

Characterization of Multi-Drug Resistant Gram-Negative Bacteria Present in Fresh Leafy & Salad Vegetables in Dhaka, Bangladesh

Shahrin Akter Aurin, Sohana Parvin Chowdhury, Maruf Abony, Jarin Rifa, Avijit Banik, Aneeka Nawar Fatema, Oshin Ghurnee, and Zakaria Ahmed

Abstract — This study was conducted to determine the microbiological quality of fresh raw and unwashed leafy and salad vegetables in Dhaka, Bangladesh. Six different types of samples (red amaranth, spinach, carrot, radish, tomato, and cucumber) were collected in pre-sterilized zip-lock bags from various local markets in Dhaka. All samples were transported to the Centre of Excellence for Global Health Research Laboratory of Primeasia University at earliest convenience. Samples were enriched in Nutrient Broth media and were then cultured on selective media for isolation purpose. Serial dilution was performed for the total viable count. Biochemical and carbohydrate profiling was conducted for the presumptive identification of the isolates. Commercial antibiotic discs were used for antibiogram by Kirby-Bauer disc diffusion method on Mueller-Hinton agar medium. The total microbial load ranged from 8×10^7 to 1.70×10^8 . Total 36 isolates were identified, having 7 different organisms. The most predominant organism was *Vibrio sp.* (23%) followed by *Klebsiella sp.* (20%), *Acinetobacter sp.* (19%), *Pseudomonas sp.* (19%), *Salmonella sp.* (8%), *Moraxella sp.* (8%) and *Escherichia coli* (3%). 11% of the *Vibrio sp.* isolates were *V. cholerae*, found from 4 samples. No presence of *V. cholerae* was observed in the tomato samples. *E. coli* was observed only in Carrot sample. Antibiotics from 7 different groups were tested against the organisms among which Imipenem showed the highest sensitivity (86%). Following Ceftriaxone (100%), Nitrofurantoin (94%), Erythromycin (89%) and Amoxicillin (83%) had the highest resistance against the isolated organisms. Moreover, most of the isolates showed a multi-drug resistance pattern where they were resistant to at least four drugs. Prevalence of pathogenic bacteria in raw unwashed vegetables can cause potential adverse health effects and therefore the consumers need to be conscious about the matter.

Index Terms — Fresh raw vegetables, Food-borne illness, Gram-negative bacteria, Multi-drug resistance.

I. INTRODUCTION

Different types of vegetables are consumed raw worldwide for its highly nutritional value. Usually salad vegetables are often unwashed before consumption. Vegetables are rich in carbohydrates, anti-oxidants, minerals, vitamins and fibers and often consumed uncooked [1]. In recent years many countries have undertaken various initiatives to encourage consumers to eat more vegetables as they are an essential ingredient of a healthy diet [2]. In the daily diet, vegetables have been strongly associated with improvement of gastrointestinal health, good vision, and reduced risk of heart disease, stroke, chronic diseases such as diabetes, and some forms of cancer. Some phytochemicals of vegetables are strong antioxidants and are thought to reduce the risk of chronic disease by protecting against free radical damage, by modifying metabolic activation and detoxification of carcinogens, or even by influencing processes that alter the course of tumor cells [3].

In Bangladesh Total vegetable consumption reached 4,049 kt in 2013 in Bangladesh, according to Faostat. This is 0.226 % more than in the previous year [4]. Hence consumption of raw vegetables for diet as salad has become more common among health-conscious people in recent years.

Recently vegetables have been identified and confirmed as a significant source of pathogens due to the phytonutrients present in vegetables that act as effective media for the transmission of pathogens [2]. Consumption of raw vegetables contaminated with harmful microorganisms may result in food poisoning due to the fact that there is no killing step such as heating during preparation that would inactivate the harmful microorganisms [5].

Microorganisms capable of causing human disease may be found in raw produce. Sometimes they are part of the fruit or vegetable microflora as incidental contaminants from the soil and surroundings. In other instances, they are introduced into or on food by poor handling practices in agricultural production or post-harvest processes [6].

The primary sources of microbial contamination of fresh vegetables include human and animal fecal matter, contaminated water, soil, dust, surroundings and handling equipment and poor sanitary practices throughout the production chain [6]. Contaminations may also occur at post-harvest stage through dirty wash water, cross-contamination, and consumption of raw or uncooked vegetables.

Published on November 13, 2020.

Shahrin Akter Aurin, Department of Microbiology, Primeasia University, Bangladesh.

Sohana Parvin Chowdhury, Department of Microbiology, Primeasia University, Bangladesh.

Maruf Abony, Department of Microbiology, Primeasia University, Bangladesh.

Jarin Rifa, Department of Microbiology, Primeasia University, Bangladesh.

Avijit Banik, Department of Microbiology, Primeasia University, Bangladesh.

Aneeka Nawar Fatema, Department of Microbiology, Primeasia University, Bangladesh.

Oshin Ghurnee, Department of Microbiology, Primeasia University, Bangladesh.

Zakaria Ahmed, Department of Microbiology, Bangladesh Jute Research Institute, Bangladesh.

(e-mail: zakariaahmed70@gmail.com).

Based previous investigations, pathogenic (disease-causing) strains of (STEC), *Salmonella*, Norovirus and *Listeria monocytogenes* are responsible for causing foodborne illness via fruit [7]. Multiple investigations involved *E. coli* O157:H7 illnesses linked to leafy greens [8]. Bangladeshi people are more prone to microbial outbreak due to the relatively dense population with unsanitary condition. It is estimated 30 million people in Bangladesh suffer from foodborne illnesses annually [9]. Children are more susceptible to unsafe food in comparison to adults which contributes to child mortality [10].

Often the vegetables are not properly washed before consumption due to the unawareness of the people living in Bangladesh about the hazards associated with it. To prevent the occurrence of foodborne disease and its spread from raw vegetables it is necessary to minimize the contamination with microbes. This study was undertaken to determine the prevalence of Gram-negative pathogens in fresh raw leafy and salad vegetables, without wash from different local markets in the Dhaka city and thereby analyze the quality of the products. By analyzing the quality of these products, an estimated condition of the vegetables sold at random local markets in Dhaka city can be comprehended. Previously many researchers had also conducted similar studies in both developed and developing countries as well as in Bangladesh [11]-[13]. Many of them evaluated the presence of microbes after washing with tap water and/or other disinfectants to assess the proper cleansing method of vegetables. Where our study focused on the presence of Gram-negative bacteria particularly, on the fresh and unwashed vegetables to increase public awareness of the importance of good domestic hygiene practice.

II. METHODOLOGY

A. Sample Collection and Enrichment

A total number of 12 samples of 6 different kinds were collected: red amaranth, spinach, tomato, cucumber, carrot and radish, were collected from different local markets in Dhaka city. The sampling area included Banani, Mirpur, Mohammadpur and Abdullahpur. The samples were transported to the Centre for Excellence Laboratory of Department of Microbiology, Primeasia University [14-15]. Each sample was enriched to increase the small microbial growth to a detectable level. 10g of each sample was weighed and aseptically added to 90ml of sterile Nutrient Agar and incubated at 120rpm and 37°C in a reciprocal shaker for overnight [16].

B. Determination of Bacterial Count

Bacterial count was determined using pour plate technique. The plates were then incubated at 37°C and the counts were taken after a day [17].

C. Isolation of Gram-Negative Pathogens

Different Gram-negative bacteria were isolated by culturing on different selective (e.g. Cetrimide agar, SS agar etc.) and differential media (e.g. MacConkey Agar etc.) and identified initially by the morphological characteristics of the colonies.[16] The presumptive organisms were further tested for biochemical, carbohydrate profiling and antibiotic

susceptibility test in order to obtain a more precise identification [14-15].

D. Identification of the Isolated Strains

Identification of the Isolated Strains was done by conducted microscopy and biochemical characterization. The biochemical characteristics of a bacterium provide many traits that are useful for classification and identification. Triple Sugar Iron (TSI), Motility, Indole Test, MR-VP Test, Citrate Utilization, Nitrate Reduction, Catalase, Oxidase, Urease Test, Gelatin Hydrolysis, Starch Hydrolysis [15] was conducted along with Carbohydrate Fermentation of mannitol, sorbitol, inositol, rhamnose, raffinose [18].

E. Antibiotic Susceptibility Test

For antibiotic susceptibility test, the disc diffusion method of Kirby-Bauer was used. Bacterial suspension of test isolates were uniformly spread using a sterile cotton swab on sterile Mueller- Hinton agar (MHA) petri dish [19]. The antibiotic disks were placed using sterile forceps and plates were incubated for 18–24 h at 35-37°C. Following incubation, the diameter zone of inhibition (ZOI) formed was measured in millimeter (mm).

III. RESULTS

All of the samples used in the present study were found to be contaminated with more or less organisms (Table 1). The microbial load ranged from 8×10^7 to 1.70×10^8 CFU/ml with the lowest in carrot and the highest in cucumber (Fig. 1).

TABLE 1: NUMBER OF EACH ORGANISM ISOLATED PER SAMPLE

Sample	Number of organisms found per sample								Total number of organisms per sample	
	<i>Vibrio cholerae</i>	<i>V. parahaemolyticus</i>	<i>V. alginolyticus</i>	<i>Acinetobacter sp.</i>	<i>Klebsiella sp.</i>	<i>Pseudomonas sp.</i>	<i>Moraxella sp.</i>	<i>Salmonella sp.</i>		<i>Escherichia coli</i>
Red Amaranth	1	-	-	1	2	1	-	1	-	6
Spinach	1	-	-	1	1	1	2	-	-	6
Tomato	-	-	1	1	1	-	-	-	-	3
Cucumber	1	1	-	1	1	1	-	1	-	6
Carrot	-	1	1	2	1	2	-	1	1	9
Radish	1	-	-	1	1	2	1	-	-	6
Total	4	2	2	7	7	7	3	3	1	36
Percentage of the Organisms Found in The Sample	11	6	6	19	20	19	8	8	3	

A total 35 isolates were identified, most predominant organism was *Vibrio sp.* (23%) followed by *Klebsiella sp.* (20%), *Acinetobacter sp.* (19%), *Pseudomonas sp.* (19%), *Salmonella sp.* (8%), *Moraxella sp.* (8%) and *Escherichia coli* (3%). Among the *Vibrio sp.* isolates, 3 different species were identified which include *V. cholerae*, *V. parahaemolyticus* and *V. alginolyticus* (Fig. 1, 2). *Pseudomonas spp.* is part of the natural flora and are among the most common vegetable spoilage bacteria. *Moraxella sp.* was found just in Spinach and Radish samples, while

Salmonella sp. was detected from Red Amaranth, Cucumber and Carrot. Presence of *Vibrio cholerae*, *Salmonella sp.* and *E. coli* found from the present study are concerning for public health.

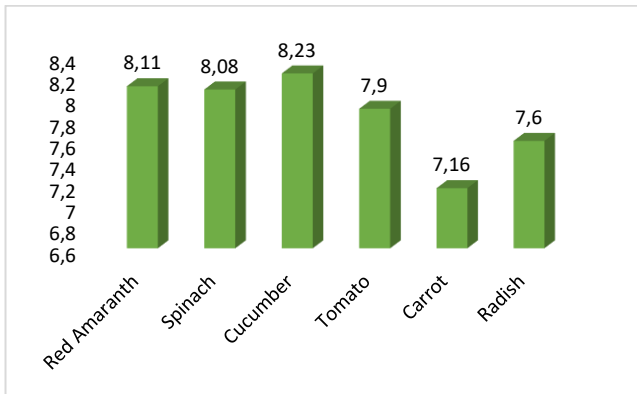


Fig. 1. Total Viable Bacterial Count (log scale).

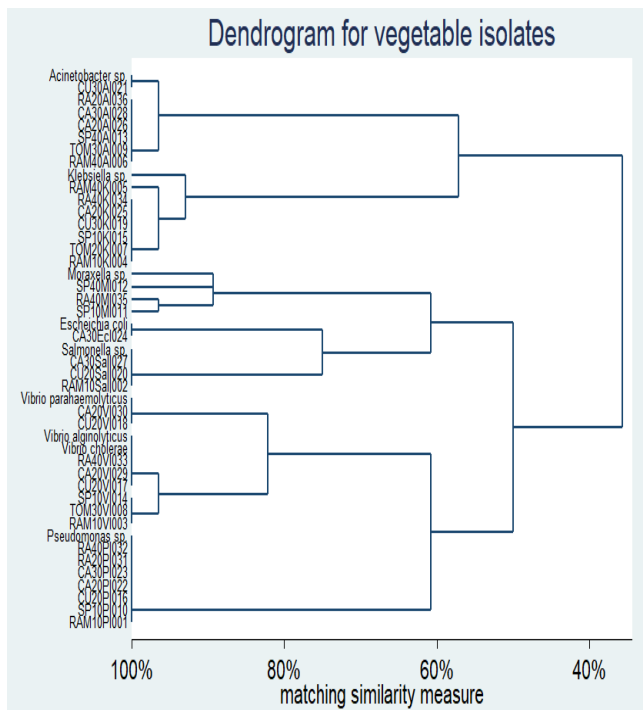


Fig. 2. Dendrogram of similarity between isolates. Different Antibiotics in Percentage (%).

One of the isolated *Salmonella sp.* was resistant to 6 of the drugs (86%). Six of *Klebsiella sp.*, two of *Pseudomonas sp.* and *Acinetobacter sp.* and one of *Moraxella sp.* was resistant to 5 of the drugs. All of the *Vibrio sp.* isolates was resistant upto 4 drugs (Fig. 3-5).

All of the isolates were also tested for their susceptibility to a number of different antibiotics. In the present study, all of the isolates were resistant to Amoxicillin, except *Pseudomonas sp.* Imipenem showed the highest sensitivity (86%) among the tested antibiotics against all the organisms, followed by Ciprofloxacin (65%) and Chloramphenicol (42%) (Fig. 4).



Fig. 3. Antibiotic Susceptibility Test on Mueller-Hinton Agar.

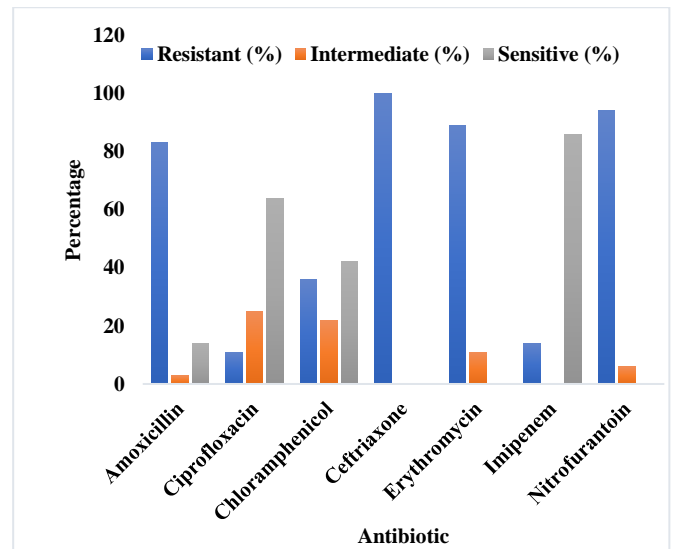


Fig. 4. Frequency of Antibiotic Susceptibility of the Isolates.

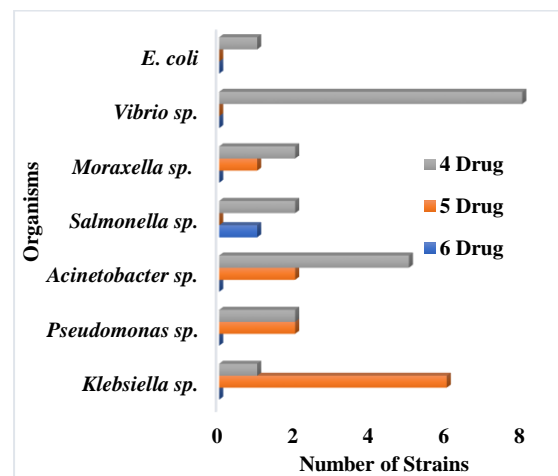


Fig. 5. Multi-Drug Resistance Pattern of the Isolates.

IV. DISCUSSION

The increasing consciousness in people regarding the nutrition has resulted in the increased consumption of raw fresh unprocessed vegetables and fruits. These foods carry indigenous microflora besides pathogenic microorganisms. A number of diseases outbreaks due to consumption of these produce have been reported previously [11], [20]. The present study was focused on the detection of Gram-negative pathogenic bacteria from unwashed raw vegetables and thus determining the quality of those products. The total bacterial count showed higher bacterial load in Cucumber (1.70×10^8) than other samples which is similar to the findings of study conducted in Dhanbad, India [21].

Among 35 isolated organisms *Acinetobacter sp.*, and *Klebsiella sp.* were present in all of the samples. However, *Pseudomonas sp.* was absent only in Tomato samples. According to current study, *V. cholerae* was isolated from 4 samples out of 12 (11%), including red amaranth, spinach, cucumber and radish. Consumption of vegetables and fruits from fields where raw sewage was used for irrigation showed association with a cholera outbreak in Peru [22].

In current study *Salmonella sp.* was isolated from 3 vegetables out of 12 (8%), which is higher than the findings of Mrittunjay *et. al.* (21) but close to findings of Kumar. (7.8%) [23]. It also reported that pond water used for irrigation, cleansing and sprinkling of vegetables by vegetable farmers and vendors might be the primary source of contamination of by *Salmonella sp.*

The presence of *E. coli* was observed only (6%) in the Carrot sample in current study, while it was the predominant (38.3%) bacterial pathogen from 50 different salad vegetables sold in Amravati City, India. [24] Another study reported 8.1% presence of *E. coli* in carrots, lettuce, green onions, and spinach samples [25].

According to our study, most of the isolates were resistant to at least four drugs. Ceftriaxone showed complete resistance to all of the isolates, which is a matter of great concern. Consumption of these multi-drug resistant (MDR) pathogen contaminated vegetables can result in serious illness to the consumers. Following Ceftriaxone (100%), Nitrofurantoin (94%), Erythromycin (89%) and Amoxicillin (83%) had the highest resistance against the isolated organisms (Fig. 5). Over the last 50 years, various studies have shown that the excessive use of antimicrobial drugs to treat human and animal infections has resulted in selective pressure, leading to antibiotic resistance. Recent studies have demonstrated that reservoirs of genes coding for antibiotic resistance are present in humans, as well as in animals, plants, and the environment, and that these genes can be transferred to human pathogens by direct contact or indirectly via ingestion of contaminated foods [26].

V. CONCLUSION

Outbreaks of human infection associated with the consumption of raw fruit and vegetables often occur in developing countries and have become more frequent in developed countries over the past decade. Results obtained from this study showed the presence of various pathogenic bacteria on the surface of unwashed fresh raw vegetables from different local markets in Dhaka city. Moreover, most of the pathogens were multi-drug resistance. It indicates the necessity of proper hygiene practice during and post-harvesting stage of the vegetables. For raw consumption further processing of these products is compulsory to ensure their quality and safety of the user. Proper washing with water and/or pretreatment with different antimicrobial agents can reduce the chance of such contaminations. The presence of MDR bacteria in the raw leafy and salad vegetables indicates the poor sanitation during and post-harvesting stage, even during transportation from the fields to the market and then to the consumers. This study showed that consumption of raw vegetables without wash can cause serious illness. To reduce the risk of getting infected by

these MDR bacteria, the raw vegetables must be washed properly before the consumption.

ACKNOWLEDGEMENT

The authors acknowledge with gratitude the support and assistance received from Md. Robeul Islam and Dipa Bhowmik in carrying out this research work.

VI. REFERENCES

- [1] Slavin, J.L. and Lloyd B. 2012, Health Benefits of Fruits and Vegetables, *Adv Nutr*, pp. 506–516.
- [2] Dias, J. 2012, Nutritional Quality and Health Benefits of Vegetables: A Review. *Food and Nutrition Sciences*, pp. 1354-1374.
- [3] Zhang, Y.Z., Gan R.Y., Li S., Zhou Y., Li A.N., Xu D.P., and Li H.B., 2015, Antioxidant Phytochemicals for the Prevention and Treatment of Chronic Diseases. *Molecules*, pp. 21138–21156.
- [4] Country Nutrition Paper Bangladesh. *Inc, International Conference On Nutrition*. s.l.: FAO, 2014.
- [5] Younus M.I., Sabuj A.A.M., Haque Z.F., Sayem S. M., Majumder S., Parvin M.S., Islam M.A., and Saha S. 2020, Microbial risk assessment of ready-to-eat mixed vegetable salads from different restaurants of Bangladesh Agricultural University campus. *J Adv Vet Anim Res.*, pp. 34–41.
- [6] UM, FAO. Improving the safety and quality of fresh fruit and vegetables: Maryland: JIFSAN, University of Maryland, Symons Hall, 2002.
- [7] Bintsis, T. 2017, Foodborne pathogens. *AIMS Microbiol*, pp. 529–563.
- [8] FAO. Foodborne Illnesses and Outbreaks from Fresh Produce. Washington, DC: FAO, 2019.
- [9] Noor, R., Feroz F. 2016, Food safety in Bangladesh: A microbiological perspective. *Stamford Journal of Microbiology*, pp. 1-6.
- [10] Ali, A. N. M. A. 2013, Food safety and public health issues in bangladesh: A regulatory concern. *European Food and Feed Law Review*, pp. 31-40.
- [11] Kabir, A., Das, A., & Kabir, M. S. 2015, Incidence of antibiotic resistant pathogenic bacteria in vegetable items sold by local and super shops in Dhaka city. *Stamford Journal of Microbiology*, pp. 13-18.
- [12] Eni, A. O., Ibukunoluwa O., & Oranus S. 2010, Microbial quality of fruits and vegetables sold in Sango Ota, Nigeria. *African Journal of Food Science*, pp. 291-296.
- [13] Bohaychuk, V. M., Bradbury, R. W., Dimock, R., Fehr, M., Gensler, G. E., King, R. K., Rieve, R. and Romero Barrios. 2010, A microbiological survey of selected Alberta-Grown fresh produce from farmers' markets in Alberta, Canada. *Journal of Food Protection*, pp. 415–420.
- [14] Banik, A., Abony M., Datta S., and Towhid S.T. 2018, Microbial Status and Multidrug Resistance Pattern of Pathogenic Bacteria Isolated from Street Food in Dhaka City, Bangladesh., *Journal of Advances in Microbiology*, pp. 1-13.
- [15] Akhi, M.A., Banik A., Ghurnee O., Das N. C., Nondi S. and Abony M. 2019, Prevalence and AntibioGram Profiling of Rotten Fruits from Different Areas of Dhaka City, Bangladesh, *European Journal of Medicinal Plants*, pp. 1-9.
- [16] Banik A., Abony M., Datta S. and Towhid S.T.*. 2019, Microbiological Quality of Ready - to - Eat Food from Dhaka, Bangladesh, *Current Research in Nutrition and Food Science*, pp. 161-168.
- [17] Rabbi, F.A., Rabbi F., Runun T., Zaman K., Rahman M. & Noor R. 2016, Microbiological Quality Assessment of Foods collected from Different Hospitals within Dhaka City. *Stamford Journal of Microbiology*, pp. 31-36.
- [18] Das N.C., Abony M., Banik A., Akhi M.A., Hossain N. & Ahmed Z., 2020, Optimization of Bacteriocin Producing Probiotic *Lactobacillus Spp.* Isolated from Broiler Chicken Gut. *Forefront Journal of Engineering & Technology*, pp. 1-8.
- [19] Abony, M., Banik A., Shishir M.A., Akter N.J., Uddin M.E., Datta S. 2018, Physico-chemical Characterization of Indigenous *Streptomyces* and Influence of pH on Antimicrobial Activity. *Microbial Bioactives*, pp. 059-067.

- [20] Francis G. 2002, Effect of vegetables type and antimicrobial dipping on survival and growth of *Listeria* and *E. coli*. *Int. J. of Food Sci. and Tech.*, pp. 711-718.
- [21] Mrittunjay, S., V. Kumar. 2017, A study on prevalence of microbial contamination on the surface of raw salad vegetables. *Biotech.*
- [22] Swerdlow, D.L. 1992, Waterborne transmission of epidemic cholera in Trujillo, Peru. *Lancet*, pp. 28-32.
- [23] Kumar, V. 2012, Incidence of *Salmonella* sp. and *Listeria* monocytogenes in some salad vegetables, which are eaten raw: a study of Dhanbad City, India. *Int J Eng Sci Res.*, pp. 1437-1442.
- [24] Mundhada, R. 2006, Bacteriological Quality of Salad Vegetables Sold in Amravati City (India). *Journal of Biological Sciences*, pp. 28-30.
- [25] Bogomolny, E., S. Swift, F. Vanholsbeeck. 2013, Total viable bacterial count using a real time all-fibre spectroscopic system. *The Royal Society of Chemistry.*
- [26] Amorim, AMB de, Nascimento J dos S. 2017, *Acinetobacter*: An Underrated Foodborne Pathogen? *J Infect Dev Ctries.*, pp. 111-114.



Shahrin Akter Aurin was born in Dhaka, Bangladesh on 15th September, 1996. Ms. Aurin completed her M.Sc in 2019 and B.Sc (Honors) in 2018, both majoring in microbiology from the Department of Microbiology, Primeasia University, Banani, Dhaka, Bangladesh. Her earlier educational background includes Higher Secondary education from Adamjee Cantonment College, Dhaka and Secondary education from Shaheed Bir Uttam Lt. Anwar Girls' College,

Dhaka, Bangladesh in the year of 2014 and 2012, respectively.

She has about 10 months research experience (1st June 2019 - 20th March 2020) in the Pilot Plant Research Laboratory of Center for Advanced Research in Science (CARS) as a Research Student at University of Dhaka. She is currently working as a Lab Instructor in the Department of Microbiology, Primeasia University, Banani, Dhaka. Her Publication include: Comparison of Individual and Synergistic Antimicrobial Activity of Common Spices against Certain Infectious Pathogen in Bangladesh; 2019; *American Journal of Plant Sciences*; 10 (9), 1599-1611.

Ms. Aurin is a member of Bangladesh Biosafety and Biosecurity Association (BBBA), Asian Federation of Biotechnology (AFOB) & American Society for Microbiology (ASM). She had 70% and 80% tuition fee scholarship for merit (CGPA > 3.75) during her undergraduate and graduate study, respectively.



Sohana Parvin Chowdhury was born in Mymensingh, Bangladesh on 18th April, 1994. Ms. Chowdhury completed her MS in 2019 and BS (Honors) in 2018, in microbiology from the Department of Microbiology, Primeasia University, Banani, Dhaka, Bangladesh. Her earlier educational achievement includes Diploma in Medical Technology majoring in Dental from Institute of Health Technology, Mohakhali, Dhaka in 2014 and Secondary education from Muslim Girls' High

School, Mymensingh, Bangladesh in 2010.

She has worked as a Research Student at the Pilot Plant Research Laboratory in Center for Advanced Research in Science (CARS), University of Dhaka from 1st June, 2019 to 20th March, 2020. She has also about 10 months working experience at ICDDR'B, Mohakhali, Dhaka, Bangladesh as a Field Organizer (September 2016 to July 2017). Her Publication include: Comparison of Individual and Synergistic Antimicrobial Activity of Common Spices against Certain Infectious Pathogen in Bangladesh; 2019; *American Journal of Plant Sciences*; 10(9), 1599-1611.

Ms. Chowdhury is a member of Bangladesh Biosafety and Biosecurity Association (BBBA) & American Society for Microbiology (ASM).



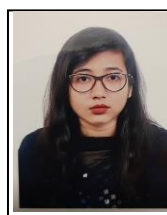
Maruf Abony was born in 20th November, 1993 in Dhaka, Bangladesh. Mr. Abony completed his MS in Microbiology in 2016 and B.Sc (Honors) in Microbiology in 2015 from Department of Microbiology, Primeasia University, Dhaka, Bangladesh. His earlier educational achievements include Higher Secondary and Secondary Educations in Bangladesh International School and college, Riyadh, Saudi Arab in the year 2010 and 2008

respectively.

He has 5 years of Academic and lab teaching experience at Department of Microbiology, Primeasia University in Dhaka, Bangladesh as a Lecturer

(2018-till present) and Lab Instructor (2015-2018). He is currently working as LECTURER, Department of Microbiology, Primeasia University in Banani, Dhaka, Bangladesh. His most recent works include: Prevalence Of Phytopathogenic *Aspergillus niger* and *Aspergillus flavus* Isolated from Various Samples in Bangladesh; *International Journal of Development Research*, 10(8), 38693-38697, 2020; Optimization of Bacteriocin Producing Probiotic *Lactobacillus Spp.* Isolated from Broiler Chicken Gut, *Forefront Journal of Engineering & Technology*, 2(3), 2020, 1-8, Scientific Forefront Journals; & Prevalence and Antibiogram Profiling of Rotten Fruits from Different Areas of Dhaka City, Bangladesh, *European Journal of Medicinal Plants*, 30(4): 1-9, 2019.

Mr. Abony is member of Bangladesh Biosafety and Biosecurity Society (BBBS) Bangladesh Or Biosafety Office, ICDDR'B, 68 Shaheed Tajuddin Ahmed Sarani, Mohakhali Dhaka - 1212, Bangladesh; Asian Federation of Biotechnology (AFOB), 403, Get-Pearl Tower 12, Gaetbeol-ro, Yeonsu-gu, Incheon 21999, Korea; & American society of Microbiologist, 1752 N St. NW, Washington, DC 20036, USA . He was a Gold medalist for his achievement in secondary school exam in 2008, he was awarded 50% tuition fee scholarship for merit (CGPA > 3.75) during his undergraduate study and in different terms he was elected as treasurer, Member secretary & Chairperson of Organizing committee of Microbiology Department of Primeasia University.



Jarin Rifa was born in Dhaka, Bangladesh, on 28th July, 1997. Ms. Rifa completed her MS in Microbiology in 2020 and B.Sc(Honors) in Microbiology in 2018 from Department of Microbiology, Primeasia University, Dhaka, Bangladesh . Her earlier educational achievement includes Higher Secondary educations in Kishlaya Girls' School & College, Dhaka, Bangladesh in the year of 2012 and Secondary educations in Bir Shreshtha Noor Mohammad Public College, Dhaka, Bangladesh in the year of 2014.

Bangladesh in the year of 2014.

Ms. Rifa is a member of Bangladesh Biosafety and Biosecurity Association (BBBA). She worked as a research student in Bangladesh Council of Scientific and Industrial Research, IFST, Food Microbiology Laboratory, Dhaka, Bangladesh in the year of 2019 for six months.



Avijit Banik was born in 3rd March, 1990 in Bangladesh. Mr. Banik completed his B.Sc (Honors) and MS in Microbiology in 2013 and 2015, respectively from Department of Microbiology, Primeasia University, Dhaka, Bangladesh. His earlier educational achievement includes Higher Secondary and Secondary education in Prestigious Government School and College in Feni Distract, Chittagong, Bangladesh.

He has 3 years of lab teaching and conducting Research experience at Department of Microbiology, Primeasia University in Dhaka, Bangladesh as a Lab Instructor (2017-till present). Before joining Primeasia University Mr. Banik Working as a "Project Intern" in Food Analysis and Research Laboratory, CARIS, Dhaka University from 1st June 2013 to 7th March 2014. Last 3 years Mr. Banik Published his 14 research Articles in different National and International Publication. His most recent publication includes: Microbiological Quality of ready-to-eat food from Dhaka, Bangladesh. *Curr Res Nutr Food Sci* 7(1). 2019; Comparative Phytochemical and Antibacterial Properties of Piper beetle Leave Extracts from Barguna and Moheshkhali, Bangladesh. *Iran J Med Microbiol.* 14 (2):125-132. 2020; Optimization of Bacteriocin Producing Probiotic *Lactobacillus Spp.* Isolated From Broiler Chicken Gut (March 20, 2020). Prevalence of Phytopathogenic *Aspergillus niger* and *Aspergillus flavus* Isolated from Various Samples in Bangladesh; *International Journal of Development Research*, 10(8), 38693-38697, 2020.

Mr. Banik is member of Bangladesh Biosafety and Biosecurity Association (BBBA), Asian Federation of Biotechnology (AFOB) & American society of Microbiologist. During his undergraduate study and in different terms he was elected as Treasurer, Member secretary & President of Organizing committee of Microbiology Department of Primeasia University.



Aneeka Nawar Fatema was born in 8th October, 1992 in Dhaka Bangladesh. Ms. Fatema completed Masters of Public Health (MPH) from the University of Sydney, Australia in 2017 and B.Sc. (Honors) in Microbiology in 2015 from Department of Microbiology, BRAC University, Dhaka, Bangladesh. She obtained her Ordinary (O) levels in 2008 and Advanced (A) levels in 2010 in science from Sunnysdale and Maple Leaf International School

respectively, both in Dhanmondi, Dhaka, Bangladesh.

She is currently working as a LECTURER in the Department of Microbiology, Primeasia University, Banani, Dhaka, Bangladesh. She was also recruited as a part time LECTURER in 2019 at Public Health Department, North South University and also worked as a RESEARCH ASSOCIATE at BRAC University from 2017 to 2019, Dhaka Bangladesh. Her most recent publications include: Hossain, A. et al., 2020. Age and gender-specific antibiotic resistance patterns among Bangladeshi patients with urinary tract infection caused by *Escherichia coli*. *Heliyon*, 6(6), 4161; Khan, A., Ashher, F., Karim, T., Fatema, A., Jahan, I., Muhit, M., Dey, A., Beard, F., Khandaker, G. (2020). Immunization of mothers of children with cerebral palsy in rural bangladesh. *Infectious Disorders - Drug Targets*, 20(3), 303-308.

Ms. Fatema is member of the Review Panel for Plos One: Infectious Diseases and was awarded with the Vice Chancellor's Gold Medal Award and was also in the Dean's List for Meritorious Students (in consecutive 4 semesters) during her Bachelor Program at BRAC University. She has also received the Special Recognition Award for High Standard of Discipline and Devotion to Duties at BRAC University in 2011. She has some media publications like, Global Resilience Partnership - GRC (2018): Flood Resilient Homes in Vietnam and Bangladesh and Prothom Alo (2018): "Shopner Bari" will not submerge in flooding events".



Oshin Ghurnee was born on 28th April, 1991 in Noakhali, Bangladesh. Ms. Ghurnee completed her MS in Ecological and Evolutionary Genomics in 2017 from Queen Mary University of London and BSc (Honors) in Microbiology from Department of Microbiology, North South University, Dhaka, Bangladesh in the year 2015. She completed her O'levels and A'levels from Saint Jude's International School, Dhanmondi, Dhaka.

She is currently working as a LECTURER (2019-till present) at the Department of Microbiology, Primeasia University in Banani, Dhaka, Bangladesh. Her previous research experiences include Internship in Microbial Ecological Laboratory at Queen Mary University of London and Internship at Department of Molecular Genetics at International Centre for Diarrhoeal Disease Research, Bangladesh, (ICDDR'B). Her most recent publications include but are not limited to: Prevalence and Antibigram Profiling of Rotten Fruits from Different Areas of Dhaka City, Bangladesh, *European Journal of Medicinal Plants*, 30(4): 1-9, 2019; Isolation of *Vibrio* in freshwater Fishes of Bangladesh (presented at) Joint International Tropical Medicine Meeting, December 2016, Bangkok, Thailand.

Ms. Ghurnee is a member of Graduate Microbiologist Society (GMS), Bangladesh & American society of Microbiologist. She was the recipient of Higher International Science and Engineering Scholarship at Queen Mary University of London for her masters and also received 25% scholarship during her bachelors from North South University, Dhaka. She served as Executive Body, Treasurer (2013-2014) at North South University Shangkritik Sangathan (NSUSS) and is currently an active member of the Organizing committee of Microbiology Department of Primeasia University.



Zakaria Ahmed was born in capital city of Bangladesh-Dhaka and his date of birth is December 14, 1970. He completed his Ph.D. in Applied Microbiology and Biotechnology from Ehime University, Japan on 2000 (Monbusho Scholarship). His major field of study is applied microbiology and enzymology, microbiology on jute.

He is currently working as SENIOR SCIENTIFIC OFFICER, Bangladesh Jute Research Institute, Bangladesh. Previously also worked as LECTURER, University Teknologi MARA, Malaysia; Associate Professor, Primeasia university, Bangladesh; Post Doctoral Fellow (JSPS fellow), National Food Research Institute, Tsukuba, Japan. He published about 74 research publications in national and international reputed scientific journals.

His current and previous research interests are environmental and natural product microbiology with particular reference to search for bio-pesticides for the control of crop and animal pests as a strategy of improving food security, search for antimicrobial agents from medicinal plants, synthesis of bioactive natural products; Bacterial enzyme and its application; Medical microbiology and Jute and its related research

Dr. Ahmed's memberships in professional societies- Member, American Society for Microbiology, USA; Member, International Society for Rare Sugar (ISRS), Japan; Member, Canadian Society of Microbiologist, Canada; Member, Canadian College of Microbiologist, Canada; Member, Bangladesh Society of Microbiology, Bangladesh; Member, Asiatic Society of Bangladesh, Bangladesh; Associate Member, Bangladesh Botanical

Society, Bangladesh; Graduate Member, Bangladesh Computer Society, Bangladesh; Life Member, Dhaka University Alumni Association, Bangladesh; Member, Bangladesh Association for Plant Tissue Culture and Biotechnology(BAPTC&B); Member, Bangladesh Association of Scientists and Scientific Professions, Bangladesh; Member, Bangladesh Association for the Advancement of Science, Bangladesh; Member, Bangladesh JSPS Alumni Association (BJSPSAA),Editorial Board Member of Research Journal of Agriculture and Biological Sciences, Pakistan; Editorial Board Member of Science and Education Publishing, Journal of Biomedical Engineering and Technology, 10 Cheswold Blvd., #1D, Newark, De, 19713, United States; Editorial Board Member of Impact Journal; Associate member of Editorial Board of American Journal of Advances in Medical Science (ARNACA), No. 133, "Mahaveer Calyx", BTM Layout 4th Stage, Bangalore-560076, Karnataka, India; Editorial board member and Reviewer in the International Journal of Sciences: Basic and Applied Research (IJSBAR); Editorial board member in the Global Society of Scientific Research and Researchers (GSSRR), American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS), Khllda - Wasfi Al Tall Street, P.O.Box : 2245 Amman, 11953, Amman, Hashemite Kingdom of Jordan; Editorial board member in the Global Society of Scientific Research and Researchers (GSSRR), International Journal of Computer (IJC), Address: Khllda - Wasfi Al Tall Street, Amman, Hashemite Kingdom of Jordan; Editorial board member and Reviewer in the American Scientific Research Journal for Engineering, Technology and Sciences (ASRJETS); Editorial board member in the Global Society of Scientific Research and Researchers (GSSRR), American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS), Khllda - Wasfi Al Tall Street, P.O.Box : 2245, Amman, 11953, Amman, Hashemite Kingdom of Jordan; Reviewer in the Journal of Agricultural Science and Technology B, David Publishing Company All rights reserved, 616 Corporate Way, Suite 2-4876, Valley Cottage, NY 1098.

Dr. Ahmed's awarded Junior High School Governmental Scholarship for academic feat in class eight (Awarded for the period of 1983 to 1986); Departmental Scholarship for the academic feat in undergraduate level (Awarded for the period 1989 to 1993); Governmental General Scholarship in graduate level for scholastic result in undergraduate level, Government of the Peoples Republic of Bangladesh (Awarded for the period 1993 to 1995); Japanese Governmental Scholarship (MONBUSHO) in doctoral course, Government of Japan (Awarded for the period 1997 to 2000); Japanese Society for the Promotion of Science (JSPS) Fellowship in Post-doctoral level, Government of Japan (Awarded for the period 2003 to 2005).