners were concerned about the completion of the antibiotic course, the effects of antibiotics, and they agreed with it, with 47.8% strongly agreeing (Table 1). The farmers are particularly concerned about the welfare of their animals and successfully adhere to the regulations regarding the end of the antibiotic treatment.
According to this survey, among 23 prescribed animal's owners, 4 owners (17.4%) thought to stop giving antibiotics after animals became well and 19 owners (82.6%) thought to discontinue giving antibiotics after giving all the recommended doses, as indicated in Table 1.
Approximately 17.4% owners among the prescribed owners, thought to keep the leftover antibiotics for future uses that could lead to improper use of antibiotics in animals, 19 owners (82.4%) discarded the unused medicines in the trash, among 23 prescribed animals owners, as shown in Table 1.
Twenty three (23) prescribed farmers in total, 12 owners (52.2%) of whom never kept antibiotic records, consequently they are unable to establish the history of previous infections and 11 owners (47.8%) of whom sometimes did so (Table 1).
Around 31.7% of farmers were concerned about antibiotic resistance, while 68.3% were not which is alarming (Fig. 5). Again, about 36.7% of farmers were concerned that using all of their prescribed antibiotics could result in antibiotic resistance, while 63.3% were unconcerned. Additionally, 65% of farmers were unaware of it, and roughly 35% of farmers were concerned that an overdose or low dose course could result in antibiotic resistance. 42 farmers (70%) were unconcerned with the antibiotic residue, compared to 18 farmers (30%) who were. Again, around 22 farmers (36.7%) followed the antibiotic withdrawal time, while 38 farmers (63.3%) did not. (Fig. 10). This ignorance contributes to antibiotic resistance, which could pose a future hazard to animal health (Olofsson, 2007).

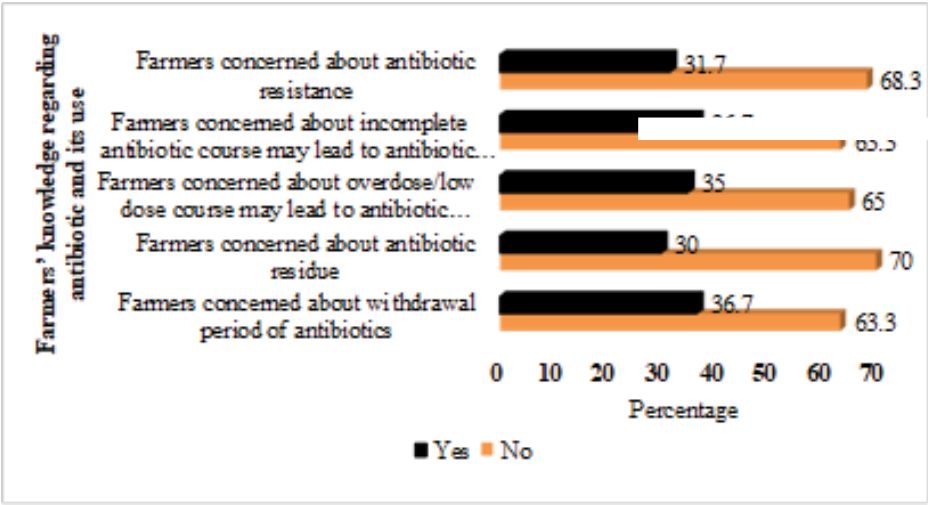

Fig. 5. Status of farmers' knowledge regarding antibiotic and its use

CONCULSION

Conclusively, veterinary practitioners use presumptive diagnosis and empirical treatment to treat animals with antibiotics due to insufficient microbial diagnostic facilities. Thorough training is

beneficial in educating farmers, feed dealers, and drug sellers about standard biosecurity procedures, proper personal hygiene, good farming practices, and the responsible use of antibiotics. The Bangladeshi government must immediately create and put into effect the necessary regulations to reduce the excessive use of antibiotics in food animals by utilizing a multi-sectoral One Health strategy.

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COMPARATIVE PROFITABILITY ANALYSIS OF MAIZE AND TOBACCO PRODUCTION IN MANIKGANJ DISTRICT OF BANGLADESH

H. M. Sammy[1*], M. A. Kabir[2], T. H. Beg[3] and R. Rahmatullah[4]

ABSTRACT

A common myth about tobacco cultivation is that tobacco is more profitable than other crops. However, tobacco farming becomes unprofitable when the opportunity costs of unpaid family labor and the costs of their significantly severe illnesses and medical care are considered. High environmental impacts from tobacco farming result in a net loss to society. To analyze profitability by comparing maize with tobacco, and estimate the health costs of individuals in tobacco-cultivated areas. A cross-sectional and comparative study was undertaken among tobacco and maize farmers with family members in Manikganj districts. A total of 120 households were selected through a multi-stage cluster sampling technique, and each household head was interviewed face-to-face using a semi-structured questionnaire to gather information on households, family members and farming. The quantitative data were analyzed using both descriptive and inferential statistical approaches. In this study, 120 households consisted of a total of 501 household members. The average land use for cultivation was 81.91 decimals for maize growers and 96.60 decimals for tobacco growers. Considering all crops in a cultivation year, the undiscounted Benefit Cost Ratio (BCR) of maize growers was higher (1.72) than that of tobacco growers (1.02). In BCR for maize production was 1.22, while tobacco production was 1.09. Moreover, Food crops cultivation is more profitable than tobacco cultivation for individual and annual crop production. To achieve a tobacco-free country by 2040, tobacco farmers should cultivate food crops that are profitable from a broader perspective instead of cultivating tobacco.

Keywords: Profitability, tobacco, maize, bcr, smoke-free

INTRODUCTION

The promise of Prime Minister Sheikh Hasina to create a smoke-free nation by the year 2040 has increased Bangladesh's constitutional duty to take action against tobacco. The area of tobacco cultivation remains significantly high in Bangladesh, which is the 12th largest tobacco producer in the world (Akm Ghulam Hussain, *et al.,* 2020). When the opportunity costs of unpaid family labor, other owned resources and the health implications of tobacco production are taken into account, tobacco farming becomes a losing endeavor. Tobacco cultivation creates a significantly high environmental cost that causes a net loss to society. Many tobacco farmers are now stuck producing a crop that is labor and input intensive and brings with it a host of health and environmental dangers. Meanwhile, the cigarette companies continue to downplay or ignore the many serious economic and environmental costs associated with tobacco. Nevertheless, the availability of unpaid family labor and the options of advanced credit as well as a buy back guarantee from the tobacco companies attract farmers to engage in and continue tobacco cultivation. Multi-stage cluster sampling technique will be used for household survey. In order to provide evidence on health and economic impact of the tobacco on cultivators of tobacco cultivated area in Bangladesh. For a season, in search of even more profits, the tobacco industry has encouraged countries and farmers to grow more tobacco (Campaign for Tobacco-Free Kids, 2001). While the tobacco industry argues that tobacco farming is a major contributor to the country's economy, the seriously damaging health and environmental impacts caused by tobacco farming have been well documented (Mackay & Eriksen, 2005). To meet demand for tobacco leaf from both domestic and foreign manufacturers of tobacco products, the extent of tobacco cultivation remains considerably high. Bangladesh is the 12th largest tobacco producing country in the world [(Maps of

[1*]Correspondence author & Associate Professor, Department of Agricultural Statistics, Sher-e-Bangla Agricultural University, Dhaka 1207, [2] Professor, Department of Statistics and Data Science, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh, [3]Assistant Professor, Department of Agricultural Finance and Management, Sher-e-Bangla Agricultural University, Dhaka 1207. [4]Graduate Researcher, Department of Industrial and Systems Engineering, College of Engineering, Lamar University, USA

world. 2018) & (Catfish, 2018) & (World list mania, 2018)]. Tobacco farming is growing fast and competing for the limited and fixed arable land of 37,674,000 acres. While in 2007–2008, a total of 72,000 acres of land was used for tobacco cultivation, it increased to 127,000 acres by 2014-2015-a 74% increase over seven years (BBS, 2016). Tobacco cultivation is highly labor intensive, as evident in similar studies conducted for Kenya (Magati *et al.*, 2016), Indonesia (Drope *et al.,* 2017) and Zambia (Goma *et al.,* 2019). During curing, tobacco farmers have to work 70 h at a stretch (Akhter *et al.,* 2018). The use of unpaid family labor is widespread. A significant number of women and child laborers are engaged in tobacco cultivation and tobacco leaf processing, which constitutes exploitation of women and children and is against the law (Children's Act; Act No. 24 of 2013). Assisting tobacco farmers to transition to maize alternatives is a key element of comprehensive tobacco control's end-game strategy and specifically required by the World Health Organization (WHO) Framework Convention for Tobacco Control (FCTC) (Jones *et al.,* 2008).

Overall objective: To analyze the profitability with comparison of maize and tobacco production in Manikganj District of Bangladesh.

Specific Objectives

i. To determine the input costs and output returns of maize and tobacco
ii. To analysis and compare the profitability with factor affecting of maize and tobacco product

MATERIALS AND METHODS

Selection of the study area

Tobacco is grown many districts in Bangladesh a preliminary survey in Manikganj district was conducted to achieve the objectives of the present study.

Sampling technique and sample size

The study selected 120 farmers, 62 tobacco growers and 58 maize, using a simple random sampling technique to minimize cost and time, despite not including all farmers in the area.

Preparation of the survey schedule:

A preliminary questionnaire was developed to gather data from survey participants, pretested with tobacco and maize farmers, and finalized after necessary revisions and substitutions.

Period of the study

Data were collected during the period of August to September in 2022 through direct interview with the farmers. Data relating to inputs and outputs were obtained by making time to time visit in the study area.

Data collection method:

The study collected data through field surveys with tobacco and maize farmers. The investigator systematically interviewed farmers, explaining the research's intent and ensuring a scholarly analysis. The interview schedule was updated to ensure accurate data collection. **Processing, tabulation and Analysis of data:**

Data was manually coded, edited, and thoroughly analyzed using Microsoft Excel and SPSS, first obtained in local units and then translated into international units.

Analytical techniques

The study compares costs, returns, profitability, and resource use efficiency of tobacco and maize production, estimating per hectare profitability for individual farmers in terms of gross return, gross margin, net return, and benefit cost ratio.

Profitability analysis

Cost of variables inputs such as land preparation, labor, seed, fertilizer, irrigation, and insecticides were calculated. Different descriptive statistics like mean, percentage, ratio, etc. Land use cost was calculated on the basis of per year lease value of land.

Gross margin

GM = TR – VC; Where, GM = Gross Margin, TR = Total Revenue, VC = Variable Cost

Net income: NI = TR – TC**;** Where, NI = Net Income, TR = Total Revenue, TC = Total Cost

For estimating net income total cost was subtracted from total revenue. Total cost includes variable cost plus fixed cost.

Interest on operating capital

Interest on operating capital was calculated by using the following formula:

Interest on Operating Capital (IOC) = Alit

Where, Al = Total investment /2, t = Total time period of investment, i = interest rate which was 9 percent per year.

Undiscounted benefit cost ratio (BCR)

A benefit-cost ratio (BCR) is an indicator showing the relationship between the relative costs and benefits of a proposed project, expressed in monetary or qualitative terms. If a project has a BCR greater than 1.0, the project is expected to deliver a positive net present value to a firm and its investors.

BCR on TC = GR /TC, Where, GR = Gross return, TC = Total Cost, If BCR>1, then the return from farm is economically satisfactory; If BCR<1, then the return from the farm is not economically satisfactory; If BCR=1, then the farm is in break- even point.

Cobb-Douglas production function

Apart from the tabular analysis, the functional technique was also followed in this study. Cobb-Douglas production function model was used to estimate the effects of key variables. This model was proved the best-fit and more reliable on theoretical and econometric aspects in real world situation.

The model of Cobb-Douglas for both tobacco and maize is as follow:

$Y= aX_1^{b_1}X_2^{b_2}X_3^{b_3}X_4^{b_4}X_5^{b_5}X_6^{b_6}X_7^{b_7}e^{ui}$

The Cobb-Douglas production function was transformed into the following logarithmic form by logging on both sides, because it could be solved by the Ordinary Least Square (OLS) method:

$\ln Y= \ln a +b_1 \ln X_1+ b_2 \ln X_2+ b_3 \ln X_3+ b_4 \ln X_4+ b_5 \ln X_5+ b_6 \ln X_6+ b_7 \ln X_7+ ui$

Where, Dependent variable, Y = Gross return (Tk/ha), Independent variables, X_1 = human labor cost (Tk/ha), X_2 = Power tiller cost (Tk/ha); X_3 = seed/seedlings cost (Tk/ha); X_4 = Fertilizer cost (Tk/ha); X_5 =Pesticide cost (Tk/ha); X_6 = Manure cost (Tk/ha), X_7 = Irrigation cost (Tk/ha) a = constant or intercept term, b_1 to b_7 = production coefficients of respective input variables to be estimated, ui = Error term, ln = Natural logarithm

Elasticity of production (Ep)

Production elasticity is defined as the percentage change in production divided the percentage change in the quantity of an input used for that production, providing the other variables remain constant. In measuring the elasticity of output, the Cobb-Douglas production function is very beneficial. It is possible to express the elasticity of output as- Elasticity of production, Ep = bi, If Ep = 1, Production elasticity is unity, Ep> 1, Production is elastic, and Ep<1, Production is inelastic.

Return to scale (RTS)

The return to scale can be achieved by summarizing the coefficients of regression of all explanatory variables in the output function of Cobb-Douglas.

This can be expressed as—Return to scale, RTS= $\sum$bi; Where, n= number of regression, and bi= regression coefficients, If, RTS=1 then it is constant return to scale, RTS>1 then it is increasing return to scale, RTS<1 then it is decreasing return to scale.

RESULTS AND DISCUSSION

Profitability of tobacco and maize (and accumulated) production

For analytical advantages, the cost items were classified into two groups;

(I) Variable cost; and (II) Fixed cost.

Variable cost included the cost of all variable factors like seed, human labor, tillage, fertilizer and manure, irrigation water and insecticides and pesticides. On the other hand, fixed cost was calculated for land use cost and interest on operating capital.

Cost of human labor: The most important input for tobacco and other crops production is human labor. It shared a large portion of total cost of tobacco and other crops production. Table 1 shows that per hectare total human labor cost for tobacco was TK. 138079.7 (56.4%) where male labor cost was TK. 119422.3(48.8%) and female labor cost was TK. 18487.6(7.5%). On the other hand for maize production, total human labor cost was TK. 81912.3(44.09%) where male and female labor cost was TK. 74232.4(40.7%) and TK. 7550.8(4.1%) respectively.
Table 4 shows that for tobacco along with other crops cultivated in the same land all around the year, human labor cost was Tk.195386.52 which was 46.45% of total variable cost and for major crops (never tobacco cultivated land) all around the year, human labor cost was Tk. 62011.20 which was 22.29% of total variable cost.

Table 1: Per hectare operation wise average cost for tobacco and maize production

Inputs Costs	Crops			
	Tobacco	%	Maize	%
Male	119422.3	48.8	74232.4	40.7
Female	18487.6	7.5	7550.8	4.1
Children	169.8	0.1	129.2	0.1
Total Human Labor Cost	138079.7	56.4	81912.3	44.9
Machinery Inputs Cost	21929.7	9.0	29368.7	16.1
Materials Input Cost	84932.7	34.7	70954.6	38.9
Total	244942.1	100.0	182235.5	100.0

Machinery input cost: In the study area, it was found that farmers used machinery in land preparation, harvesting, carrying, threshing, curing et cetera. Table.1 show that the per hectare machinery input cost was 21929.7 which is 54.55% and TK.29368.7 which is 16.1% of total variable cost for tobacco and maize production respectively. Table 4 show that the per hectare machinery input cost for tobacco along with other crops for one year was Tk. 42307.88 which was 10.06% of total variable cost and per hectare cost for major crops(in which land tobacco never cultivated) was TK. 53204.73 which was 19.12% of total variable cost.
Cost of power tiller: Farmers of Tobacco and Maize used power tiller to land preparation in the study area .Table 2 show that the cost of power tiller were Tk. 16068.0 and Tk. 17190.2 for tobacco and maize respectively.
Cost of thresher: Animal labor never used for land preparation. All of the farmers used power tiller for land preparation in the study area. Thresher was needed for threshing Maize after harvesting. Thresher is never used for tobacco threshing in Manikganj. Table 2 shows that total cost of thresher for maize is Tk. 4299.7per hectare.

Table 2. Per hectare machinery inputs average cost for tobacco and maize production

Various Inputs	Tobacco		Maize	
	Total Cost (Tk.)	% of total Cost	Total Cost (Tk.)	% of total Cost
Power tiller	16068.0	73.27	17190.2	58.53
Harvesting	346.2	1.58	1283.1	4.37
Transportation	5515.5	25.15	4917.4	16.74
Thresher		0.00	4299.7	14.64
Total	21929.7	100.00	29368.7	100.00

Cost of transportation: After harvesting both tobacco and maize, van and rickshaw was used for carrying to their home and to local market. From table 2 total cost of transportation for tobacco was Tk. 5515.5, which is 25.15percent and for maize Tk. 4917.4, which is 16.74percent of total machinery cost.

Material inputs cost: For any agricultural crop production material equipment is used during field preparation. Without agricultural materials production is impossible. Material inputs includes seed, fertilizer, irrigation, pesticides et cetera. Efficient use of them can yield high production and lack of knowledge to use them properly can produce low rate of production. Table.1 show that material inputs cost for tobacco was Tk.84932.7 which was 34.7% of total variable cost. For maize production it was TK.70954.6 which was 38.9% of total variable cost.

Cost of seed/seedlings: For any agricultural crop production seed is the basic input. Yield of any agricultural production is highly dependent on the quality of seed. Table 3 shows that for tobacco production total seed cost was TK. 15254.55 which is 2.70 percent of total variable cost for one hectare. Again for maize production total seed cost was TK. 9097.98 which is 4.99 2.70 percent of total variable cost for one hectare. Table 4 shows that seed cost of tobacco along with other crops and major crops on a year were Tk. 32119.04 and Tk. 26693.86 for one year respectively and their percentage were 7.64 and 9.60 of total variable cost.

Table 3. Per hectare variable and fixed average cost for tobacco and maize production

Items	Tobacco (Tk)	% of total cost	Maize (Tk)	% of total cost
A.Variable Cost				
1.Human labor cost	138079.7	56.37	81912.3	44.95
2. Seed cost	15254.55	6.23	9097.98	4.99
3. Fertilizer cost	46674.99	19.06	40026.17	21.96
4. Machinery cost	21929.7	8.95	29368.7	16.12
6. Pesticide	8593.83	3.51	5070.98	2.78
10. Irrigation	14409.34	5.88	16759.47	9.20
Total Variable Cost	244942.1	100.0	182235.5	100.0
Fixed Cost				
Land use cost	46240.95	79.46	44027.3	89.28
Interest on Operating Capital	11955.34	20.54	5285.8	10.72
Total Fixed Cost	58196.3	100.0	49313.1	100.0
B.Total Cost (A+B)	303138.4		231548.6	

Cost of fertilizer: Farmers of tobacco and maize used Urea, TSP, MOP, DAP and SOP. From table 3 the estimated cost of fertilizers for tobacco and maize production was Tk. 46674.99 which is 19.06% of total variable cost and TK. 40026.17which is 21.96% of total variable cost respectively. Table 4 shows that fertilizer cost of tobacco along with other crops and major crops were Tk. 58436.79 and Tk. 77306.86 for one year respectively and their percentage were 13.89 and 27.79 of total variable cost.

Cost of irrigation: Proper irrigation is essential for any kind of agricultural production. Tobacco and maize needed a large amount of water from land preparation to harvest. Table 3 shows that the charge of irrigation water for producing tobacco is Tk. 14409.34 and 5.88 percent of total cost. Table 4 show that the per hectare irrigation cost for tobacco along with other crops for one year was Tk. 33909.42 which was 8.06% of total variable cost and per hectare cost for major crops(in which land tobacco never cultivated) was TK. 37052.08 on a year which was 13.32% of total variable cost.

Cost of pesticide: Different types of insects can damage yield of tobacco and maize production. Termites, caterpillars, beetles, horned grasshoppers, rats, brown plant hopper, yellow stem borer, gal midge and leaf folder cause serious damage in tobacco and maize production. So, farmers needed to apply insecticides to control pest. Table 3 reveals the total costs of pesticides for tobacco and maize production for per hectare were Tk. 8593.83 and Tk. 5070.9 and their percentages were 3.51 and 2.78 percent respectively. Table 4 show that the per hectare irrigation cost for tobacco along with other crops for one year was Tk. 58436.79 which contributed 13.89% of total variable cost and per hectare cost for major crops(in which land tobacco never cultivated) was TK. 21926.28 which contributed 7.88% of total variable cost.

Estimation of fixed costs

Land use cost: Most of the tobacco and maize producers of the study area had their own land. Land use cost was fixed for the farmers, table 3 shows that for tobacco, it was Tk. 46240.95 which was 79.46% of total fixed cost and for maize it was TK. 44027.3 which was 89.28% of total fixed cost.

Interest on operating capital (IOC): The interest on operation cost was calculated by taking into account all the operating cost incurred during the production period of tobacco and maize. Table 3 shows that, per hectare interest on operating costs were estimated as Tk. 11955.34 which was 20.54% and TK. 5285.8 which was 10.72% of total fixed cost for tobacco and maize respectively.

Estimation of total cost: The variable cost and the fixed cost were aggregated to calculate the total cost for tobacco. Table 3 reveals that total cost were Tk. 303138.4 and Tk. 231548 for tobacco and maize respectively. Table 4 show that the per hectare fixed cost for tobacco along with other crops for one year was Tk. 87851.78 in which land use cost was Tk.55792.14 (63.51%) and interest on operating cost was Tk.32059.64 (36.49%) of total fixed cost and per hectare total fixed cost for major crops (in which land tobacco was never cultivated) was TK.69350.37 in which land use cost was Tk.50530.87 (72.86%) and interest on operating cost was Tk.18819.5 (27.14%) of total fixed cost.

Table 4. Per hectare variable and fixed average cost for tobacco along with other crops and non-tobacco crops (the land in which tobacco was never cultivated) production in the same land for one year

Items	Tobacco along with other crops (Tk)	% of total cost	Major crops (Tk)	% of total cost
C.Variable Cost				
1.Human labor cost	195386.52	46.45	62011.20	22.29
2. Seed cost	32119.04	7.64	26693.86	9.60
3. Fertilizer cost	58436.79	13.89	77306.86	27.79
4. Machinery cost	42307.88	10.06	53204.73	19.12
6. Pesticide	58436.79	13.89	21926.28	7.88
10. Irrigation	33909.42	8.06	37052.08	13.32
Total Variable Cost	420596.43	100.00	278195	100.00
Fixed Cost				
Land use cost	55792.14	63.51	50530.87	72.86
Interest on Operating Capital	32059.64	36.49	18819.5	27.14
Total Fixed Cost	87851.78	100.0	69350.37	100.0
D.Total Cost (A+B)	508448.21		347545.37	

Gross return: Total earning amount of main product and by product is the amount of gross return. Gross return per hectare was calculated by multiplying the total amount of products by average farm gate price. By product was included for tobacco and maize production. From table 5 the gross return of tobacco and maize production were Tk. 331797.4 and Tk. 283425.7 respectively. The returns from main product and by-product specifically were Tk. 329437.8, Tk. 2359.4 form tobacco and Tk. 283304.7and Tk. 121 form maize.

Table 5. Per hectare gross return for tobacco and maize

Return	Tobacco	%	Maize	%
Product	329437.8	99.3	283304.7	100.0
By Product	2359.7	0.7	121.0	0.0
Total Value	331797.4	100.0	283425.7	100.0

Profitability of tobacco and maize (and accumulated all crops) production:

Table 6 shows the profitability of tobacco and maize production. Here, the gross return of tobacco and maize per hectare were Tk. 331797.4 and Tk. 283425.7 respectively. The variable cost of tobacco was TK. 244942.1 and maize was TK. 182235.5. Total fixed cost of tobacco was TK. 58196.3 and maize was TK. 49313. Here the estimated gross margin, net return and BCR of tobacco were TK. 86855.3 TK. 28659 and TK. 1.09 respectively, again estimated gross margin, net return and BCR of maize were TK. 101190.2, TK. 51877.1 and TK. 1.22. Table 7 show that the gross return of tobacco along with other crops for one year was Tk. 518618.7 and the gross return of major crops (in which land tobacco never cultivated) for one year was TK. 596384.38.Gross margin, Net return and BCR for tobacco along with other crops for one year were Tk. 98022.24 ,Tk.10170.46 and 1.02 respectively. Gross margin, Net return and BCR for major crops (in which land tobacco was never cultivated) for one year were Tk. 318189.38, Tk.248839.01 and 1.72 respectively. The estimated BCR (benefit cost ration) of tobacco explain that if the producer invest Tk. 1 on tobacco production, the producer get Tk. 1.09 in return.

Again, in the case of maize, if farmers invest Tk. 1 on maize production, farmers earn Tk. 1.22 in return. Both tobacco and maize products were profitable in the study area. Maize production was more profitable for the producers in the study area. For a land in which tobacco and other crops were cultivated in a year one after one, if the farmers invest Tk.1, the farmers earn Tk.1.02 after a year. Again, for a land in which any types of crop were cultivated (tobacco was never cultivated) if the farmers invest Tk. 1, the farmers get Tk. 1.72after one year. Cultivation of tobacco along with other crops one after one were less profitable but cultivation of other crops except tobacco around the year were more profitable.

Table 6. Profitability of per hectare tobacco and maize production

Items	Tobacco	Maize
A. Gross Return	331797.4	283425.7
B. Total Variable Cost	244942.1	182235.5
C. Total Fixed Cost	58196.3	49313.1
D. Total Cost	303138.4	231548.6
E. Gross Margin (A-B)	86855.3	101190.2
F. Net Return (A-D)	28659	51877.1
G. BCR (A/D)	1.09	1.22

Table 7. Profitability of per hectare for tobacco along with other crops and major crops (never tobacco cultivated) production in the same land for one year

Items	Tobacco along with other crops (Tk.)	Major crops (Tk.)
A. Gross Return	518618.7	596384.38
B. Total Variable Cost	420596.4	278195
C. Total Fixed Cost	87851.78	69350.37
D. Total Cost	508448.2	347545.37
E. Gross Margin (A-B)	98022.24	318189.38
F. Net Return (A-D)	10170.46	248839.01
G. BCR (A/D)	1.02	1.72

Factors affecting of tobacco and maize production

Estimation of tobacco and maize production function

The Cobb-Douglas production function model was utilized to analyze the profitability of tobacco and maize production, considering six independent variables: human labor cost, power tiller cost, seed cost, fertilizer cost, irrigation cost, and pesticide cost. Table 8 reveals that human labor cost, machinery and

seed cost have no significant effect on the gross return of tobacco and maize production in the study area.

Fertilizer cost (X_4): Table 8 reveals that fertilizer had no significant effect on gross return on tobacco production but the regression coefficient of fertilizer cost for maize is 0.08280 which is positive and significant at 1% level. This indicates considering all others factor constant by increasing 1% cost of fertilizer gross return increase by 0.08280%.

Pesticide cost (X_5): From table 8, the regression coefficient of pesticide cost for tobacco is -0.0498 which is negative and significant at 5% level. . This indicates considering all others factor constant by increasing 1% cost of pesticide, gross return decrease by 0.0498% and pesticide cost had no significant effect on gross return of maize production.

Irrigation cost (X_7): From table 8, the regression coefficient of irrigation cost for tobacco is 0.0198 which is positive and significant at 5% level. . This indicates considering all others factor constant by increasing 1% cost of irrigation, gross return increase by 0.0198%. On the other side, pesticide cost had no significant effect on gross return of maize production.

Table 8: Estimated values of coefficients of Cobb-Douglas production function

Explanatory variable	Co-efficient (Maize)	t-Value (Maize)	Co-efficient (Tobacco)	t-value (Tobacco)
Intercept	11.269	10.8700	12.2170	13.0971
Human labor Cost (X1)	-0.0014	-0.0161	0.1557	1.9928
Machinery Cost (X2)	-0.0202	2.3735	-0.0216	-0.7169
Seed Cost (X3)	0.0423	-0.2899	0.0071	0.2109
Fertilizer Cost (X4)	0.08280***	2.0935	-0.0966	-1.1936
Pesticide Cost (X5)	-0.0857	-3.0340	-0.0498**	-2.7141
Irrigation Cost (X7)	-0.0003	-0.0124	0.0198**	0.7431
R^2	0.4886		0.2113	
Adjusted R^2	0.3749		0.1253	
F-value	4.2994***		2.4557**	

(Source: Field survey, 2022)

Note: *** and ** indicate significant at 1% level and 5% level

Coefficient of multiple determination (R^2, adjusted R^2): The coefficient of determination (R^2) in Table 8 indicates that the independent variables in the model explained 21.13% and 48.86% variation in the gross return of tobacco and maize, respectively. Adjusted R2 values for tobacco and maize were 0.1253 and 0.3749, respectively, indicating that these variables still explained 12.53% and 37.49% of the variation in gross return, respectively.

Goodness of fit (F-Value): The F value for tobacco was found 4.2994 which were significant at 1% level indicating the good fit of the model, from table 8. The F value for maize was found 2.4557 which were significant at 5% level indicating the good fit of the model from table 8.

Elasticity of production (Ep): Table 9 shows that all inputs are individually inelastic for tobacco and maize production, indicating that the gross return per hectare of tobacco and maize does not significantly change with the change of independent variables.

Table 9. Elasticity of production and return to scale

Inputs	Maize	Remarks	Tobacco	Remarks
Human Labor Cost	-0.0014	Inelastic	0.1557	Inelastic
Machinery Cost	-0.0202	Inelastic	-0.0216	Inelastic
Seed Cost	0.0423	Inelastic	0.0071	Inelastic
Fertilizer Cost	0.08280	Inelastic	-0.0966	Inelastic
Pesticide Cost	-0.0857	Inelastic	-0.0498	Inelastic
Irrigation Cost	-0.0003	Inelastic	0.0198	Inelastic

Return To Scale ($\sum Bi$)	0.0175	Decreasing Return To Scale	0.0146	Decreasing Return To Scale

(Source: Field survey, 2022)

Return to scale (RTS): The total elasticity of production, when equal to 1, indicates constant returns to scale. If greater than 1, it indicates an increasing return to scale, and when less than 1, it indicates a decreasing return to scale. Table 9 shows that tobacco and maize have a decreasing return to scale, indicating that farmers are operating in the rational zone of production (stage 2). From Table 9 it was obvious that if all the variables were increased by 1%, the gross return of tobacco would increase by 0.0146%. On the other side, if all the variables were increased by 1%, the gross return of maize would increase by 0.0175%.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Food crop cultivation is more profitable than tobacco cultivation for individual and annual crop production. To achieve a tobacco-free country by 2040, tobacco farmers should switch to food crops that are profitable from a broader perspective. Total human labor costs for tobacco per hectare were TK. 138079.7 (56.4%), of which TK. 119422.3 (48.8%) and TK. 18487.6 (7.5%) were incurred by men and women, respectively. On the other hand, the overall cost of human labor for the production of maize was TK. 81912.3 (44.09%), with the labor costs for men and women being TK. 74232.4 (40.7%) and TK. 7550.8 (4.1%), respectively. For tobacco and maize, the total cost was Tk. 303138.4 and Tk. 231548, respectively. The gross return of tobacco and maize production were Tk. 331797.4 and Tk. 283425.7 respectively. The returns from main product and by-product specifically were Tk. 329437.8, Tk. 2359.4 form tobacco and Tk. 283304.7and Tk. 121 form maize. Tobacco's gross margin, net return, and BCR were TK. 86855.3, TK. 28659, and TK. 1.09, respectively. For maize, those estimates were TK. 101190.2, TK. 51877.1, and TK. 1.22.

Recommendation

- It's a common misconception that tobacco is more profitable, but this is untrue. Compared to tobacco, maize is more profitable. Authority should disseminate this information to people.

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APPLICATION OF REVISED BLOOMS TAXONOMY IN ENGLISH TEST BATTERIES FOR AGRICULTURE STUDENTS IN BANGLADESH: AN EVALUATIVE INVESTIGATION

F. Sultana[1], V. Sharma[2], T. Tabassum[3] and G. M. A. Taher[4]

ABSTRACT

Learning outcomes of an English course are successfully materialized when the contents are assessed, tested, and finally evaluated in a valid and reliable way, strengthening a positive backwash effect. Benjamin Bloom's Taxonomy is widely accepted and used as an assessment tool that measures the students' cognitive development. This paper aims to evaluate the English question papers prepared for the agriculture learners using revised Bloom's taxonomy at a public agricultural university in Bangladesh. It explores the extent to which the objectives of the English curriculum are reflected in question papers. Notwithstanding, it also investigates the cognitive level of taxonomy in practice to assess the students' proficiency. The impetus to work on this topic comes from observing students' more unsatisfactory performance in the English final examination that reflects their low level of understanding. For this purpose, the English curriculum and questions of different faculties during 2015 to 2019 have been taken into account as a source of data. Moreover, critical descriptive and content analyses are accomplished depending on the verb lists of Bloom's taxonomy. Besides, the collected data are then quantified to demonstrate them in a statistical form. Accordingly, five English teachers were interviewed on the application of Bloom's taxonomy in the research context. Henceforth, this study includes a mixed-method approach using both qualitative and quantitative data. The findings of the paper reveal that the question papers include mostly the lower-domain or level of taxonomy focusing the remember, understand, and to some extent apply levels. Further, the objectives have not been duly justified in the question papers. Hence, it reveals that the present assessment technique does not follow a higher domain of metacognitive skills in developing the creative faculty of the students. Finally, the study suggests that the existing English questions need to be prepared to focus on the higher cognitive domain of knowledge to make the learners cognitively competent in communication.

Keywords: ELT, evaluation, bloom's taxonomy, assessment, tool, cognitive domain, critical thinking

INTRODUCTION

Education is a route that helps to intake, construct, and develop learners' attitudes, beliefs, thoughts, knowledge, as well as intelligence. Henceforward, graduate agriculture students need to be taught in a way so that they can contribute to the modern globalized world using their creative faculty. Different assessment processes and rubrics have been used to measure the degree of students' learning outcomes, developments, and achievements. It is widely held that there is a constant and direct relationship between the assessment process and pedagogical learning systems (Hasan *et al.,* 2013) as they create, shape, process contents, materials, and formulate ways of creative learning. However, to develop the cognitive thinking process in a pedagogical teaching-learning context, Benjamin Bloom developed the taxonomy which is being used as the ELT practitioners' guide as well as an assessment tool since 1956 (Herring *et al.,* 2019). The educational objectives of the established taxonomy are to help the curriculum developers, teachers, ELT practitioners to create productive learning activities and assessment tools to measure the students' learning (Hasan *et al.,* 2013). Assessment tools and taxonomies help to collect, record, explain and transfer information about students' progress during the formation and development of knowledge, concepts, attitudes, beliefs, and skills (NCCA, 2004 as cited in Fayyaz *et al.,* 2019). Therefore, question papers formation in different English language skills has become one of the traditional and celebrated assessment tools to measure learners' proficiency (Rajvinder, 2018). Question papers need to be valid and reliable so that they can create a positive

[1] Asst. Professor, Dept. of HSS, Dhaka University of Engineering and Technology, Gazipur, Bangladesh [2]Professor, Dept. of English, Aligarh Muslim University, Aligarh, India, [3]Asst. Professor, Dept. of Language, Sher-e- Bangla Agricultural University, Dhaka Bangladesh. [4]Doctorate Fellow, Department of English, Aligarh Muslim University, Aligarh, India

backwash effect on the students. They should contain all levels of cognitive skills in order that the students can sharpen their reasoning and intellectual faculty of knowledge. As poor and low-quality examination papers make the learners be dependent on the use of rote memory (Cepni and Azar, 1998). Therefore, critical and logical questions need to be set to make the learners creative and intellectually proficient (Bruladi, 1988).

In an agricultural context in Bangladesh, both formative and summative assessments are practiced role play, presentation, laboratory reports, assignments, project work, problem-solving activities, formal written examinations, etc. to measure the learning of the students. Unfortunately, it has been observed that in the selected agricultural university, the only summative form of assessment, formal final examination, is extensively used to assess the students' learning outcome. Besides, it has also been perceived that students set learning outcomes, predominantly attaining communicative competence, mentioned in the curriculum is also not duly ensured by the practiced assessment systems. Therefore, this paper attempts to evaluate the English question papers made for the undergraduate agriculture students using revised Bloom's taxonomy to find out to what extent the objectives of the English curriculum are reflected in question papers. Nevertheless, it also tries to investigate what cognitive level of taxonomy, lower or higher, is in practice to assess the students' proficiency.

Statement of the problem

Agriculture students have to accomplish both verbal and written communication in English efficiently both in their educational and workplace sectors. Notwithstanding, they need to construct, analyze, create as well as use knowledge to solve problems in both academic and practical fields. This could be ensured if the six hierarchical knowledge domain of Bloom taxonomy is used in the question papers to measure their competence in the English language. However, the existing assessment processes to measure their English language proficiency seem inadequate to assimilate all domains of knowledge. Hence, the research article is an attempt to evaluate the existing English question papers to find out the level of the cognitive knowledge domain. It also looks into the alignment of the curriculum objectives reflected in the question papers.

Research questions

This research paper includes two research questions. They are as follows:

1. To what extent the objectives of English curriculum are reflected in the question papers?
2. What level of cognitive domain of Bloom's taxonomy is in use in the existing English paper to measure the students' competence?

Theoretical background

To evaluate the English questions prepared for the agricultural learners in Bangladesh, it is important to scrutinize the introspective views and thoughts of other scholars both home and abroad about the assessment tools and evaluation process in alignment with the revised Bloom's taxonomy. To fulfill the purpose of this research paper, the scholar centers on the cognitive code theory of language teaching that helps the students to use their reasoning capability, build as well as create their own thoughts, ideas, and views depending on their existing schema. Therefore, this paper has taken into consideration the constructivist theory of learning that is a process of making new knowledge from the known ideas, schema (Vygotsky, 1978). This constructivist theory can be best executed by the implication of the 'zone of proximal development' concept where the students can self-direct themselves using their creative and analytical faculty to solve activities both in pairs and groups with the help of their teachers as facilitators (Usman, 2015). Therefore, this study intends to focus on the learner-centered, guided self-directed module of the humanistic approach of language learning as the agricultural learners need to be contributors that require cognitive critical ability, both in their academic and work areas (Herring & Somoye, 2019). However, memorizing and regurgitating facts only assure rote learning which lacks reasoning, discerning, and critical thinking ability. Therefore, it is important to ensure the creative aspect of learning by the implementation of a higher domain of Bloom's taxonomy in assessment procedures.

The English curriculum of the selected agricultural university primarily aims to make the learners capable of communicative competence. In addition, it seeks to develop their grammatical, lexical,

listening, speaking, reading, and writing skills respectively. Therefore, the evaluation of English question papers is conducted to explore whether their communicative competence, grammatical competence (Canale and Swain, 1980), and the LSRW skills are ensured or not through the practiced examinations. Besides, the challenge lies in introducing all the six levels of taxonomy in the assessment process as almost all the higher secondary and tertiary assessment systems employ memory and recalling facts (Crooks, 1988). As well, classroom practices are used to conducting classes focusing on the lower level of cognition like remembering, defining, or recalling any objects (Whittingon & Newcomb, 1993 as cited in Eber & Parker, 2007).

Subsequently, it further attempts to look into whether the reflection of the cognitive domain of Bloom's taxonomy is used or not in the English question paper and what level of cognitive is used in question papers. Hence, the researcher intends to employ self-directed learning methods as here students can identify their needs, select goals, materialize resources, and assess learning outcome of their own without taking others help (Knowles, 1975) to aid the agricultural learners in attaining behavioral and cognitive knowledge reflected in Bloom's taxonomy.

Bloom's taxonomy is a classification system of educational objectives and a widely used assessment rubric that consists of six cognitive levels of abstractions namely knowledge, comprehension, application, analysis, synthesis, evaluation. Later, the graduated levels are renamed as remember, understand, apply, analyze, evaluate, create (Anderson, 1999).

Remember: This is the foundation level of cognitive processing which involves recalling, retrieving, and recognizing information from long-term memory. It takes account of learning different kinds of facts, incidents, and ideas and memorizing that information

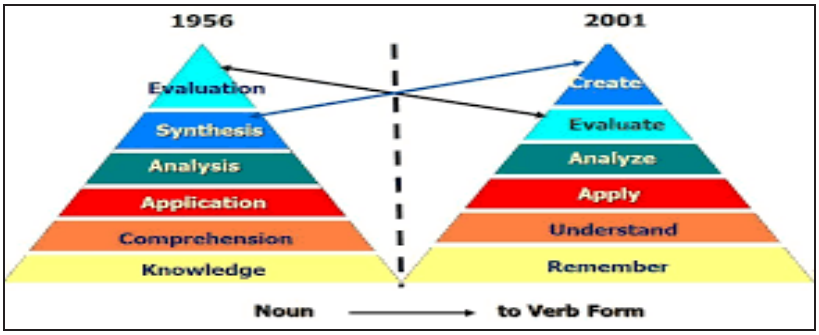

Fig. 1. Changes in the sub-domain of Bloom's Taxonomy

The common verb lists that are used here to teach the learners recalling information are tell, define, identify, describe, list, outline, match, show, state, etc.

Understand: In this level, students are able to integrate their existing cognitive knowledge with the perceived information. Experiential cognitive learning makes the students competent in differentiating, classifying, categorizing, arranging, interpreting, predicting, illustrating, and summarizing information.

Apply: At this point, learners are capable of executing and implementing their prior schematic knowledge in a new situation by applying, inferring, modifying, predicting, examining, and calculating ideas and thoughts.

Analyze: This level involves breaking materials into different constituent parts and then being able to relate them correctly to serve the overall purpose. This cognitive process domain attempts to make the learners organizing, analyzing, debating, and deconstructing information.

Evaluate: At this higher domain of knowledge, students can make judgments on any issue, detect fallacies or inconsistencies of any process, and determine the quality of anything depending on leveled criteria. Therefore, the level lets them appraise, criticize, recommend, support, standardize, and validate any sought of knowledge or idea.

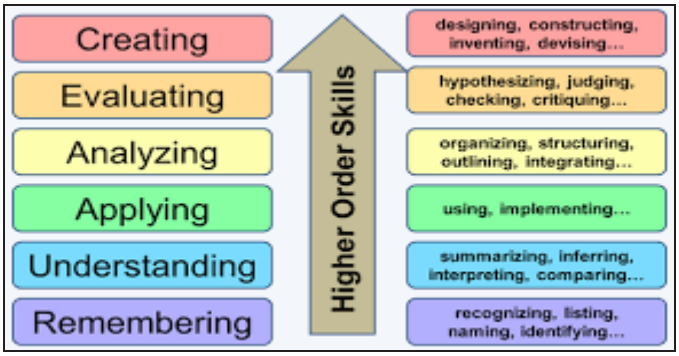

Fig 2. The revised Taxonomy

Create: Creating is the highest level of cognitive learning where the learners are expected to be able to put different materials and elements together to create a new coherent entity. This level helps the learners to design, draw a conclusion, write, produce, and develop ideas based on preferences.

The assessment techniques that include both the learning and cognitive skills according to the six hierarchical stages of Bloom affirm students' reasoning, decision-making, critical thinking, synthesis, and analysis ability (Jones *et. al.,* 2009). Contrastively, most of the assessment tools cover up only the remembering level and end by the memorized chunks and data (Köksal and Ulum, 2018). Therefore, only the lower stage of cognitive skill is reflected in the traditional and practiced question papers that make the learners used to rote learning. Among the six cognitive stages of Bloom, the three steps are recognized as lower and the other three are as higher cognitive order skills (Eber & Parker, 2007). Hence, the lower order skills are remembering, understanding, and applying whereas the higher domains are analyzing, evaluating, and creating (Orey, 2010). Swart (2010) experimented with the discrepancies among the lower and higher-order skills found in question papers and revealed that they only included the lower domains, highly up to the application level. This kind of assessment where low and poor quality questions are set made the students fully dependent on their memorization (Çepni & Azar, 1998). Similarly, Köksal and Ulum (2018) conducted a study to explore the higher and lower cognitive level of questions used to measure students' proficiency. The study revealed that general questions really lack higher cognitive thinking.

Finally, they suggested recommendations to improve the quality of the question papers using creative tasks so that the learners can use their theoretical knowledge in practical communication. In a similar vein, Ebar and Parker (2007) reinforced that exposure in the classroom should be given in a higher domain of knowledge to make them acquiant with experiential learning; otherwise, the students will be dependent on their remembered information. This could be guaranteed by the incorporation of all six cognitive aspects of knowledge. Therefore, they strengthen the use of six levels of the cognitive domain as an assessment tool.

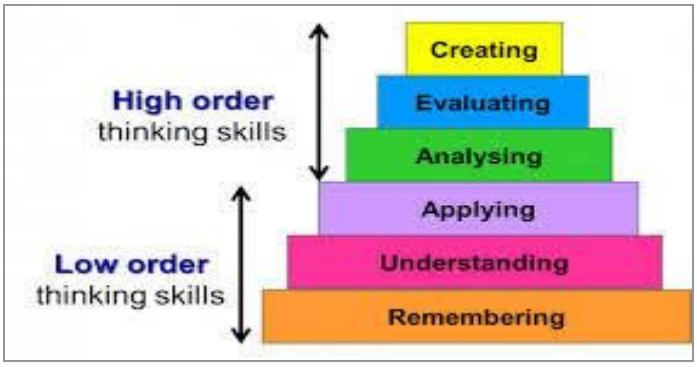

Fig. 3. The lower and higher divisions of Bloom's Taxonomy

A cross-analysis among students' performance, cognitive skill requirements, and learning outcomes in light of Bloom's taxonomy has been done by (Jones *et al.,* 2009) where they suggested that examination questions need to be made in alignment with the course objectives so that the performance of the students can be at a satisfactory level. Additionally, besides using all six domains of skills in question papers, Bloom taxonomy can direct and guide to form behavioral and cognitive learning objectives. It can be ascertained both by the active participation of the educational practitioners and the learners in a pedagogic context. Once the upper domain of taxonomy is introduced, the learners can self-direct themselves in any situation. Therefore, Bloom's taxonomy ensures experiential, self-guided learning where the learners can construct their own form of knowledge in real-life situations (Herring & Somoye, 2019).

The conducted researches presented that in most of the cases only the remembering and understanding levels are justified in question papers. As a result, the prescribed objectives mentioned in the curriculum are most of the times remain unimplemented. Resultantly, learners face difficulties in constructing new ideas using their existing knowledge. Further, the objectives of teaching are not confirmed properly. Though lots of works are directed in this field, the agricultural learning context in Bangladesh is ignored in terms of applying Bloom's taxonomy properly in assessing students' proficiency. This is realized by seeing the poor performance of the students in creating and analyzing any academic and non-academic activities. In the agriculture context, English is taught as a foundation course. Hence, the specific needs and objectives of the students are to be given priority.

Therefore, in this research paper, the researcher looks into the curriculum objectives and introspects whether they are met or not in the examination question papers. Besides, the level of the cognitive domain which is in practice in assessing students' outcomes is also judged to look into the application of Bloom's taxonomy as a tool to construct reasoning capability.

MATERIALS AND MEHOD

This section briefly describes the nature of the research, methods of data collection, and analysis procedure.

Mixed-method research

This study followed an approach to analyze and describe the contents. The content used for this study included the five years' English question papers from 2015 to 2019 set for the undergraduate agriculture learners in Bangladesh. "Qualitative content analysis scrutinizes transcribed texts that count the instances of words, phrases, or grammatical structures that fall into special categories ((Dornyei, 2010)." Subsequently, this study analyzes the five years' English questions depending on the verb lists of Bloom's taxonomy to measure the cognitive level that is practiced at present in the research sites. It also includes interviews of five English teachers who are currently teaching the agriculture learners about the use of Bloom's taxonomy in the evaluation process. After analyzing question papers based on verb lists, they have been then categorized into the six levels of Bloom's taxonomy. The content categories have been then analyzed using Microsoft excels to determine the relative frequencies and percentages of the levels used in questions. Thus, the study followed a mixed-method approach.

Data collection

At the outset, the qualitative data, the English question papers of 2015 to 2019, were collected from the examination controller section of the public agricultural university, Bangladesh. Consistently, the English curriculum has also been consulted to match the course objectives with the question papers. Later on, an inclusive interview is conducted with the five English teachers teaching at the research site at different times to collect interview data about the use of Bloom's taxonomy in preparing the English questions for the undergraduate agriculture students.

Data analysis techniques

The data have been analyzed using a descriptive content analysis technique where the researcher has to manually identify, select, match the level of cognitive skill level using Bloom's verb lists and curriculum objectives. Then they are quantified using MS Excel to show them graphically.

RESULTS AND INTERPRETATIONS

Findings from the question analysis (2015 to 2019)

The bar charts, as well as the pie charts in this section, recapitulate the percentages and frequencies of the six levels of the cognitive domains in Bloom's Taxonomy that are used as rubrics in assessing the English language skills likely the vocabulary, writing, reading, speaking, and listening skil**ls** of the undergraduate agriculture learners in Bangladesh.

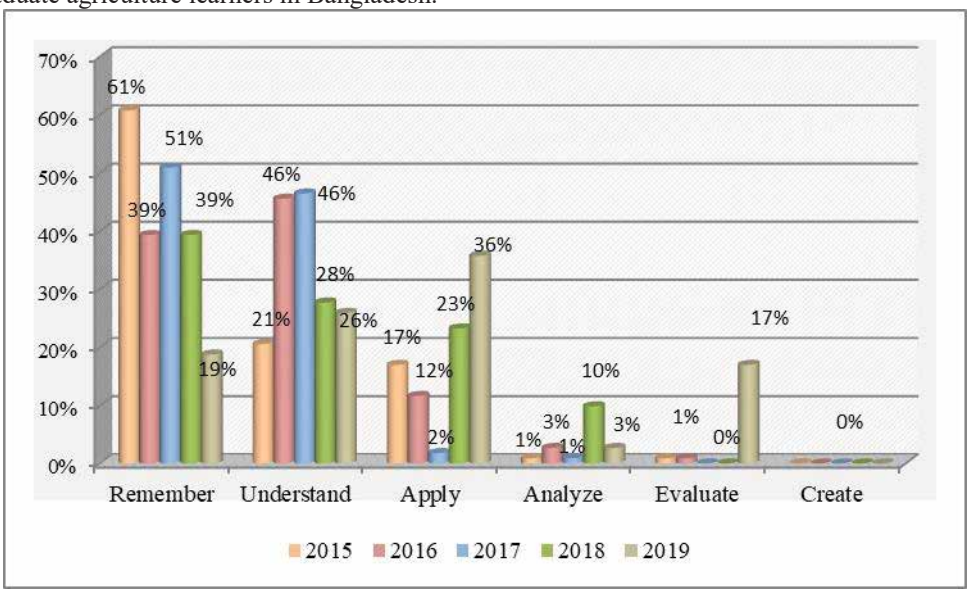

Fig. 4. Subtle categorization of Evaluation levels in assessing vocabulary skill

The bar chart in Fig. 4 demonstrates the percentages of the six cognitive domains of Bloom's taxonomy that have been used in the English question papers from 2015 to 2019 to assess the attainment of the students' vocabulary knowledge. During theis period, total 560 questions were prepared, each year comprising 112 vocabulary questions by the English teachers teaching at the agricultural site to measure the students' vocabulary development.

It is evident from the chart that throughout these years, teachers employed mostly lower domain vocabulary questions as the remember, understand and apply levels prominently stood upright in the chart minimizing the analyze, evaluate and create level. Henceforward, in 2015 and 2017, 61% and 51% questions are set from the remember domain. likewise , 39% lexis questions were included from the remember level as well in 2016 and 2018 respectively. In a similar vein, 46% questions were prepared from the understand domain in the years 2016 and 2017. Though the vocabulary questions in 2015, 2016, and 2017 include remarkably the lower-order cognitive knowledge stage, the questions in 2019 is somewhat different from the earlier ones as here 36% and 17% questions are set from the apply and evaluate level. Notwithstanding, in 2018, 10% questions are assorted from the higher apply domain.

Nevertheless, none of the respective years' questions include the create domain to develop the students' problem-solving capabilities. In Fig. 5, the frequencies of the six cognitive domain of Bloom's taxonomy in measuring the agriculture students' vocabulary skill during 2015-2019 is presented. It is clear that the vocabulary measurement questions mostly include the lower-order domain of Bloom's taxonomy. During those time frames, the questions incorporate 42% remember level verb lists, 33% understand level, and 18% apply level verbs. Contrastively, the vocabulary testing questions did not cover any create domain though only 3% and 4% questions are assorted from analyze and evaluate domains respectively.

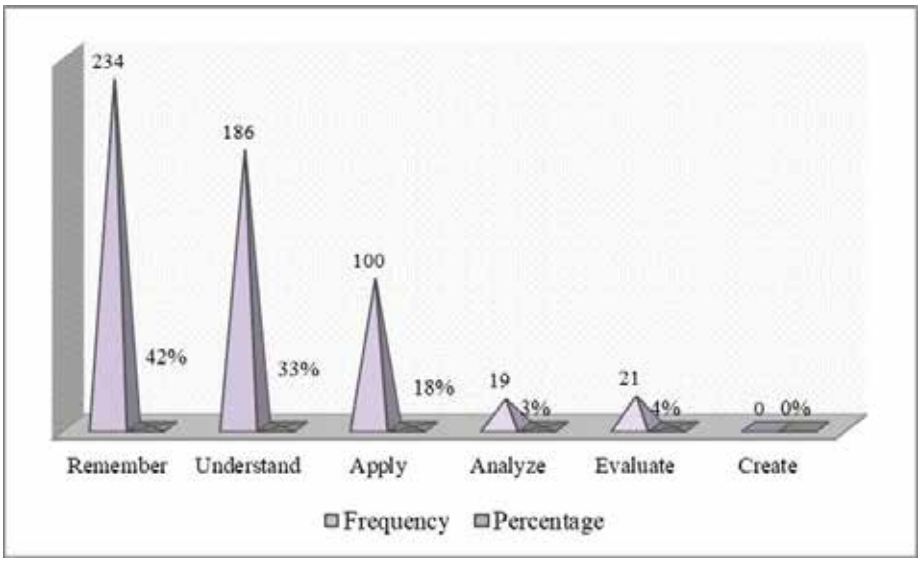

Fig. 5. Frequencies of the six levels of the Cognitive domains in Bloom's Taxonomy in assessing vocabulary Skill (2015-2019)

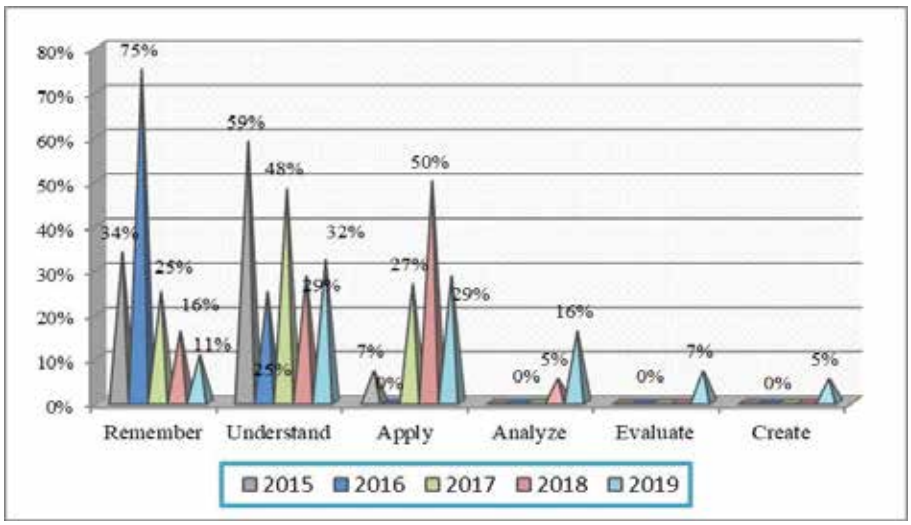

Fig. 6. Subtle categorization of Evaluation levels in assessing Writing Skill

Fig. 6 illustrates the percentages of the six levels of Bloom's taxonomy in measuring the agriculture learners' writing skills from 2015 to 2019. The chart clearly depicts that mostly the remember, understand, and apply levels have extensively been used in the respective years to assess the students' writing capabilities. The highest level, 75%, writing test questions are organized from the remember section in 2016. Similarly, 59% and 48% questions in 2015 and 2017 are accomplished from the understand domain which is also a lower domain of cognitive knowledge. Alternatively, the least questions were taken from the higher cognitive domain like analyze, evaluate, and create stage. Here, only 16% writing assessment questions are included from analyze domain, 7% from evaluate, and only 5% from create level in 2019 which is not proportionate to improve the agriculture students' writing skill.

In Fig. 7, the pie chart exemplifies the total frequencies (2015 to 2019) of the six cognitive domain of Bloom's taxonomy in evaluating the agriculture learners' writing skill. At this point, 39%, 108 action verbs have consistently been used that connote to the objectives of the understand level. Likewise, 32%, 90 in number, writing tests are conducted using the lower remember level. Correspondingly, 23% questions include the apply domain.

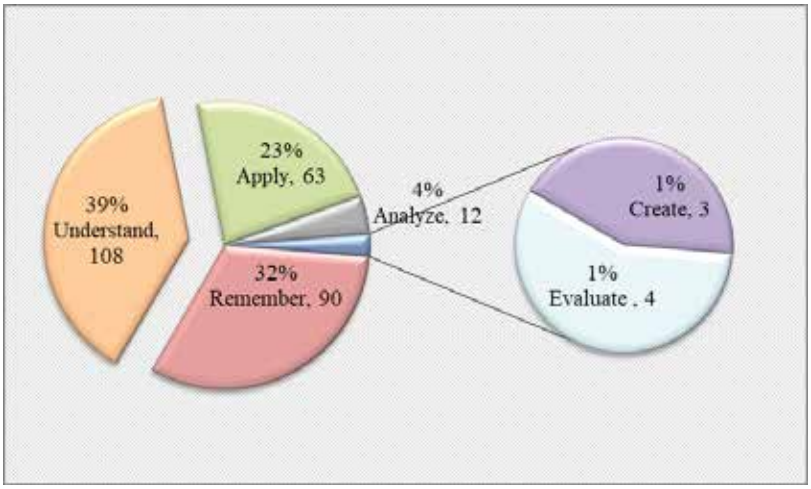

Fig. 7. Frequencies of the six levels of the Cognitive domains in assessing Writing Skill (2015-2019)

Contrastively, the higher domain writing questions are only 1% and 4% that is not up to the mark of any standard writing test.

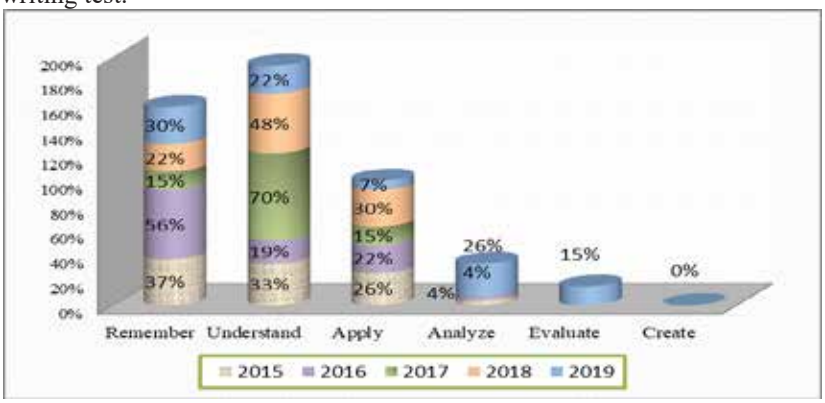

Fig. 8. Subtle categorization of Evaluation levels in assessing Reading Skill

Fig. 8 shows the percentages in the six evaluation levels of Bloom's taxonomy in measuring the reading skills of the agriculture learners from 2015 to 2019. It is clearly portrayed that most of the reading tests comprise understand and remember level questions that make the learners habituated in the rote mode of language learning. 70% and 56% questions are set from understand and remember domain in 2016 and 2015 though 26% were from the application level in 2015. Besides, 48% were from the understand level in 2018.

Thereof, it is obvious in the bar graph that the reading test questions in the years of 2015, 2016, and 2017 consecutively are set from the lower domain of Bloom's taxonomy. A change is noticed in 2019 where the inclusions of all the six cognitive domains are apparent as it includes 26% analyze, 15% evaluate, and lastly 0% create level questions.

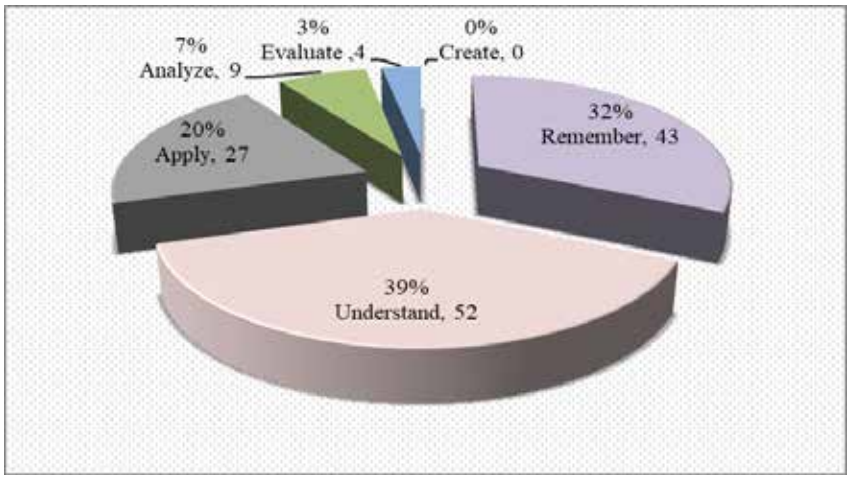

Fig. 9. Frequencies of the six levels of the Cognitive domains in Bloom's Taxonomy in assessing Reading Skill (2015-2019)

The pie chart in Fig. 9 explores the frequencies of the action verbs used in evaluating the reading skill of the agriculture students. Most of the questions are fixed employing the remember (32%) and understand (39%) level respectively. 20% is set from the application domain whereas only 7% and 3% are from analyzing and evaluate sections. Besides, no question is made using the create option.

Fig. 10 demonstrates the proportions of the six cognitive echelons of Bloom's taxonomy in measuring the agriculture learners' speaking skills from 2015 to 2019. It is vivid in the chart that the speaking test questions are prepared solely based on the lower domain of Bloom's taxonomy namely the remember, understand, and apply level.

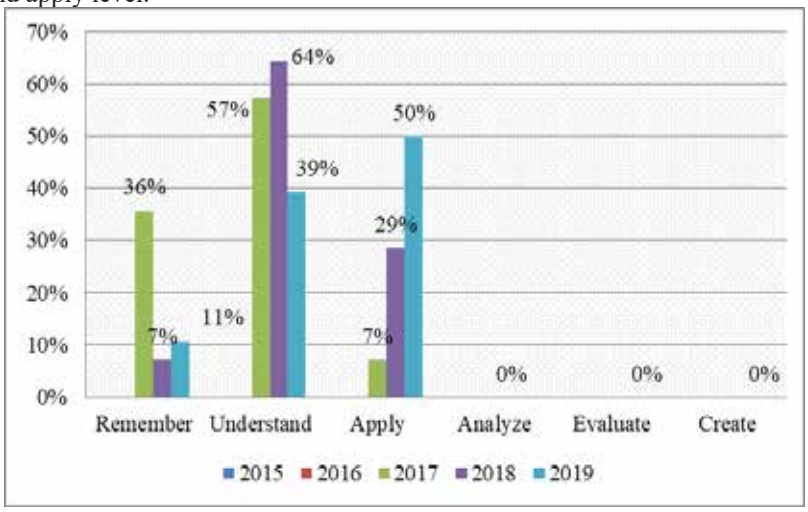

Fig. 10. Subtle categorization of Evaluation levels in assessing Speaking Skill

For instance, the majority of the questions 64%, 57%, and 50% are set from understand and apply domain in 2018, 2017, and 2019 respectively. Contrastively, no speaking test questions are fixed from the higher domain cognitive level, analyze, evaluate, and create section, in those years. Resultantly, the speaking assessment system in those periods could not cater to the communications skill proficiency of the students.

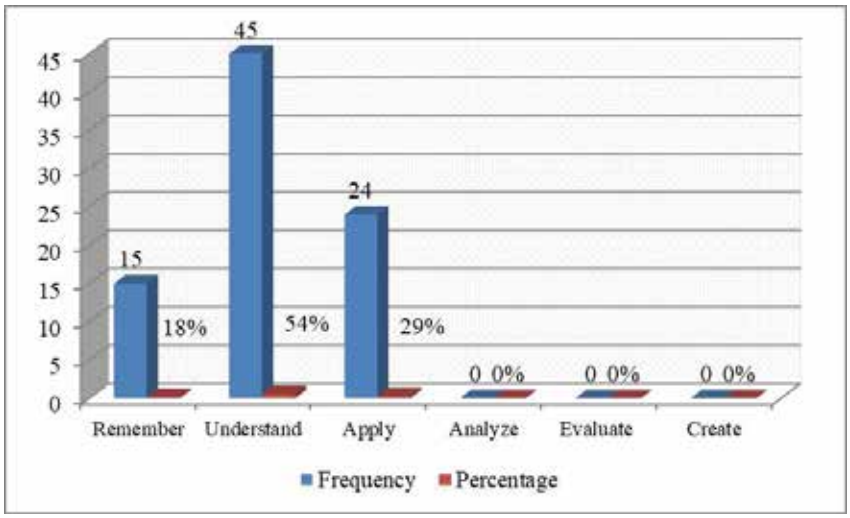

Fig. 11. Frequencies of the six levels of the Cognitive domains in Bloom's Taxonomy in assessing Speaking Skill (2015-2019)

The bar graph in Fig. 11 reconnoiters the frequencies of the six cognitive domains of Bloom's taxonomy that have been incorporated in assessing the agriculture students' speaking skills during 2015 to 2019. The chart subtly explores that the students' speaking competency is assessed merely including 54% questions from the understand section, 29% from apply, and 18% from the remember domain. Besides during those years, learners are not judged by any type of questions that made them analyze, evaluate, and create any kind of information.

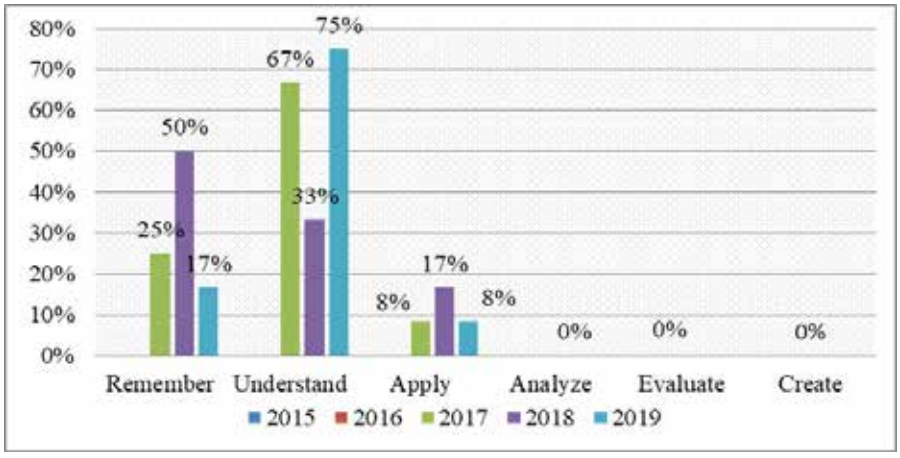

Fig. 12. Subtle categorization of Evaluation levels in assessing Listening Skill

Fig. 12 is the representation of the calculations of six evaluation domains of Benjamin Bloom that have been assorted to test the agriculture students' listening competency during 2015 to 2019. The bar chart projects that 75% and 67% questions are made from the understand level in 2017 and 2017 respectively. Besides, 50% listening test questions are covered from remember level in 2018. The higher order cognitive domains such as analyze, evaluate and create have not been applied to measure the students' listening skill. Therefore, it is evident that the listening skill assessment criteria completely resort to the lower cognitive domains of Bloom taxonomy.

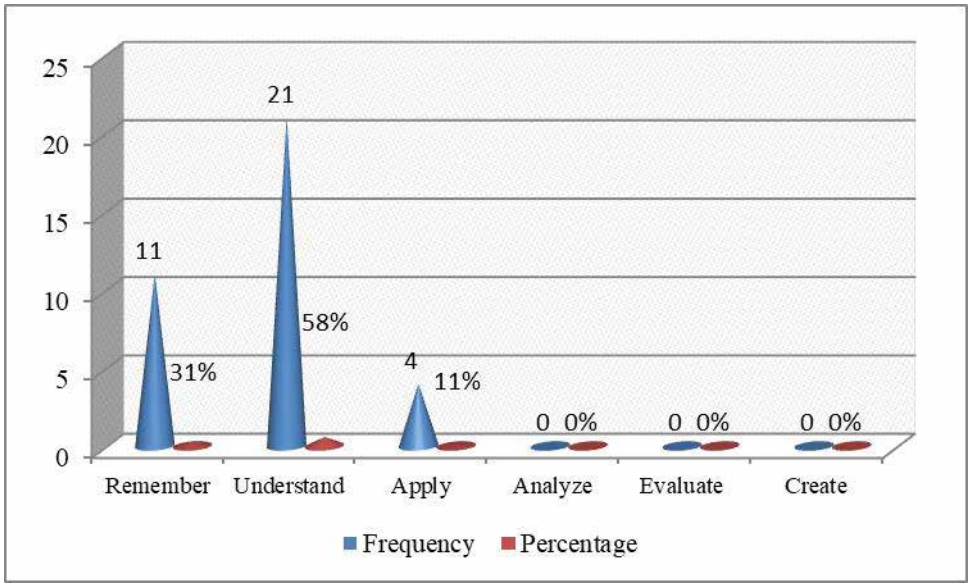

Fig. 13. Frequencies of the six levels of the Cognitive domains in Bloom's Taxonomy in assessing Listening Skill (2015-2019)

Fig. 13 exemplifies the frequency of the listening test questions according to the six cognitive orders of Benjamin Bloom. The graph exports that 58% listening questions are made from the understand section, 31% from remember, and 11% from apply. Moreover, during those periods, the higher domains were neglected completely in making the learners utilize their creative and reasoning faculty.

Findings from the teachers' interview data

The five English teachers teaching at the agriculture research site haveoutlined that the techniques and the existing English language assessment criteria are summative in nature. It still sticks to the traditional ways of evaluation processes as most of the formats comprise broad, narrative, and extended questions. Almost all the teachers reveal that in 2015, 2016, 2017, and 2018 mostly, the students' English language competency was measured by the extended written tests. Moreover, listening and speaking tests were not conducted at all maintaining the six cognitive levels as there were constraints of digitalized classrooms. Resultantly, the students resort to the only 'touch and pass' system and for this, they used to collect the English question papers of earlier years. Hence, the objectives of the courses to be communicatively competent and gain the mastery of the LSRW skills remain unfulfilled by the assessment and evaluation procedures. Referring to the predictability of the question papers, one of the teachers uttered that "the prevalent assessment procedure makes the students habituated to collect and solve the earlier year examination papers. These types of culture in the evaluation process create a negative backwash effect among the students and lead them to the rote mode of learning systems". Two of the teachers also employ that they rarely could embrace the higher domain questions both in class and examination as to do so, the students have to give enough time to practice. Nevertheless, as the class time and the number of classes are fixed and limited, sometimes it became hard to manage for the teachers to introduce those advanced domain tasks to be accomplished in classrooms. Therefore, time constraints made the system focus on just the completion of the syllabus concentrating on the usual format of tasks and assessment systems. Henceforth, though recently certain steps have been initiated by the Institutional Quality Assurance Cell (IQAC) and university authority to form a standardized format of questions including the six cognitive domains of Bloom, though they are still not up to the mark. Hence, the teachers' interview data delineated that the English language

assessment systems in the research context hardly include the advanced cognitive level questions as there remain some resource and infrastructural constraints. Resultantly, in most of the LSRW skills, only the lower domain cognitive questions are found dominant that made the learners focus on just the competition of the required syllabus rather than developing reasoning faculty.

DISCUSSIONS AND RECOMMENDATION

The results from the evaluation of English questions of the last five years and the interview records of the teachers signify that the agriculture students' LSRW skills' measurement procedures do not embody all the perceptive areas of Bloom's taxonomy. Correspondingly, the high percentages of the final questions in measuring the students' vocabulary and LSRW skills represented in the charts and graphs cover the understand, remember, and application-level stages. The findings of this study are inlined with Swart's as well as Koskal & Ulum's experiment where they reconnoitered that the respective questions lack higher-domain taxonomy and cognitive thinking skills. Therefore, the objectives of the course curriculum are not justified and met by the assessment criteria. Hence, (*Jones et. al.'s* ,2009) suggestion 'creating questions aligning with the course objectives to let the students perform satisfactorily in academic and social contexts' need to be considered predominantly. Accordingly, many agriculture graduates cannot stimulate, think, and redirect different tasks both in academic and non-academic contexts. Some of the students cannot write properly to please their corporations as well. Above and beyond, many of them remain incompetent to reason clearly and perform proficiently in solving and analyzing complex and creative techniques as well as non-technical problems (Swart, 2010). Further, it is evident that the vocabulary questions mostly include the 'make' 'frame', 'write', 'define', 'identify', 'form', 'choose', 'what are', 'complete', 'use', 'give', 'change' etc. action verbs in written questions which mostly comply to the lower remember and understand level of Bloom's taxonomy. Resultantly, the students barely can retain and apply their skills in different employment sectors. Likewise, the absence of complex thinking questions in the vocabulary test cannot stimulate their mental activities. Thus, Fayyaz recommended assessments need to integrate higher domain levels to make the students creative, practical, and realistic. In a similar vein, the writing tests mostly incorporate the verbs like 'write', 'describe', 'place', 'define', 'put', 'study', 'discuss' that also connotes to the remember and understand intellectual level. Besides, 'transferring' and 'analyzing' tasks were encompassed in the final examination to a lesser extent. Here, the higher-order levels are seen ignored distinctly. As a standard question constructs as well as promotes creativity, problem-solving and decision framing capabilities, and critical-thinking skills, the writing test questions need to associate all the cognitive stages so that the students become capable of constructing meaning in real-life situations (Swart, 2010). The reading test questions generally include only the 'reading comprehension' tasks that include multiple-choice questions, gap filling, short question answers, etc. The other reading skills like scanning, skimming, predicting, paraphrasing, and summarizing have been least taught and measured in the past five years. Therefore, the questions include only the lower-level cognitive skills that make the students memorize concepts and facts rather than analyzing things. The verbs that have been constantly used in reading tests are 'read', 'answer', 'choose', 'what', 'which', 'write', 'complete', 'match', 'when' etc. Besides, the descriptive content analysis process illustrates that very few questions in reading tests are set from the analysis and apply sections using verbs like 'how', and 'why'. Similarly, the listening and speaking tests were conducted based on the summative format of assessments that ultimately could not fulfill the students' expectations in being communicatively competent in oral skills. Therefore, it is evident from the analysis that the English questions fail to incorporate and bridge the gap between higher and lower domain skills proportionately that eventually fail to ascertain the agriculture students' creative and reasoning faculty. As a result, some suggestions are proposed both by the teachers and students to create skillful questions as it helps them foster and stimulate perceptive abilities (Chin & Langsford, 2004). The recommendations are as follows:

- The number of English classes and the duration of the classes need to be increased to make the learners proficient in English.

- The number of English courses to be enhanced side by side their core subjects.
- The language classrooms need to be technically sound and digitally equipped.
- The materials need to be more contextualized and culture-bound to make the learners intrinsically motivated to learn English rather than completing the syllabus for the sake of passing examinations.
- The teachers ought to include more interesting and elaborative language tasks that ensure interaction and the inculcation of problem-solving skills. Besides, in the light of Ebar and Parker(2007), classroom exposures need to be accomplished from a higher domain for experiential learning.
- Students need to give proper time and assistance in solving language puzzles.
- ELT practitioners would assist the students to use their schematic knowledge to be in the zone of proximal development.
- Students have to be given both written and oral feedback where necessary.
- The speaking tests need to include more practical orientations like presentations, debates, role-plays, etc.
- Listening tests to be conducted solely to focus on listening based activities.
- Reading and writings need to incorporate all the sub-skills like teaching and testing scanning, skimming, predicting, paraphrasing, writing academic etiquettes, etc.
- Finally, the teachers have to use rubrics while setting questions and include more open-ended type questions in tests.
- Balancing of six cognitive domains needs to be ensured in question papers.

CONCLUSION

The research study evaluates the English question papers of the last five years (2015-2019) using Bloom's taxonomy as a theoretical framework. The descriptive content analysis procedure by sorting the verb lists used in making questions revealed that the English question papers were not appropriately balanced intaking both the lower and higher cognitive levels of Bloom. Consequently, the course objectives, to be communicatively proficient in mastering LSRW skills in the academic and professional arena, are not justified. Besides, the analysis and findings of the research reveal that only lower domain knowledge-based questions are used repeatedly to measure agriculture students' language skills. As a result, accordingly have argued that they cannot reflect, conceptualize, develop, and finally adapt scholarly thinking in solving complex and nontechnical hitches. Therefore, a balance is suggested between higher and lower domains of cognition to make the learners adept in all the language skills that could certainly produce skilled and expert agriculturists in future.

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COMPARATIVE HEALTH HAZARD ANALYSIS OF NON-TOBACCO AND TOBACCO PRODUCER IN MANIKGANJ DISTRICT OF BANGLADESH

H. M. Sammy[1*], M. A. Kabir[2], R. Rahmatullah[3], A. Y. Sampa[4] and S. Islam[5]

ABSTRACT

Tobacco farming people, especially women and children, suffer from specific kinds of respiratory diseases at the time of curing in direct sunlight or the fired-cured method. Tobacco cultivation is responsible for severe non-communicable diseases among tobacco producers and other people in tobacco-cultivated areas. To estimate the health costs of individuals in tobacco-cultivated areas, a cross-sectional and comparative study was undertaken among tobacco and non-tobacco farmers with family members in Manikganj districts. A total of 120 households were selected through a multi-stage cluster sampling technique, and each household head was interviewed face-to-face using a semi-structured questionnaire to gather information on households, family members, health hazards (categorized as severe, moderate, and mild), and farming. The quantitative data were analyzed using both descriptive and inferential statistical approaches. In this study, 120 households consisted of a total of 501 household members. About three-fifth (64.27%) of all household members suffered from tobacco-related sickness. The average treatment costs for non-tobacco and tobacco growers were BDT 5,015 and BDT 9,733.57, respectively. The average number of sick days and lost workdays were 17.74 and 9.82 for non-tobacco growers, compared to 20.17 and 12.29 for tobacco growers. The binary logistic regression results indicate that sicknesses were found to be a higher risk for tobacco growers at the severe level compared to non-tobacco growers. The health risks of tobacco farming, including green tobacco sickness and other issues caused by excessive exposure to pesticides, chemicals, tobacco dust, and long working hours; the severity of these issues increased during cultivation. Moreover, tobacco cultivation carries the risk of disease burden. To achieve a tobacco-free country by 2040, tobacco farmers should cultivate food crops that are profitable and no health hazard of the farmers from a broader perspective instead of cultivating tobacco.

Keywords: Health hazard, tobacco, logistic regression, sickness, smoke-free.

INTRODUCTION

Farmers who plant, cultivate and harvest tobacco are at risk of suffering from a form of nicotine poisoning known as "Green Tobacco Sickness". This symptoms causes nausea and vomiting that can lead to hospitalization and lost work time (Ballard *et al.,* 1995). Green tobacco sickness (GTS) is the condition that mainly affects the tobacco harvesters. It is caused by the absorption of nicotine through the skin while the workers are engaged in handling the uncured tobacco leaves (Fotedar S & Fotedar V 2017). It is estimated that 86% of the nicotine absorbed by the body is bio-transformed into cotinine, the main metabolite of nicotine, with a half-life of around 20 hours (Dhar P. 2004). For a season, in search of even more profits, the tobacco industry has encouraged countries and farmers to grow more tobacco (Dhar P. 2004). While the tobacco industry argues that tobacco farming is a major contributor to the country's economy, the seriously damaging health and environmental impacts caused by tobacco farming have been well documented (Mackay & Eriksen, 2005). The hazards posed by tobacco cultivation place tobacco workers at increased risk of injury and illness. Children and adults (mainly women) working with tobacco frequently suffer from green tobacco sickness (GTS), which is caused by dermal absorption of nicotine from contact with wet tobacco leaves. GTS is characterized by symptoms that may include nausea, vomiting, weakness, headache, dizziness, abdominal cramps, and difficulty in breathing, as well as fluctuations in blood pressure and heart rate (Kinh & Bales, 2002). Five parameters particulate matter ($PM_{2.5}$, PM_{10}), carbon dioxides (CO_2), volatile organic compounds (VOCs), temperature and humidity are measured and mentioned to reduce the air pollution (Sarker *et*

[1] Corresponding authors & Associate Professor, Dept. of Agricultural Statistics, Sher-e-Bangla Agricultural University, Dhaka 1207, [2] Professor, Dept. of Statistics and Data Science, Jahangirnagar University, Savar, Dhaka-1342, [3]Graduate Researcher, Department of Industrial and Systems Engineering, College of Engineering, Lamar University, USA, [4]Assistant Professor, [5]MS Student, Dept. of Agricultural Economics, Sher-e-Bangla Agricultural University, Dhaka 1207, Bangladesh

al., 2022). Tobacco use is one of the major risk factors for non-communicable diseases. About 46.0% of adult males and 25.2% of adult females in Bangladesh use tobacco (WHO, 2019). In 2018, Bangladesh experienced nearly 126,000 deaths caused by tobacco-attributable diseases, accounting for around 13.5% of all-cause deaths in the population (Faruque *et al.,* 2020).To meet demand for tobacco leaf from both domestic and foreign manufacturers of tobacco products, the extent of tobacco cultivation remains considerably high. Bangladesh is the 12th largest tobacco producing country in the world [(Maps of world. 2018) & (Catfish, 2018) & (World list mania, 2018)]. Tobacco farming is growing fast and competing for the limited and fixed arable land of 37,674,000 acres. While in 2007–2008, a total of 72,000 acres of land was used for tobacco cultivation, it increased to 127,000 acres by 2014-2015-a 74% increase over seven years (BBS, 2016). In order to enforce the policies on tobacco control in Bangladesh, reliable information on the economic and health effects of tobacco farming is urgently needed. To the best of my knowledge, there remains no research on the health and economic impact of the tobacco on cultivators of tobacco cultivated area in Bangladesh. While all of the studies discussed about the harmful effects of tobacco cultivation on health and environment and regarded it as an important dimension, no attempt has been made to measure, compare or estimate it. Without these estimates, making decision by policymakers is not possible. By estimating five parameters (particulate matter ($PM_{2.5}$, PM_{10}), carbon dioxides (CO_2), volatile organic compounds (VOCs), temperature and humidity), by examining the relationship between tobacco and non-tobacco cultivation and self-reported illness in the study population between tobacco and non-tobacco around the year, this study will fill the evidence gap of tobacco cultivation. The findings of this study may be of use for evidence-based policy making against tobacco in Bangladesh and elsewhere.

Overall objective: To analyze the health hazard with comparison of non-tobacco and tobacco producers in Manikganj District of Bangladesh.

Specific Objectives

i. To determine the health status of related individuals;
ii. To estimate the economic cost of the adverse health effects of tobacco and non-tobacco farming households;
iii. To compare the health hazard of tobacco and non-tobacco growers.

MATERIALS AND METHODS

Selection of the study area

A preliminary survey in Manikganj district, Bangladesh, was conducted to gather data on tobacco cultivation, with farmers randomly selected from various villages.

Sampling technique and sample size

Total 120 farmers were randomly selected taking 62 from tobacco farmers another 58 from non-tobacco farmers. A simple random sampling technique was followed in the present study for minimizing cost, time and to achieve the ultimate objectives of the study.

Preparation of the survey schedule:

A draft questionnaire was prepared for a survey, pre-tested by tobacco farmers, and revised with necessary amendments and alternatives.

Period of the study:

Data were collected during the period of August to September in 2022 through direct interview with the farmers. Data relating to inputs and outputs were obtained by making time to time visit in the study area.

Data collection method:

The study conducted a field survey with tobacco and non-tobacco farmers, involving interviews and systematic questions to gather relevant information for a scholarly analysis.

Processing, tabulation and analysis of data:

Data was manually coded, edited, and thoroughly analyzed using Microsoft Excel and SPSS (version 23), first obtained in local units and then translated into international units.

Analytical techniques

The study examines the impact of tobacco cultivation on the health of related individuals, using self-reported illness data from the last twelve months. A multivariate binary logistic regression model will determine relative risk, while a simple linear logistic regression will predict success.

model can be expressed as $\log_e[\frac{\pi(X_i)}{1-\pi(X_i)}] = \beta_0 + \beta_1 X_i$

Where, the quantity $\pi(X_i) = E(y_i = 1 \mid X_i)$ represent the conditional probability that Y=1 given X and expressed as $\pi(X_i) = \frac{e^{\beta_0 + \beta_1 X_i}}{1 + e^{\beta_0 + \beta_1 X_i}}$.

If one consider a collection of p independent variables denoted by the vector X/=(X_1, X_2, …,Xp) then the multiple logistic regression model is given by the equation as

$$\log_e[\frac{\pi(X_i)}{1-\pi(X_i)}] = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + ----+\beta_p X_{pi}$$

RESULTS AND DISCUSSIONS

Health status

The overall prevalence of tobacco-related sickness stood at 63.7 percent for household members in tobacco cultivated area (Table 1). That's because this survey collected data on three different severity levels of illness—severe, moderate, and mild—and found that the aggregate of these three was higher in Manikganj. Taking into account the level of illness separately helped illustrate the causes which are shown below.

Table 1. Distribution of health status of the household population by farmer type

Symptom of Sickness of Total HH Member		Total HH Members
No.	%	No
319	63.7	501

Severe sickness:

The members who were working half of the working hours generally they were suffering severe weakness. In tobacco-cultivated areas, 22% of members suffered severe weakness, whereas 58.3% of tobacco-cultivated household members suffered severe weakness and non-tobacco cultivated household members was 47.7%. Severe nausea is a condition in which a person feels nauseous at the thought of eating. In tobacco-cultivated areas, 1.8% of members suffered severe nausea, where all were tobacco-cultivated household members (Table 2). When a person feels dizzy all the time when standing up, they are suffering from severe dizziness. In tobacco-cultivated areas, 3.7% of household members experienced severe vertigo, where all were tobacco-cultivated household members. A person is deemed to have a severe headache if they have head pain for the at least four hours per day. Approximately 2.8% of inhabitants in tobacco-growing regions reported experiencing severe headaches. Whereas, approximately 66.7% of residents living in tobacco-growing families suffered from excessive headaches, whereas the remainder were in non-tobacco-growing households. A person is considered to have severe upper abdominal pain when they feel pain in the upper abdomen half time a day or more. In areas where tobacco was grown, 6.4% of residents reported severe upper abdominal pain, whereas 57.1% of residents in tobacco-cultivated households suffered excessive upper abdominal pain, and the rest 42.9% of residents in non-tobacco-cultivated households suffered extreme upper abdominal pain. A person is considered to have severe lower abdominal pain when they feel pain in the lower abdomen half time a day or more. About 1.8% of residents reported severe lower abdominal pain in areas where tobacco was grown. While, approximately 50% of residents in non-tobacco-cultivated households suffered excessive lower abdominal pain, while the rest, 50% of tobacco-cultivated households, suffered extreme lower abdominal pain. When individuals suffer from acute insomnia, they do not

sleep for more than four hours day after day. In areas where tobacco was cultivated, 3.7 percent of residents suffered from severe insomnia, whereas half of severe insomnia was found in households where tobacco cultivation took place, and the remaining half of residents in households where tobacco cultivation did not take place suffered from extreme insomnia. People are deemed to have severe asthma when they cannot maintain regular breathing and experience difficult breathing throughout the day. In tobacco-growing regions, 5.5% of residents had severe asthma. In contrast, around 66.7% of people in tobacco-growing households suffered from severe asthma, compared to 33.3% of residents in non-tobacco-growing household. People with a heart rate that fluctuates more than 25 times per minute are at a significant risk for heart attacks and are deemed to have extremely high heart rates. In locations where tobacco was grown, approximately 11.9% of residents reported severely elevated heart rates, whereas 53.8% of residents in tobacco-cultivated households and 46.3% of residents in non-tobacco-cultivated households suffered from excessively high heart rates. People are believed to have excessive sweating; when they work, their bodies are typically drenched with sweat. In tobacco-growing regions, 11% of residents reported excessive perspiration. In comparison, 58.3% of those living in tobacco-growing households and 41.7% of those living in non-tobacco-growing households experienced excessive perspiration. When someone needs medication three times a day for their muscle discomfort, medical professionals classify their condition as severe. In regions where tobacco was grown, 12.8% of inhabitants reported having severe muscular pain, 64.3% of severe salivation symptoms were discovered in tobacco-cultivated households, and the remaining 35.7% of residents in non-tobacco-cultivated households' member suffered from extreme muscle pain. When a person eats food only once in a day, this is considered to be a serious loss of appetite. 2.8% of residents in areas where tobacco was grown reported having a severe loss of appetite, while 33.3% of severely lost appetite were found in households where tobacco was cultivated, and the remaining 66.7% of residents in households where tobacco was not grown had members who suffered from an extreme loss of appetite (Table 2). People are said to be suffering from acute itching since they are constantly scratching all over their bodies. About 4.6% of residents in areas where tobacco was grown reported having severe itching, whereas 80% severe itching was found in households where tobacco cultivation took place, and the remaining 20% of residents in households where tobacco cultivation did not take place suffered from extreme itching.

Table 2. Symptoms of Severe Sickness of the Household Population by Farmer Type

Severe Sickness	Tobacco		Non-Tobacco		Total	
	No.	%	No.	%	No.	%
Weakness	14	58.3	10	41.7	24	22.0
Nausea	2	100.0		0.0	2	1.8
Vomiting	1	100.0		0.0	1	0.9
Dizziness	4	100.0		0.0	4	3.7
Headache	1	33.3	2	66.7	3	2.8
Pain upper abdominal	4	57.1	3	42.9	7	6.4
Pain lower abdominal	1	50.0	1	50.0	2	1.8
Insomnia	2	50.0	2	50.0	4	3.7
Asthma	4	66.7	2	33.3	6	5.5
High heart rate	7	53.8	6	46.2	13	11.9
High sweating	7	58.3	5	41.7	12	11.0
Pale body	1	100.0		0.0	1	0.9
Extreme salivation	1	100.0		0.0	1	0.9
Muscle pain	9	64.3	5	35.7	14	12.8
Loss appetite	1	33.3	2	66.7	3	2.8
Itching	1	20.0	4	80.0	5	4.6
Others	1	12.5	7	87.5	8	7.3

Moderate sickness:
From table 3 in tobacco-growing regions, 17.8% of people reported feeling moderately weak, with 46.0% in tobacco-growing households and 54.0% in non-tobacco-growing households. Moderate nausea occurs between two and three times daily, with 1.4% experiencing mild to moderate nausea in tobacco-growing regions. Moderate vomiting occur when people throw up twice or three times a day, with 1.1% experiencing moderate vomiting. Moderate dizziness is a fleeting sensation of lightheadedness upon standing up, with 12.1% reporting moderate vertigo. Moderate headaches occur for less than four hours per day, with 12.4% in tobacco-growing areas and 54.5% in non-tobacco-growing households. Moderate upper abdominal pain occurs less than half the time a day, while moderate lower abdominal pain occurs less than half the time per day. Moderate insomnia affects 56.7% of people in tobacco-growing households and 43.3% in non-tobacco-growing households. Moderate heart rates fluctuate 24 to 25 times per minute, with 2.5% in tobacco-growing areas and 77.8% in non-tobacco-growing areas. People sweat moderately, with 44.4% in tobacco-growing households and 55.6% in non-tobacco areas. Moderate loss of appetite occurs when a person eats food 1-2 times a day, with 5.9% in tobacco-growing areas and 57.1% in non-tobacco-growing households. Moderate eye irritation occurs when more than 25% of the eyes itch, with 0.3% in tobacco-growing areas. (Table 3).

Table 3. Symptoms of Moderate Sickness of the Household Population by Farmer Type

Moderate Sickness	Tobacco		Non-Tobacco		Total	
	No.	%	No.	%	No.	%
Weakness	29	46.0	34	54.0	63	17.8
Nausea	2	40.0	3	60.0	5	1.4
Vomiting	2	50.0	2	50.0	4	1.1
Dizziness	25	58.1	18	41.9	43	12.1
Headache	24	54.5	20	45.5	44	12.4
Pain upper abdominal	5	50.0	5	50.0	10	2.8
Pain lower abdominal	1	33.3	2	66.7	3	0.8
Insomnia	17	56.7	13	43.3	30	8.5
Asthma	6	42.9	8	57.1	14	4.0
High heart rate	2	22.2	7	77.8	9	2.5
High sweating	4	44.4	5	55.6	9	2.5
Muscle pain	41	50.0	41	50.0	82	23.2
Loss appetite	12	57.1	9	42.9	21	5.9
Itching	7	43.8	9	56.3	16	4.5
Eye itching	1	100.0		0.0	1	0.3
Total						100.0

Mild sickness:
The study found that 16.9% of people felt weak in tobacco-growing regions, 50% in tobacco-growing households, and the rest in non-tobacco-growing households. Mild dizziness was reported by 18.3% of households, while 19.2% reported mild headaches. Upper abdominal pain was reported by 3.6% of residents, while insomnia affected 53.8% of people in tobacco-growing households. Muscular pain was reported by 7.5% of inhabitants, with 39.1% found in tobacco-growing households (Table 4). Overall, mild symptoms were prevalent in tobacco-growing regions, with varying degrees of severity in tobacco-growing and non-tobacco-growing households. In the majority of cases of mild sickness such as nausea, vomiting, upper abdominal pain, asthma, and muscle pain, non-tobacco growers suffered on a large scale because non-tobacco growers were residents of the same area and were affected by tobacco cultivation, particularly curing time.

Table 4. Symptoms of Mild Sickness of the Household Population by Farmer Type

Mild Sickness	Tobacco		Non-Tobacco		Total	
	No.	%	No.	%	No.	%
Weakness	26	50.0	26	50.0	52	16.9
Nausea		0.0	2	100.0	2	0.7
Vomiting		0.0	1	100.0	1	0.3
Dizziness	31	53.4	27	46.6	58	18.9
Headache	29	49.2	30	50.8	59	19.2
Pain upper abdominal	3	27.3	8	72.7	11	3.6
Pain lower abdominal	1	100.0		0.0	1	0.3
Insomnia	14	53.8	12	46.2	26	8.5
Asthma	4	40.0	6	60.0	10	3.3
High heart rate		0.0	3	100.0	3	1.0
High sweating	7	58.3	5	41.7	12	3.9
Pale body		0.0	1	100.0	1	0.3
Muscle pain	9	39.1	14	60.9	23	7.5
Loss appetite	22	57.9	16	42.1	38	12.4
Itching	2	40.0	3	60.0	5	1.6
Eye itching	5	100.0		0.0	5	1.6

Health status and treatment cost:

In a tobacco-cultivated area, table 5 shows that the average treatment cost for self-reported illness was considered for the last year. In the area where tobacco was grown, people spent on average tk. 711 as a doctor's fee, which was 13.8% of the total cost. Tobacco growers spent tk. 889, which was 61.6%, and non-tobacco growers spent tk. 537, which was 38.4%. In a tobacco-cultivated area, people spent on average tk. 3567 on medicine, which was about 69.2% of the total treatment cost, while tobacco growers spent on average tk. 4742 (65.4%) and non-tobacco growers spent on average tk. 3567 (34.6%). In every sphere, such as hospital costs, transportation costs, and accompanying costs, tobacco growers spend more than non-tobacco growers because tobacco growers are more affected by tobacco cultivation.

The average total cost was tk. 5152, where tobacco growers spent on average tk. 9733.57 (66%) and non-tobacco spent on average tk. 5015 (34%). In one year, the average sick days in tobacco-cultivated areas were 19.04, whereas tobacco growers' average sick days were 20.17 days, and for non-tobacco growers, it was 17.74 days. The average time lost working in a tobacco-cultivated area was 11.11 days, compared to 12.29 days for tobacco growers and 9.82 days for non-tobacco growers.

Table 5. Area Specific Treatment Cost and Lost Working Days of the Household Population by Type of Farmer

Treatment Cost	**Tobacco**		**Non-Tobacco**		**Total**	
	No.	**Row %**	**No.**	**Row %**	**No.**	**Column%**
Doctor's Fee	889	61.6	537	38.4	711	13.8
Medicine Cost	4742	65.4	2429	34.6	3567	69.2
Hospital Cost	423	80.4	100	19.6	259	5.0
Transport	525	60.9	326	39.1	424	8.2
Accompany Cost	262	76.3	79	23.7	169	3.3
Other Cost	17	36.8	28	63.2	23	0.4
Total Cost	9733.57	66.0	5015	34.0	5152	100.0
Average Sick Days	20.17		17.74		19.04	
Lost Working Days	12.29		9.82		11.11	

Binary logistic regression analysis:

From table 6 Tobacco growers are at a higher risk of developing various health issues, including weakness, headache, upper abdominal pain, insomnia, asthma, high sweating, and high sweating. The risk of mild weakness is 1.029 times higher than non-tobacco growers, while moderate and severe weakness is 0.790 times and 1.302 times higher respectively. Headaches are 1.173 times higher for tobacco growers, 1.564 times higher for moderate growers, and 0.454 times higher for severe growers. Upper abdominal pain is 0.365 times lower for tobacco growers, 0.855 times lower for moderate growers, and 1.007 times higher for severe growers. Insomnia is 1.648 times higher for tobacco growers than non-tobacco growers, 0.926 times lower for severe growers, and 0.926 times lower for mild growers. Asthma is 0.635 times lower for tobacco growers than non-tobacco growers, 0.718 times lower for moderate growers, and 0.995 times lower for severe growers. High sweating is 1.604 times higher for tobacco growers than non-tobacco growers, 0.832 times lower for moderate growers, and 1.814 times higher for severe growers. These health risks are influenced by factors such as smoking, smoking-related diseases, and environmental factors.

Table 6. Predictors of Tobacco Growers by Binary Logistic Regression Analysis

Variables	Relative risk for Manikganj districts of tobacco growers	P-Value
Weakness	1.00	0.04
Mild	1.029	
Moderate	0.790	
Severe	1.302	
Headache	1.00	0.13
Mild	1.173	
Moderate	1.564	
Severe	0.454	
Pain of Upper Abdomen	1.00	0.05
Mild	0.365	
Moderate	0.855	
Severe	1.007	
Insomnia	1.00	0.10
Mild	1.169	
Moderate	1.648	
Severe	0.926	
Asthma	1.00	0.06
Mild	0.635	
Moderate	0.718	
Severe	0.995	
High Sweating	1.00	0.07
Mild	1.604	
Moderate	0.832	
Severe	1.814	
Constant	0.882	

CONCLUSION AND RECOMMENDATION

Conclusion

Tobacco cultivation carries the risk of disease burden and environmental hazards. Tobacco producers have been more suffered from severe tobacco related diseases such as weakness, nausea, vomiting, dizziness, upper abdominal pain than non-tobacco producers. Because non-tobacco households were impacted by environmental illnesses that were brought on by tobacco producers' actions, the moderate

and mild categories of these disorders were practically same between tobacco and non-tobacco producers. Total average treatment cost BDT. 5152 where tobacco households was almost double (BDT. 9733.57) than non-tobacco households (BDT. 5015). Tobacco growers were more likely to experience mild and severe weakness, mild and moderate headaches, severe upper abdominal pain, mild and moderate insomnia, asthma, and high sweating compared to non-tobacco growers. These factors contributed to the overall health risks associated with tobacco cultivation.

Recommendation

Given the prevailing high levels of illiteracy in the study area and the lack of awareness to take decisive measures to enhance awareness and educate the community about the risk with tobacco use.

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