

Project ID: 638

Competitive Research Grant

Sub-Project Completion Report on

Qualitative Assessment of Bottled Drinking Water
and Evaluation of Pesticide Residues in Raw,
Washed and Cooked Vegetables

Project Duration
April 2017 to September 2018

Nutrition Unit
Bangladesh Agricultural Research Council



Submitted to
Project Implementation Unit-BARC, NATP 2
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

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Citation:

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Project Implementation Unit
National Agricultural Technology Program-Phase II Project (NATP- 2)
Bangladesh Agricultural Research Council (BARC)
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Bangladesh

Edited and Published by:

Project Implementation Unit
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Acknowledgement

The execution of CRG sub project has been completed by the Nutrition Unit, BARC using the research grant of USAID Trust Fund and GOB through Ministry of Agriculture. We would like to thank to the World Bank for arranging the grant fund and supervising the CRGs by BARC. It is worthwhile to mention the cooperation and quick responses of PIU-BARC, NATP 2 in respect of field implementation of the sub project in multiple sites. Preparing the project completion report required to contact a number of persons for collection of information and processing of research data. Without the help of those persons, the preparation of this document could not be made possible. All of them, who made it possible, deserve thanks. Our thanks are due to the Director, PIU-BARC, NATP 2 and his team who have given their whole hearted support to prepare this document. We hope this publication would be helpful to the agricultural scientists of the country for designing their future research projects in order to technology generation as well as increasing production and productivity for sustainable food and nutrition security in Bangladesh. It would also assist the policy makers of agricultural sub- sectors for setting their future research directions.

Publishes in: September 2018

Printed by:

Acronyms

%	= Percent
°C	= Degree Centigrade
AAM	= American Academy of Microbiology
ADI	= Average Daily Intake
BARC	= Bangladesh Agricultural Research Council
BDS	= Bangladesh Standards
BLQ	= Below Limit of Quantification
BSTI	= Bangladesh Standards and Testing Institute
Co-PI	= Co principal investigator
CRG	= Competitive Research Grant
CS ₂	= Carbon Di-Sulphide
EPA	= Environment Protection Authority
Fin.	= Financial
HCL	= Hydrochloric Acid
Kg	= Kilogram
L	= Litre
LOQ	= Limit of Quantification
mg	= Milligram
MPN	= Most Probable Number
MRL	= Maximum Residue Level
N/A	= Not applicable
NATP	= National Agricultural Technology Project
ND	= Not Detected
NR	= Not Required
NTU	= Nephelometric Turbidity Unit
p ^H	= Value as negative logarithm of hydrogen ion conc. In a sample
Phy	= Physical
PI	= Principal Investigator
PIU	= Project Implementation Unit
PP	= Project Proposal
SGS	= Standard Global Services
TDS	= Total Dissolve Solid
Tk	= Taka
USA	= United States of America
WHO	= World Health Organization

Table of Contents

SL. No.	Subjects	Page No.
	Cover page	ii
	Citation	iii
	Acronyms	iv
	Table of Contents	v
	List of Tables	vi
	List of Plates and Figures	vi
	Executive Summary	vii
A.	CRG Sub-project Description	1
1	Title of the CRG sub-project	1
2	Implementing organization	1
3	Name and full address with phone, cell and E-mail of PI/Co-PI (s)	1
4	Sub-project budget	1
5	Duration of the sub-project	1
6	Justification of undertaking the sub-project	1
7	Sub-project goal	3
8	Sub-project objectives	3
9	Implementing locations	3
10	Methodology in brief	4
	10.1. Chemical and microbial assessment of bottled and jar drinking water samples	4
	10.2. Determination of pesticide residue levels in the vegetable samples	6
	10.3. Development of communication materials for wide awareness building	8
11	Results and Discussions	9
	11.1. Chemical and microbial assessment of bottled and jar drinking water samples	9
	11.2. Determination of pesticide residue levels in the vegetable samples	17
	11.3. Development of communication materials for wide awareness building	23
12	Research highlight/findings	25
B.	Implementation Position	26
C.	Financial and physical progress	26
D.	Achievement of Sub-project by objectives	27
E.	Materials Development/Publication made under the Sub-project	28
F.	Technology/Knowledge generation/Policy Support (as applied):	28
G.	Information regarding Desk and Field Monitoring	28
H.	Lesson Learned	29
I.	Challenges	29
	Annexure	30

List of Tables

SL. No.	Subjects	Page No.
Table 1:	Details of the bottles drinking water used for analysis	5
Table 2:	List of vegetables collected for pesticide residue study	7
Table 3:	List of vegetables and tested pesticide groups for quantification of remaining residue level at different stages	8
Table 4:	Quantitative analysis of chemical (mineral content) parameters of bottled and jar drinking water	9
Table 5:	Classification of TDS content ranges of bottled and jar drinking water	10
Table 6:	Chloride concentration in bottled and jar water samples	11
Table 7:	P ^H and Nitrate values of bottled and jars drinking water sources	12
Table 8:	Quantitative analysis of microbial counts of bottled and jars drinking water	12
Table 9:	Variation of test results of particular parameters of bottled water with the information printed on the label of the producer	14
Table 10:	Variation of test results of particular parameters of bottled water with the information printed on the label of the producer	14
Table 11:	Variation of test results of particular parameters of bottled water with the information printed on the label of the producer	15
Table 12:	Variation of test results of particular parameters of bottled water with the information printed on the label of the producer	15
Table 13:	Qualitative variation of jar water samples with that of BDS values	16
Table 14:	Qualitative variation of jar water samples with that of BDS values	16
Table 15:	Qualitative variation of jar water samples with that of BDS values	17
Table 16:	Average residue level of pesticide in different stages of Cauliflower	18
Table 17:	Average residue level of pesticide in different processing stages of Country Bean	19
Table 18:	Average residue level of pesticide in the different processing stages of Long Yard Bean	20
Table 19:	Average residue level of pesticide in different processing stages of Cabbage and Red Amaranth	20
Table 20:	Average residue level of pesticide in different processing stages of Bitter Gourds	21
Table 21:	Average residue level of pesticide in different processing stages of Ladies Finger	21
Table 22:	Average residue level of pesticide in different processing stages of Brinjal	22
Table 23:	Average residue level of pesticide in different processing stages of Green Chillies	22
Table 24:	Average residue level of pesticide in cooked mixed vegetables	23

List of Plates

SL. No.	Subjects	Page No.
Plate 1:	Pictorial views of bottled and jar drinking water sample collection spots/shops	4
Plate 2:	Labelled bottled and jar water samples for chemical and microbial analysis	6
Plate 3:	Mixed vegetable items collected from different markets	8
Plate 4:	Awareness Creating BCC Tools on Balanced Diet and Safe Food	24
Plate 5:	Leaflets produced under the research project	25

List of Figures

SL. No.	Subjects	Page No.
Figure 1:	Remaining Pesticides Residue Level in Vegetables	17
Figure 2:	Pesticides residue above MRL at different processing stages	18

Executive Summary

The study was carried out with the goal to generate information on the quality of bottled and jar drinking water and pesticide residue levels in vegetables at different stages of processing thereby to build awareness among the consumers. For quality assessment of the bottled and jar drinking water 35 branded bottled water samples and 250 jar water samples were collected from 18 different districts of Bangladesh. Chemicals and minerals undertaken for water quality studies were Total Dissolved Solids (TDS), Chlorides (Cl), Nitrates (NO_3), and P^{H} . For microbial quality assessment of the drinking water Total Coliform and Faecal Coliform count were also done. For determination of residue levels of the different pesticides in the raw (unwashed), washed and cooked samples of major indigenous widely used vegetables and leafy vegetables, a total of ninety six samples were collected from the different markets of Dhaka city and adjacent areas of Savar, Gazipur, Tongi and divisional districts including the farmer's plots. Preparation of mixed vegetables and cooking were done using kitchen gas oven at 100°C . Presence of a total of 30 mostly used pesticides under different groups were studied. In every cases, both for water and vegetables the samples were analysed in triplicate in the accredited laboratories of SGS Bangladesh and Chennai Ltd. Study revealed the concentration of TDS to be very low in almost all the branded bottled drinking water that varied within the range of 8-240 mg/l against the Bangladesh standard value of maximum 500 mg/l. The amount of TDS in the jar water samples was however found little bit higher (62-474 mg/l). The presence of chloride was also found to be at an acceptable level against Bangladesh Standard (BDS) value of max 250 mg/l with a wide range of variation between bottled and jar water sample sources (1.97-55 mg/l and 3.99-91.97mg/l respectively). The P^{H} values of both the sources of water samples (bottled and jar water) found around the acceptable range of BDS values of 6.4-7.4. The NO_3 value of the bottled drinking water was found at much lower level (0.17-0.22 mg/l) than the maximum BDS value of 4.5 mg/l. Jar water samples were found to contain high number of total Coliform and Faecal coliform that was recorded to be 17-1600 MPN/100 ml and 11-240 MPN/100 ml respectively indicating that the jar water is not safe for drinking. While, for the bottled drinking water, average amount of bacteria was <1.8 MPN/100 ml i.e., almost absence of Coliform and Faecal coliform that indicated their acceptability with having no health risk. Remarkable variation was found to exist between the labeled mineral composition and parameters of the bottled water with that of the test results of the water samples, done under this study. Analysis of the vegetable samples of different categories revealed positive impact of washing and subsequent cooking on the level of pesticide residues in the vegetable samples. In all cases, the results clearly indicated that pesticide residues found in the samples of raw vegetables was higher (62.5%) than that in the same samples when tested after washing (37.5%) and cooking (18.75%). However, residue level measuring above MRL was found only in 12.5% and 6.25% of the raw and washed vegetable samples respectively. No pesticide residues were noticed in any of the cooked vegetables other than Carbendizam, Cypermethrin, Chlorpyrifos and Dimethoate but, for all those pesticides the residue level was found to be below MRL.

CRG Sub-Project Completion Report

A. Sub project Description

1. Title of the CRG sub-project:

Qualitative Assessment of Bottled Drinking Water and Evaluation of Pesticides Residue in Raw, Washed and Cooked Vegetables

2. Implementing organization:

Nutrition Unit
Bangladesh Agricultural Research Council (BARC)
Farmgate, Dhaka -1215. Bangladesh.

3. Name and full address with phone, cell and e-mail of PI/Co-PI(s):

Principal Investigator:

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BARC, Farmgate, Dhaka
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4. Sub-project budget:

- 4.1: Total Tk. 57,51,400.00
- 4.2 Revised (if any) Tk. 50,44,505.00

5. Duration of the sub-project:

- 5.1 Start date (based on LoA signed): April 2017
- 5.2 End date : 30 September 2018

6. Justification for undertaking the project:

Food safety is broadly considered as an important determining factor for sustainable immunity of body for better health and growth of a nation. In Bangladesh, as a densely populated, low capita income and high birth rate country, it become a highly challenging task for the national machineries to overcome the prevailing food and water safety issues which is directed by integrated action of causes and function of multiple actors, like back education, knowledge gap, lacking scientific expertise, financial solvency, role of actors with market system, lack of awareness, etc. Drinking water and agriculture products namely vegetables are the mostly daily consumed items by the people in different forms and sources those are vulnerable to various risks due to human interventions and natural causes.

In case of drinking water, Bangladesh has experienced a dramatic increase in the consumption of bottled water more especially plastic container drinking water (i.e. bottle and jar) in the recent years. The increase in demand for these products is driven by few important factors, like:

(i) Changes in fashion towards the consumption of designer water; (ii) Increased concerns about the contamination of the piped water supply; and (iii) An increased influx of people into the major shopping areas and some fast food shops as well as restaurants, with a requirement for quality drinking water.

Despite worldwide efforts and use of modern technologies for the production of safe drinking water transmission of waterborne diseases is still a matter of major concern. This problem is not only confined in the developing world where water treatment may not exist or is inadequate like ours but also in many developed countries. Contamination in drinking water in Bangladesh may occur because of improper production and processing, limitation of water treatment facilities, improper storage, lack of regulations, weak monitoring and limited understanding and awareness among the consumers.

Bottled mineral water generally contains various minerals and trace elements which are natural compounds formed through geological processes or other dissolved substances that alter its taste or give it therapeutic properties. But at present, information available on the chemical properties and microbiological aspects of these water products is inadequate to satisfy frequently raised public questions regarding quality of products. However, researchers and policy makers felt the need and importance to know the state of quality of the marketed drinking waters so that the consumers can be assured of their quality and safety.

The vital function of water fluid in a biological system is transmission of nutrients from one cell to another cell and to allow harmful toxic substances produced through physiological process of a biological system to expel through urinary process. Dietary Guideline of Bangladesh thus suggested per day intake of 1.5 to 3.5 litre of drinking water by every adult (man or women) to lead a normal healthy life. Therefore, knowledge about chemical and microbiological properties of drinking water is important to ensure the intake of drinking water with standard qualities so that one can lead a healthy life.

On the other hand, so far as agriculture is concerned, Bangladesh is fortunate enough that the country is blessed with natural rich soil, diversified agro-ecological systems including low lying flood plains, drought prone areas, coastal flooded zones, many rivers where almost all nutrient rich varieties of fruits, vegetables and cereals can be grown under a natural cycle of seasonal changes. Few decades back, there was abundance of cultivable lands, the supply of food was more than the demand and people used fresh food materials in most natural form. Now a day, the population spurt in our country has given rise to unemployment, poverty and food shortage. The demands for safe food increased to a greater extent those are being meeting up through importation or through local production under a poor monitoring system of production malpractices. This shortage of good quality safe food and ignorance of consumers considered as the main cause for adulteration of foodstuffs where traders and producers intentionally debasing the quality of food offered for sale either by mixture or substitution of inferior substances or by the removal of some valuable ingredient.

Manmade chemicals are an integral and vital part of present day human life style. These are used at a vast range from agricultural production including processing food items to life saving drugs. Application of chemicals under various forms is improving the production and shelf life of the processed foods but in case of their undue application there remains the health risk in these foods. Such chemicals used in agriculture are generally categorized in three as follows:

- (i) Pesticides (for protection of insects and pest);
- (ii) Nonfood grade coloring agent (to keep fruits and vegetables fresh and attractive); and
- (iii) Chemicals used for the protection of spoilage of various food products etc.

In Bangladesh, crop farmers generally use varieties of pesticides belonging to different chemical groups for protecting their crops from different insects and diseases and there is a practice that almost every time they apply both insecticide and fungicides together. Vegetable growers generally apply pesticides to the crop at different stages of growing like before flowering, during flowering, early fruiting, and at green stage to until harvesting. But in between harvesting and marketing time, a number of malpractices by many of the traders are done to keep the vegetable fresh look and attractive which particularly done in case of long distance travel from crop field to selling point and when longer preservation time is required.

Knowledge on the existence and level of such chemical residues at post-harvest wash and in cooked form should be investigated thoroughly. With the gradual increase in population size of the country there has been a steady increase in food demand in the country. This has now become a challenging job for the farmers/producers to provide adequate fresh and safe food directly to the nation. This is because, in Bangladesh, in one hand gradual decreasing in cultivable land yearly by approximately 1.0% because of development and construction activities for human need and on the other hand, alarming increased use and unethical application of pesticides for increasing yields and for commercial interest. Unethical application of chemicals and pesticides thus invites the challenges of biodiversity conservation and various human health hazards due to residual effect of those pesticides.

Therefore, under the stated circumstances, the Nutrition Unit of BARC has undertaken the program to develop research findings based guideline and protocols to mitigate the safety problems related to commercial drinking waters and pesticide residue in vegetables at different stages of processing like, raw, fresh, washed and cooked.

7. Sub-project goal:

The overall goal is to know the quality status of bottled and jar drinking water available in Bangladesh market and to estimate the left over residue in the vegetables during processing, at raw, washed and cooked samples and develop guidelines to mitigate the problems.

8. Sub-project objectives:

- i. Chemical and microbial assessment of different types of bottled and jar drinking water in Bangladesh market
- ii. To determine the residue levels of pesticides in the raw, washed and cooked samples of major indigenous vegetables
- iii. Development of communication materials for wide awareness building for pesticide and healthy water for public health

9. Implementing location(s):

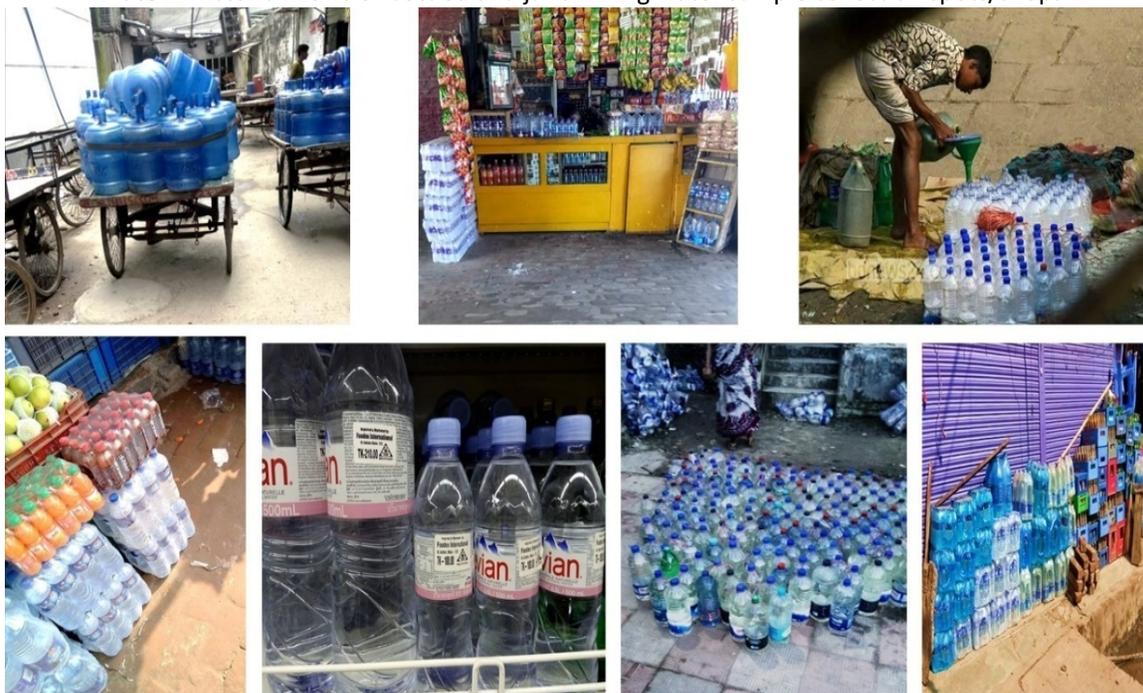
All over the country (including major drinking water and vegetables available and producing areas)

10. Methodology (in brief):

10.1. Chemical and microbial assessment of bottled and jar drinking water samples:

Bottled and jar water samples and related information were collected randomly from different sources (like open market, producer, wholesale/retail shop and restaurant) of 18 district towns, namely Dhaka, Chattagram, Barisal, Khulna, Rajshahi, Cumilla, Feni, Rangpur, Dinajpur, Bogra, Sirajgonj, Pabna, Patuakhali, Savar, Gazipur, Mymensingh, Sylhet and Narsingdhi (Plate 1) under six divisions of the country. A pre-tested questionnaire (Annexure- 1) was used for recording of information on production, labeling practices and marketing of bottled drinking water and jar water.

Plate 1: Pictorial views of bottled and jar drinking water sample collection spots/shops



For qualitative assessment (chemical properties and microbial analysis), 35 branded bottled drinking water (Table 1) and 250 jar water samples were collected from the selected market places. For collection of jar drinking water samples, widely used areas of Dhaka city viz., Farmgate, Gulistan, Sadar Ghat, Khilgaon, Mohammadpur, Mirpur, Uttara, Mohakhali, Keraniganj, Chokbazar, Gulshan, Banani, Jatrabari, Gabtoli Bus Stand, Savar, Asulia, Tongi, Gazipur, Motijheel, New market including Nilkhet areas were given preference. Besides, for the first time ever, under the research, three imported drinking water bottle samples were also taken and analyzed to evaluate their qualitative status.

Immediately after collection, the samples were marked with proper coding and stored in cool place until analysis (Plate 2). Under the quantitative and qualitative assessment of the water samples, water P^H and mineral contents such as TDS, Chloride, Nitrate, and microbial analysis on Total Coliform and Faecal Coliform load were determined. Both Chemical and Microbial analysis were

carried out in the accredited laboratories of SGS Bangladesh Ltd. following the standard analytical procedures for specific items.

Table 1: Details of the bottles drinking water used for analysis

Sl. No	Trade name of samples	Producer company	Sl. No	Trade name of samples	Producer company
1	ACME Premium Water	ACME Aquadate and Beverage Limited	19	Masafi Pure natural* Drinking Water	-
2	ALMA	AST Beverage Limited	20	Mina Aqua	Gemcon Food & Agricultural products Ltd.
3	Blu Drinking Water	Mymensingh Agro Limited	21	Mughal Drinking Water	Mughal Pure Water Industries Ltd
4	Britannia Drinking Water	Britannia Foods & Beverage LTD.	22	MUM Drinking Water	Pertex Beverage Limited
5	Confidence Drinking Water	Confidence Food and Beverage Limited	23	Mamia Drinking Water	Mashrifa Food Products Ltd
6	Crystal Premium Drinking Water	Mymensingh Agro Ltd.	24	Muskan Drinking water	S A Beverage Limited
7	Doctor KhabarPani	Quality Milk Products Industries Ltd	25	Nectar Drinking Water	BD Thai Food and Beverage Limited.
8	Eco Natural Drinking Water	PRAN Mymensingh Agro Ltd.	26	No .1 Drinking Water	United Mineral Water and PET Industries Ltd
9	Everest Drinking Water	Everest Drinks and Dairy Products Limited	27	Oceania Pure Drinking Water	Mymensingh agro limited
10	Evian Eau*MineraleNaturelle Natural Mineral Water	Imported & Marketed by: Foodex International	28	Premium Drinking Water	Premium Beverage and Food Limited
11	Evian Natural* mineral water	Imported & Marketed by: Elated Marketing Ltd.	29	Prince Pani	Paradise Food Products Limited
12	Fena Premium Water	Grand Consumer Bangladesh Limited	30	Rivera Pure Drinking Water	Aku Food and Beverage Ltd.
13	Jibon	Soti PET Industries Ltd	31	Shanti Pure Drinking Water	Dhaka WASA
14	Lilia Drinking Water	Roots Food and Beverage Ltd	32	Shyamoli Drinking Water	Shyamoli Food and beverage (pvt.) Ltd.
15	MAA	Kohonoor Azad Food and Beverage Limited	33	Spa Drinking Water	Akij Food and Beverage Limited
16	Kinley	International Beverage private Ltd.	34	Pani Drinking Water	PRAN Mymensingh Agro Ltd.
17	Aquafina	Pepsico and Transcom Beverages Ltd	35	Saka*	Saka International Limited
18	Fresh Drinking Water	United Mineral Water and PET Industries Ltd			

*=Imported water samples

Plate 2: Labelled bottled and jar water samples for chemical and microbial analysis



10.2. Determination of pesticide residue levels in the vegetable samples:

To study the pesticide residue, total ninety six samples of ten commonly consumed selected vegetables and leafy vegetables (Table 2) were collected in fresh raw condition from the markets of Dhaka city (Mohammadpur, Mirpur, New market, Basabo, Malibag, Kawran Bazar, Savar, Uttar Khan, etc) and markets of adjacent areas of Gazipur and Tongi. However, fresh raw sample of Cabbage and Red Amaranth were directly collected from the farmer's plots.

Table 2: List of vegetables collected for pesticide residue study

Sl. no.	Name of vegetables		Comments
	English name	Bangla name	
1.	Cauliflower	dzjKwc	Collected from markets
2.	Country Bean	‡`kxmxg	Collected from markets
3.	Long Yard Bean	eiewU	Collected from markets
4.	Cabbage	evavuKwc	Collected directly from farmers plots
5.	Red Amaranth	jvjkvK	Collected directly from farmers plots
6.	Bitter Gourd (improved variety)	Kijøv	Collected from markets
7.	Bitter Gourd (indigenous variety)	D`Ív	Collected from markets
8.	Ladies Finger	‡Xuok	Collected from markets
9.	Brinjal	‡e,b	Collected from markets
10.	Green Chilies	KuvPvgwiP	Collected from markets
11.	Mixed Vegetables (Bitter Gourds, Ladies Finger, Cabbage, Broccoli, Cauliflower, Brinjal, Tomato, Long Yard Bean, Country Bean, Corianders leaf, Green Chiles)	wg`Wmwâ (Kijøv, D`Ív, ‡Xuom, eªKjx, wkg, evauvKwc, dzjKwc, U‡g‡Uv, eiewU, ‡e,b(‡Mvj l jg^v), a‡bcvZv l KuvPvgwiP)	Farmers field (Uttar khan, Narshingdi, Gazipur & Jessore) Jatarabari, Karwan Bazar, Mohammadpur town hall, Mirpur, Gabtoli, New market, etc.

The collected every single type of vegetable samples was then separated into three different parts. One part of the required amount of samples was packed in raw condition. Another part of the vegetable samples were adequately washed under laboratory tap water as per home kitchen practice; and the other part of the same samples of washed vegetables were cooked ensuring kitchen oven temperature at 100°C. Then, all the three parts of each type of vegetables were properly packed in zip locked polyethylene bags and labeled them by type (both vegetable type and processing type) and kept at low temperature in refrigerator for further analytical study. Finally, all the samples were sent to the international overseas accredited laboratory SGS Chennai, India with the standard guidelines for testing. For analysis of each of the samples, three replications were used to minimize the error.

Preparation of mixed vegetable for residue analysis

Along with other vegetables, items of mixed vegetables were also collected in fresh raw condition from the same markets of Dhaka city (Plate 3). Items selected for mixed vegetable preparation was Bitter Gourds (improved and indigenous varieties), Ladies Finger, Broccoli, Cauliflower, Tomato, Long Yard Bean, Brinjal (oval and long), Country Bean, Corianders leaf and Green Chili. Immediately after collection, vegetable samples were cut into small pieces of standard cooking size and washed thoroughly under laboratory tap water and cooked fully in kitchen gas oven ensuring the temperature at 100° C. Cooked vegetable samples were then allowed to cool down to normal and kept in zip locked polyethylene bags to preserve at low temperature in refrigerator. Finally, the preserved cooked samples were analyzed in triplicate for detection of pesticide residue in the accredited laboratories of SGS Chennai Ltd.

Plate 3: Mixed vegetable items collected from different markets



A total number of 30 pesticides under different groups commonly used by the farmers during production practices of the selected vegetables were taken under consideration for study the presence of the residue level at different stages of processing of vegetables (i.e. fresh raw, washed and cooked). Residue study of different pesticides against different specified vegetable samples attempted is shown in Table 3.

Table 3: List of vegetables and pesticide groups tested for quantification of residue level at different stages

Sl. No	Name of the selected vegetable	Name of the Pesticide taken for residue analysis
1.	Cauliflower	Chlorpyrifos; Cypermethrin;
2.	Country Bean	Fenitrothion; Fenvelerate; Lambada-
3.	Long Yard Bean	Cyhalothrin; Abamectin; Carbaryl;
4.	Cabbage	Carbendazim; Carbosulfan; Cartap;
5.	Red Amaranth	Chlorantraniliprole; Diazinon;
6.	Bitter Gourd (Improved variety)	Dimethoate; Emamectin benzoate;
7.	Bitter Gourd (Indigenous variety)	Imidacloprid; Carbofuran; Indoxacarb;
8.	Ladies Finger	Iprovalicrab; Malathion; Metalaxyl;
9.	Brinjal	Profenophos; Propiconazole; Quinalphos;
10.	Green Chili	Spinosad – A; Spinosad–D; Spinosad (sumof A &- D); Thiamethoxam; Methomyl; Thiodicrab;
11.	Mixed Vegetable (Bitter gourds, Ladies finger, Broccoli, Cauliflower, Tomato, Long yard bean, Brinjal (oval and long), Country bean, Corianders leaf and Green chili)	and Dithiocarbomates

10.3. Development of communication materials for wide awareness building

Preparation of research finding based awareness building, communicable extension materials and research papers using Behaviour Change Communication (BCC) tools for wide awareness building for pesticides and healthy water.

11. Results and Discussions:

11.1. Chemical and microbial assessment of bottled and jar drinking water samples

The different types of bottled and jar drinking water samples were collected randomly from different sources of Bangladesh to evaluate the quality considering the chemical and microbial characteristics.

Under this study, chemical analysis for total dissolved solids (TDS), Chloride, pH, NO₃, along with the microbial content and the level of contamination for total Coliform and Faecal coliform in water was conducted. Comparative statement of analytical results of bottled and jars drinking water along with BDS values for TDS, Chloride, pH, NO₂, NO₃, Pb, Cr, Fe, etc. are shown in Table. 4.

Other than the WHO drinking water standards, a number of nations have their own standards of drinking water. Likewise, in Bangladesh, BSTI has developed standards for drinking water (BDS) for the nation based on various influencing factors other than the physico-chemical properties. In general, variation in ingredients level in drinking water is mostly determined by the character of the geographical location (Geo-chemical properties), environmental features, physical condition of the people, biological evaporation, food and feeding habit, and income and nutrition intake level of the nation.

Table 4 shows that all most all the brands of bottled drinking water tested had low TDS concentration within the range of 8-240 mg/l and for the jar drinking water the level was a bit higher (62-474mg/l) but was within the range of the Bangladesh standard value of maximum 500 mg/l.

Table 4: Quantitative analysis of chemical (mineral content) parameters of bottled and jar drinking water

Elements/Minerals	Accepted Conc. (As per BDS)	Brand bottled water	Jar water
TDS (mg/l)	500	8 - 240	62 - 474
Chloride (mg/l)	250	1.97-55	3.99 - 91.97
pH	6.4 – 7.4	6.36 - 7.70	6.73 - 7.75
Nitrite (mg/l)	NR	ND	ND
Nitrate (mg/l)	4.5	0.17-0.22	-
Lead (mg/l)	0.01	ND	ND
Chromium (mg/l)	0.05	ND	ND
Iron (mg/l)	0.3	ND	ND

Classified observation of the findings showed that 100% of the bottled drinking water and 89% of the jar water samples were found to fall under excellent category (according to WHO) that contained exceptionally low level (below 300 mg/l) of total dissolved solids (Table 5). For bottled drinking water 79% of the samples showed values below 100 mg/l which was 11% for Jar water sample. Approximately 11% of the jar water samples found to contain TDS above 300 mg/l and could be categorized as “Good” as per the WHO standard but there was no sample of bottled water found within this range.

Table 5: Classification of TDS content ranges of bottled and jar drinking water

WHO standard	TDS content ranges (mg/l)										
	Excellent (Below 300)				Good (301 – 600)				Least accepted (601 – 900)	Low grade (901 – 1200)	Not acceptable (Above 1200)
Study ranges	Up to 100	101- 200	201- 300	Total	301- 400	401- 500	501- 600	Total	-	-	-
Bottled drinking water (%)	79.32	10.34	10.34	100	-	-	-	-	-	-	-
Jar water (%)	10.53	36.84	42.11	89.48	5.26	5.26	0	10.52	-	-	-

TDS is generally considered as the dissolved minerals, salts, metals, cations and anions. Components of TDS are all inorganic salts (like, magnesium, Calcium, Potassium, Sodium, Bicarbonate, Chloride and Sulphite and trace amount of organic materials).

According to WHO standards <300 mg/l TDS is considered as excellent while 300-600 mg/l as good (Table 5). It is worthwhile to mention that test of drinking water is more or less influenced by the presence of TDS. Presence of TDS more than normal range of 600- 900 mg/l or above is considered not suitable for consumption. On the other hand much lower amount of TDS in water, as was found in many samples of bottled drinking water, may cause the water tasteless and not suitable for drinking because of the presence of low amount of soluble minerals and salts etc. therefore, the under grade water need to be improved and maintained properly for the sake of human health and the taste of water. However, it is assumed that low amount of TDS in the bottled drinking water sample was because of application of “Reverse Osmosis (RO)” technology for the control of microbial load in water that also drastically reduces the mineral contents of water. Investigation also assured that comparatively higher amount of TDS in jar water sample (62-474 mg/l) was because of not using “RO” technology in case of jar water treatment.

Optimum level of TDS is generally said to be responsible for the taste of any drinking water without causing any health risk. Increased amount of TDS increases the alkalinity, hardness and salinity of water that may cause blockage in water flow system (through pipe or tube) and directly or indirectly invites a favorable condition for multiplication and growth of various microbes.

The level of presence of Chloride also showed a level of acceptance against Bangladesh Standard value of maximum 250 mg/l with a wide range of variation between the two samples sources i.e. 1.97-55 mg/l for bottled water and 3.99-91.97mg/l for jar water sample (Table 6).

Chloride is an important electrolyte mineral that plays important role in transmission of anion charge in biological process. It is generally found in every kinds of cell (at various levels). It has the ability to pass through the cell membrane and thus transmit necessary nutrients to the cell and tissue for normal function of a body cell. Chloride performs its activities by maintaining water balance around the cell and tissues through which the electrolytes also play vital role to keep the renal function normal. Therefore, presence of required amount of water and soluble chloride level in a human body is a vital requirement for sustainable life process. Daily normal requirement of chloride is generally varies between 750 – 900 mg/l (drinking water that maintain the quality standards may provide 500 - 650 mg/l of Chloride as single source if taken 2.0 – 2.5 liter per day by an adult and the remaining quantity of Chloride may be fulfilled through various other food sources).

Basic components of TDS are soluble minerals and salts required for normal physiology and electrolytic balance of the body functions in addition to ascertain taste of drinking water. Low level presence of TDS in both bottle water and jar water causes tasteless of water. Much low amount of TDS in bottle water was probably due to the application of RO technology for water treatment process. Same observation was also noted in case of Chloride. However to maintain a drinking water quality standard additional efforts need to be initiated to increase ingredients level up to the prescribed level.

Low concentration of chloride (below 120 mg/l) may cause diarrhea followed by vomiting. As a result there may be an acute shortage of HCl acid that may further cause alkalosis disease. Adrenal glands and renal function may also be responsible for drastic reduction of blood Chloride. On the other hand, high content of blood Chloride may cause dehydration that ultimately causes high blood pressure. Higher level of Chloride in blood than the required level acts as controller of Sodium chloride metabolism. Compared to the values of Chloride as per BDS, the present findings of bottle water sources although showed within acceptable level but that is much lower than the required level (1.97 – 55 mg/l) with little bit higher but also less (3.99 – 91.97 mg/l) in the jar water sample (i.e. drinking of 2.5 liter of bottle water may provide maximum 137 mg of Chloride while for jar water this amount may be 230 mg per day considering the maximum value of concentration obtained which is true only for few of the jar water samples). The finding indicates that majority of the bottled (83%) and jar water (53%) samples content up to the range of 20 mg/l Chloride and only 5% of the jar water sample fall within the Chloride content range of 81-100%. Findings thus indicated that none of the bottled drinking water and jar water sample was suitable to satisfy the normal requirement of Chloride level for human body (Table 6).

Table 6: Chloride concentration in bottled and jar water samples

Drinking water source	Chloride content (mg/l)					BDS (mg/l)
	Up to 20.0	21-40	41-60	61-80	81-100	
Bottle water (%)	83.33	10.0	6.67	-	-	250
Jar water (%)	52.63	42.11	-	-	5.26	

The P^H values of both the sources of water samples found around the acceptable range of BDS values of 6.4-7.4 (Table 7). The range of P^H value in bottled water and jar water was 6.36 - 7.70 and 6.73-7.75, respectively those considered as safe for drinking, because it is neither acidic nor alkaline enough to be dangerous in the human body. According to the Environment Protection Authority (EPA) of USA, drinking water with P^H of less than 6.0 can be corrosive and filled with toxic metals.

On the other hand water with high P^H value of above 8.5 has a slippery feel, taste a bit like baking soda and may leave deposits on fixtures. The above findings thus confirm that the drinking water of both the sources of water have suitable P^H range for human consumption.

The nitrate value of the bottled drinking water was found to be much lower (0.17-0.22 mg/l) against the maximum BDS value of 4.5 mg/l (Table 7).

Table 7: P^H and Nitrate values of bottled and jars drinking water sources

Drinking waterSource	P ^H value	Nitrate Conc. (mg/l)
Bottled water (%)	6.36 - 7.70	0.17-0.22
Jar water (%)	6.73 - 7.75	Below level of detection
BDS	6.4 – 7.4	4.5 mg/l
EPA, USA (Followed under drinking water quality Acts as per WHO standard)	6.5 to below 8.0	Below 10 mg/l

Comparatively higher level of nitrate contamination possibly may cause through the sources like animal wastes, unreticulated sewage disposal or any industrial or food processing wastes etc. during processing of water. But for bottled water processing plants in Bangladesh, these sources are not available in the production areas. Nitrate is highly soluble in water making it ready transported through soil to ground water which is the principal source of drinking water. Nitrate is a compound that is formed when nitrogen combines with oxygen. High level of nitrate can pose a risk to babies less than six months who are formulae fed and the unborn foetus of pregnant women. When taken within the limit, nitrate can have health benefits through helping in proper body functioning. Too much nitrate in the body can cause serious health effects, specially for infants and others also those more sensitive to effects of nitrate exposure. Excess also restrict the oxygen transport in the blood stream.

Presence of microbes in the bottled and jar drinking water

Presence of any level of Coliform and Faecal coliform in drinking water may cause great threat to human health. As per BDS guideline existence of these bacteria in drinking water is totally unacceptable. Microbial study of the samples of both the sources revealed a great variation in existence of these bacteria between bottled drinking water and jar drinking water (Table 8). The result reflects the level of threat of the jar water due to presence of comparably higher amount of bacteria of both type (Total Coliform 17-1600 MPN/100 ml and Faecal coliform 11-240 MPN/100ml). While for the bottled drinking water, amount of bacteria was <1.8 MPN/100ml i.e. almost absence of Coliform and Faecal coliform that indicates their acceptability and health risk freeness.

Table 8: Quantitative analysis of microbial counts of bottled and jars drinking water

Element	Brand bottled water	Jar water	BDS standard
Coliform (MPN/100 ml)	<1.8	17-1600	0
Faecal coliform (MPN/100 ml)	<1.8	11-240	0

Total Coliform and Faecal Coliform count is considered as an indicator of degree of contamination of drinking water. Total Coliform count indicates the contamination due to natural sources and intestinal and excretion of man and animal sources. Therefore, one cannot draw any inference on human health risk and threat level on the basis of total Coliform count only, but it also requires to know the amount of presence of the Faecal coliform because it reflects the drinking water contamination and risk level that happen only because of intestinal and excretory discharges of man and animals. The findings of the present study reveals that all jar water samples are the carries of total Coliform and Faecal coliform that indicate a great threat to public health.

Jar water samples collected from different places found almost contaminated with total Coliform and Faecal coliform at different degrees. High level of presence of these microbes was recorded from Elephant Road, Chalk Bazar, Basabo, Gulshan and Banani jar water samples. But for jar water samples collected from Sadar Ghatarea shown highest count value for both total Coliform and Faecal Coliform (1600 and 240 MPN per 100ml) indicate high degree contamination of jar drinking water and not suitable for human consumption. However, in bottled drinking water samples presence of microbes was not noticed in any case indicating suitability of drinking water of these sources by human in respect of microbe's contamination. Absence of microbes in bottle water might be due to the effect of Reverse Osmosis (RO) Technology that generally applies during bottle drinking water processing.

As per BDS and WHO, presence of any Coliform and Faecal Coliform bacteria in drinking water is unacceptable. Analysis of jar water samples collected from widely used city points revealed alarming situation due to presence of high label of Coliform and Faecal Coliform bacteria at different degrees (low to high) in jar water. While in this regard, bottle drinking water was found risk-free. Strong monitoring of jar water processing activities may reduce/remove the health threats totally by control of microbes.

Labeling practice of marketed water bottles:

Observations recorded from the survey findings revealed that traders are not serious about proper reflection of the composition and other required information on the body of the bottle as label which is obligatory. A good number of bottled drinking water producer used labeled information as per their trade interest hiding the facts. Remarkable variation was found to exist between the labeled mineral composition/parameters of the bottled water with that of the test results of the water samples done under the study. While in case of jar water, majority of the producers (approx. 95%) did not label and/or used any other printed information on the body of the jar on mineral composition however, information on microbial count of jar water was totally absent in case of 100% jar. As consequences of all those practices, mass people are unconsciously drinking poor quality or under quality bottled water and jar water and becoming health affected. Study findings and variations are presented in Table 9-12. Summary of the study findings are stated as follows:

- 1. Table 9
 - Label value of the company for TDS and Chloride are not consistent with the laboratory analysis value of the same bottle water sample;
- 2. Table 10
 - Label value of the company for TDS and Chloride are not consistent with the laboratory analysis value of the same bottle water sample;
 - Used the BDS values in the label as water quality properties of the bottle water;
 -

- 3. Table 11
 - Label value of the company for TDS and Chloride are not consistent with the laboratory analysis value of the same bottle water sample;
- 4. Table 12
 - Much variation between the label value of the company for TDS and Chloride with the laboratory analysis value of the same bottle water sample;

Table 9: Variation of test results of particular parameters of bottled water with the information printed on the label of the producer

SN	Sample Code	Parameters	Unit	BDS Standard	Test Result	Company Label	Comments
1.	SSML-002_1	p ^H	-	6.4-7.4	7.70	6.4-7.4	Actual values of TDS and Chloride showing dissimilarities with the company label.
		TDS	mg/l	500	194	<250	
		Chloride	mg/l	250	7.88	<250	
		Nitrite (NO ₂)	mg/l	Nil	ND	-	
		Nitrate (NO ₃)	mg/l	4.5	0.19	<2.5	
		Arsenic (As)	mg/l	0.01	ND	-	
		Cadmium (Cd)	mg/l	0.003	ND	<0.003	
		Iron (Fe)	mg/l	0.3	ND	-	
		Manganese (Mn)	mg/l	0.5	ND	<0.1	
		Lead (Pb)	mg/l	0.01	ND	<0.01	
		Total Coliform	MPN/100 ml	0	<1.8	-	
Faecal Coliform	MPN/100 ml	0	<1.8	-			

Table 10: Variation of test results of particular parameters of bottled water with the information printed on the label of the producer

SN	Sample Code	Parameters	Unit	Standards	Test Results	Company label	Comments
2.	SSHN-002_2	p ^H	-	6.4-7.4	6.90	6.4-7.4	- Actual values of TDS and Chloride showing dissimilarities with the company label. - Copy of BDS values used in the label of water bottle.
		TDS	mg/l	500	38	500	
		Chloride	mg/l	250	1.97	250	
		Nitrite (NO ₂)	mg/l	Nil	ND	Nil	
		Nitrate (NO ₃)	mg/l	4.5	0.19	4.5	
		Arsenic (As)	mg/l	0.01	ND	0.01	
		Cadmium (Cd)	mg/l	0.003	ND	0.003	
		Iron (Fe)	mg/l	0.3	ND	-	
		Manganese (Mn)	mg/l	0.5	ND	-	
		Lead (Pb)	mg/l	0.01	ND	0.01	
		Total Coliform	MPN/100 ml	0	<1.8	-	
Faecal Coliform	MPN/100 ml	0	<1.8	-			

Table 11: Variation of test results of particular parameters of bottled water with the information printed on the label of the producer

SN	Sample Code	Parameters	Unit	Standards	Test Results	Company label	Comments
3.	DLLA-003_5	p ^H	-	6.4-7.4	6.92	6.4-7.4	Actual values of TDS (56) and Chloride (3.94) that showing inconsistency with the presented label value of the producer, e.g. <500 & <250, respectively
		TDS	mg/l	500	56	<500	
		Chloride	mg/l	250	3.94	<250	
		Nitrite (NO ₂)	mg/l	Nil	ND	Nil	
		Nitrate (NO ₃)	mg/l	4.5	0.17	Nil	
		Arsenic (As)	mg/l	0.01	ND	Nil	
		Cadmium (Cd)	mg/l	0.003	ND	<0.03	
		Iron (Fe)	mg/l	0.3	ND	-	
		Manganese (Mn)	mg/l	0.5	ND	Nil	
		Lead (Pb)	mg/l	0.01	ND	<0.01	
		Total Coliform	MPN/100 ml	0	<1.8	-	
Faecal Coliform	MPN/100 ml	0	<1.8	-			

Table 12: Variation of test results of particular parameters of bottled water with the information printed on the label of the producer

SN	Sample Code	Parameters	Unit	Standards	Test Results	Company label	Comments
4.	BAIFD-005_1	p ^H	-	6.4-7.4	6.81	6.4-7.4	Actual values of TDS are 20 & Chloride is 0. Whereas, in the company label both values were shown as <250 which is misleading.
		TDS	mg/l	500	20	<250	
		Chloride	mg/l	250	ND	<250	
		Nitrite (NO ₂)	mg/l	Nil	ND	Nil	
		Nitrate (NO ₃)	mg/l	4.5	0.21	<4	
		Arsenic (As)	mg/l	0.01	ND	Nil	
		Cadmium (Cd)	mg/l	0.003	ND	<0.003	
		Iron (Fe)	mg/l	0.3	ND	-	
		Manganese (Mn)	mg/l	0.5	ND	-	
		Lead (Pb)	mg/l	0.01	ND	<0.01	
		Total Coliform	MPN/100 ml	0	<1.8	-	
		Faecal Coliform	MPN/100 ml	0	<1.8	-	

In addition to that, many producers irrespective of the original properties of the jar water also use the parameters value of BDS directly as their own water value on the label. The findings of the test also indicated level of contamination of jar water by microbes (Table 13-15). Summary of the findings are stated as follows:

1. Table 13
 2. Table 14
 3. Table 15
- High level presence of Coliform;
 - High level presence of Coliform and Faecal coliforms
 - Highest level presence of Coliform and Faecal coliform;

Table 13: Qualitative variation of jar water samples with that of BDS values

SN	Sample Code	Parameters	Unit (mg/l)	Standards	Test Results	Comments
5.	DMMD-003_7J	p ^H	-	6.4-7.4	7.75	High level of the presence of Coliform
		TDS	mg/l	500	62	
		Chloride	mg/l	250	5.99	
		Nitrite (NO ₂)	mg/l	Nil	ND	
		Nitrate (NO ₃)	mg/l	4.5	ND	
		Arsenic (As)	mg/l	0.01	ND	
		Cadmium (Cd)	mg/l	0.003	ND	
		Iron (Fe)	mg/l	0.3	ND	
		Manganese (Mn)	mg/l	0.5	ND	
		Lead (Pb)	mg/l	0.01	ND	
		Total Coliform	MPN/100 ml	0	17	
		Fecal Coliform	MPN/100 ml	0	<1.8	

Table 14: Qualitative variation of jar water samples with that of BDS values

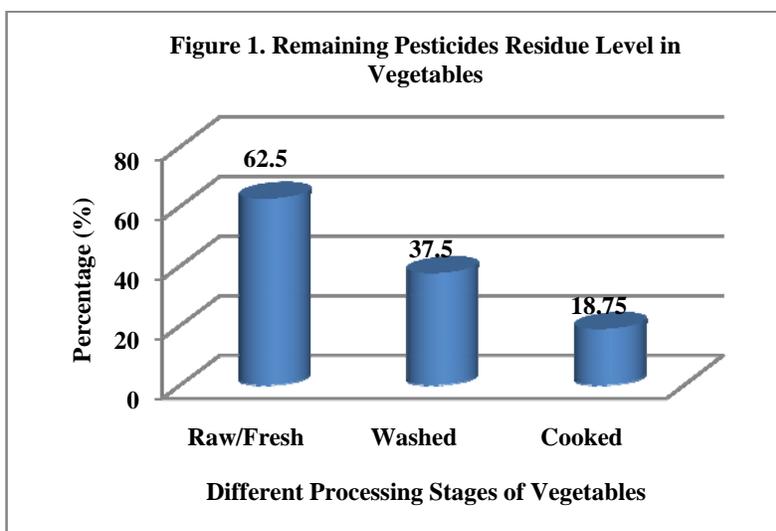
SN	Sample Code	Parameters	Unit (mg/l)	Standards	Test Results	Comments
6.	DGSTN-003_15J	p ^H	-	6.4-7.4	6.98	High level of the presence of Coliform and Faecal coliforms
		TDS	mg/l	500	474	
		Chloride	mg/l	250	91.97	
		Nitrite (NO ₂)	mg/l	Nil	ND	
		Nitrate (NO ₃)	mg/l	4.5	ND	
		Arsenic (As)	mg/l	0.01	ND	
		Cadmium (Cd)	mg/l	0.003	ND	
		Iron (Fe)	mg/l	0.3	ND	
		Manganese (Mn)	mg/l	0.5	ND	
		Lead (Pb)	mg/l	0.01	ND	
		Total Coliform	MPN/100 ml	0	130	
		Faecal Coliform	MPN/100 ml	0	79	

Table 15: Qualitative variation of jar water samples with that of BDS values

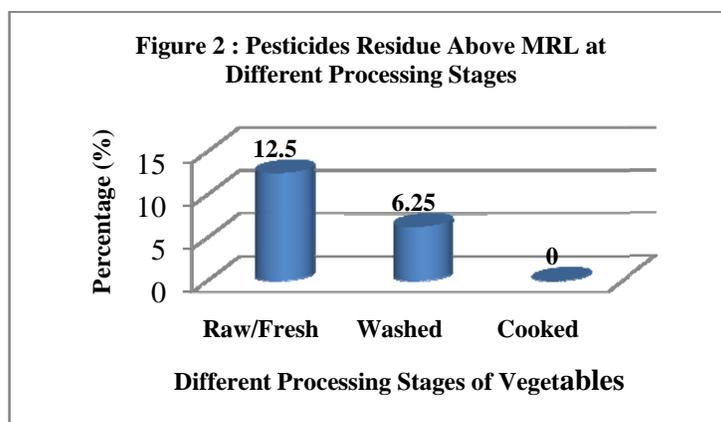
SN.	Sample Code	Parameters	Unit (mg/l)	Standards	Test Results	Comments
7.	DSGHT-003_19J	p ^H	-	6.4-7.4	6.86	Highest level of the presence of Coliform and Faecal coliforms
		TDS	mg/l	500	328	
		Chloride	mg/l	250	31.99	
		Nitrite (NO ₂)	mg/l	Nil	ND	
		Nitrate (NO ₃)	mg/l	4.5	ND	
		Arsenic (As)	mg/l	0.01	ND	
		Cadmium (Cd)	mg/l	0.003	ND	
		Iron (Fe)	mg/l	0.3	ND	
		Manganese (Mn)	mg/l	0.5	ND	
		Lead (Pb)	mg/l	0.01	ND	
		Total Coliform	MPN/100 ml	0	1600	
		Faecal Coliform	MPN/100 ml	0	240	

11.2. Determination of pesticide residue levels in the vegetable samples

In this study, types and number of different vegetable samples were used to quantify the residue level of pesticide at fresh raw, washed and cooked stages. Figure 1 show that in all the cases pesticide residues found in the samples of raw vegetables was higher (62.5%) than that in the same samples when tested after washing (37.5%) and cooking (18.75%).



However, 12.5% of fresh raw and 6.25% of the washed samples were found with pesticides residue above Maximum Residue Limit (MRL) level (Figure 2). Moreover, pesticides residue of Cypermethrin, Chlorpyrifos, Carbendizam and Dimethioate in particular was also found in some of the cooked samples, but all of these residues were below the recommended level of MRL.



Quantification of level of specific pesticide in the different vegetables

All categories of pesticides are not commonly applied to all the vegetables and crops rather it is determined by the type of disease and causative agents that the vegetable/crop is vulnerable to and season of culture, stage of development and nature of active ingredients of the chemical compounds, etc. Therefore, only the most commonly used pesticides applied to different selected vegetables in various occasions were considered to assess their residue level at different stages of that particular vegetable.

Dithiocarbomates is a commonly used fungicidal agent widely applied in cauliflower production of Bangladesh. Detection of residue level of this fungicide in fresh raw and washed Cauliflower samples shows a value below the MRL (1.0 mg/kg) for human in both the cases i.e. 0.104 mg/kg for raw fresh samples and 0.196 mg/kg for washed samples (Table 16). However no residue was detected in cooked samples of Cauliflower (LOQ: 0.050). Findings thus revealed that presence of residue of the fungicidal agent in Cauliflower at any stage is not harmful to human.

Table 16: Average residue level of pesticide at different stages of processing in Cauliflower

Vegetable	Name of Pesticide	mg/kg			
		Residue level		MRL*	ADI*
Cauliflower (dzjKwc)	Dithiocarbomates (Mancozeb, Maneb, Propineb, Metiram, Thiram, Zineb & Ziram Collectively estimated as CS2)	Raw/ Fresh	0.104	1.0	0.01-0.03
		Washed	0.196		
		Cooked	BLQ (LOQ: 0.050)		

*MRL: Maximum Residue Limit; *ADI: Average Daily Intake

Four most widely used pesticides for Country Bean growing are Fenvelerate, Chlorantraniliprole, Dimethoate and Emamectin benzoate. Table 17 shows the average residue level of the pesticides at different processing stages of Country Bean. Fenvelerate residue in Country Bean in washed sample was detected to be 0.010 mg/kg while in the fresh raw sample the residue was below the limit of quantification (0.010 mg/kg). Level of Chlorantraniliprol residue detected in raw/fresh and washed sample was 0.020 and 0.014 mg/kg respectively. In case of cooked the residue was below the limit of quantification. Presence of Dimethoate at all the three stages of the vegetable, i.e., raw, washed and cooked in particular was 0.164, 0.186 and 0.099 mg/kg respectively. For Emamectin benzoate,

the detected residue level was 0.023 mg/kg in fresh raw samples, while in other two stages viz., washed and cooked, the value was below the limit of quantification. The finding of the analysis on residue level for the above four widely used pesticides in Country Bean revealed that in all the cases, the residue level detected was below the MRL for the particular pesticide and was also within the average daily intake level for human.

Table 17: Average residue level of pesticides at different processing stages of Country Bean

Vegetable	Name of Pesticide	mg/kg			
		Residue level		MRL	ADI
Country Bean (+`kxcÖRvwZimxg)	Fenvelerate	Fresh raw	BLQ (LOQ: 0.010)	2	0.02
		Washed	0.010		
		Cooked	BLQ (LOQ: 0.010)		
	Chlorantraniliprole	Fresh raw	0.020	0.03	0 - 0.03
		Washed	0.014		
		Cooked	BLQ (LOQ: 0.010)		
	Dimethoate	Fresh raw	0.164	2	0.002
		Washed	0.186		
		Cooked	0.099		
	Emamectinbenzoate	Fresh raw	0.023	0.05	0.0005
		Washed	BLQ (LOQ: 0.010)		
		Cooked	BLQ (LOQ: 0.010)		

Five pesticidal agents (Chlorpyrifos, Cypermethrin, Fenvelerate, Carbendazim and Dimethoate) that are widely used in Long Yard Bean production was tested for their residue level (Table 18). Same concentration of 0.012 mg/kg of Chlorpyrifos residue was detected in both fresh raw and washed samples of Long Yard Bean which was below the MRL for human. In other form (cooked), it was below the limit of quantification. Cypermethrin was also found below the limit of quantification in fresh raw and washed samples. However, a minimum level of residue was detected in cooked samples (0.025 mg/kg) which was also found below MRL for human. Fenvelerate residue was also detected below MRL (2.0 mg/kg) both in fresh raw and washed samples (0.310 and 0.327 mg/kg, respectively). Residue of the same agent in cooked sample was also below the limit of quantification. In case of both Carbendazim and Dimethoate, fresh raw samples of Long Yard Bean showed residue level of 0.010 and 0.236 mg/kg, respectively, indicating that the limit of residue is below the MRL for human (0.5 and 2.0 mg/kg, respectively). For both of these pesticides, washed and cooked samples showed the residue level below the limit of quantification. Therefore, the residue levels of all the above five pesticides used in Long Yard Bean is not harmful for human as the levels are far below of the MRL.

Table 18: Average residue level of pesticide in the different processing stages of Long Yard Bean

Vegetable	Name of Pesticide	Residue level (mg/kg)		mg/kg	
				MRL	ADI
Long Yard Bean (eiewU)	Chlorpyrifos	Fresh raw	0.012	0.2	0.01
		Washed	0.012		
		Cooked	BLQ (LOQ: 0.010)		
	Cypermethrin	Fresh raw	BLQ (LOQ: 0.010)	0.5	0.05
		Washed	BLQ (LOQ: 0.010)		
		Cooked	0.025		
	Fenvelerate	Fresh raw	0.310	2	0.02
		Washed	0.327		
		Cooked	BLQ (LOQ: 0.010)		
	Carbendazim	Fresh raw	0.010	0.5	0.03
		Washed	BLQ (LOQ: 0.010)		
		Cooked	BLQ (LOQ: 0.010)		
Dimethoate	Fresh raw	0.236	2	0.002	
	Washed	BLQ (LOQ: 0.010)			
	Cooked	BLQ (LOQ: 0.010)			

Cabbage samples were directly collected from the farmer's plots and studied for the residue level for two mostly used pesticides Chlorpyrifos and Cypermethrin. The findings of the study are shown in Table 19. Residue analysis of Chlorpyrifos in fresh raw, washed and cooked sample of Cabbage showed its presence at a concentration far below the MRL value (1.0 mg/kg) for human. The concentration of Cypermethrin was below the limit of quantification for washed and cooked samples but it was 0.069 mg/kg in fresh raw sample against a MRL value of 2.0 mg/kg. The findings thus indicates the residue level of the above two pesticides is within the consumable level for human.

The only widely applied pesticide in production of Red Amaranth is Carbendazim. For analyzing its residue level in this leafy vegetable, field samples were directly collected from farmers plot. Findings on residue status in fresh raw vegetable sample was below the limit of quantification, while it was recorded 0.114 mg/kg (higher) in washed samples which was even below the MRL value (Table 19). The higher value in washed sample than the fresh raw samples may be due to variation in dose and time of application of pesticide in the different plots. The cooked samples showed residue level of 0.042 mg/kg that was also far below the MRL value i.e. it is not also harmful for human.

Table 19: Average residue level of pesticide at the different processing stages of Cabbage and Red Amaranth

Vegetable	Name of Pesticide	mg/kg			
		Residue level		MRL	ADI
Cabbage (evuavKwc)	Chlorpyrifos	Fresh raw	0.386	1.0	0.01
		Washed	0.058		
		Cooked	0.034		
	Cypermethrin	Fresh raw	0.069	2.0	0.05
		Washed	BLQ (LOQ: 0.010)		
		Cooked	BLQ (LOQ: 0.010)		
Red Amaranth (vjkvK)	Carbendazim	Fresh raw	BLQ (LOQ: 0.010)	0.5	0.03
		Washed	0.114		
		Cooked	0.042		

Investigation on the average residue level of 25 commonly used pesticide at various stages of production and processing of Bitter Gourd (improved variety called Korrolla in Bangla) reveals that

the vegetable is safe for human in all forms (i.e. fresh raw, washed and cooked forms). For all the forms, residue was below the limit of quantification (Table 20). And in case of Indigenous Bitter Gourd (called Ustha in Bangla), residue detection investigation done only for Carbendazim in cooked samples indicated its presence at a very low concentration (0.024 mg/kg) which was also below the MRL for human consumption.

Table 20: Average residue level of pesticide at different processing stages of Bitter Gourds

Type of Vegetables	Name of Pesticide	Residue level (mg/kg)		mg/kg	
				MRL	ADI
Bitter Gourd (Kijøv)	Cyhalothrin, Abamectin, Carbaryl, Carbendazim, Carbosulfan, Cartap, Chlorantraniliprole, Diazinon, Dimethoate, Emamectin benzoate, Imidacloprid, Carbofuran, Indoxacarb, Iprovalicrab, Malathion, Metalaxyl, Profenophos, Propiconazole, Quinalphos, Spinosad – A, Spinosad – D, Spinosad (sum of A &- D), Thiamethoxam, Methomyl, Thiodicrab	Fresh raw	BLQ (LOQ: 0.010)	0.05	0.01-0.03
		Washed	BLQ (LOQ: 0.010)		
		Cooked	BLQ (LOQ: 0.010)		
Bitter Gourd (D'ív)	Carbendizam	Cooked	0.024	0.05	0.03

Similar findings on residue levels of pesticides as in Bitter Gourds were observed for different forms of Ladies Finger and Brinjal. In addition, Dithiocarbomates residue analysis also showed the presence below the limit of quantification in both Ladies Finger and Brinjal (Table 21 and 22 respectively).

Table 21: Average residue level of pesticide in different processing stages of Ladies Finger

Type of Vegetables	Name of Pesticide	Residue level (mg/kg)		mg/kg	
				MRL	ADI
Ladies Finger (+Xuok)	Cyhalothrin, Abamectin, Carbaryl, Carbendazim, Carbosulfan, Cartap, Chlorantraniliprole, Diazinon, Dimethoate, Emamectin benzoate, Imidacloprid, Carbofuran, Indoxacarb, Iprovalicrab, Malathion, Metalaxyl, Profenophos, Propiconazole, Quinalphos, Spinosad – A, Spinosad – D, Spinosad (sum of A &- D), Thiamethoxam, Methomyl, Thiodicrab	Fresh raw	BLQ (LOQ: 0.010)	1.0	0.01-0.03
		Washed	BLQ (LOQ: 0.010)		
		Cooked	BLQ (LOQ: 0.010)		
	Dithiocarbomates	BLQ (LOQ: 0.050)			

Table 22: Average residue level of pesticide in different processing stages of Brinjal

Type of Vegetable	Name of Pesticide	Residue level (mg/kg)		mg/kg	
				MRL	ADI
Brinjal (te,b)	Cyahalothrins, Abamectin, Carbaryl, Carbendazim, Carbosulfan, Cartap, Chlorantraniliprole, Diazinon, Dimethoate, Emamectin benzoate, Imidacloprid, Carbofuran, Indoxacarb, Iprovalicarb, Malathion, Metalaxyl, Profenophos, Propiconazole, Quinalphos, Spinosad – A, Spinosad – D, Spinosad (sum of A & D), Thiamethoxam, Methomyl, Thiodicrab	Fresh raw	BLQ (LOQ: 0.010)	0.2 - 0.5	0.01-0.03
		Washed	BLQ (LOQ: 0.010)		
		Cooked	BLQ (LOQ: 0.010)		
	Dithiocarbomates	BLQ (LOQ: 0.050)			

Detection level was also below the limit of quantification for all the commonly used pesticides and fungicides in the different forms (fresh raw, washed and cooked) of Green Chilies (Table 23).

Table 23: Average residue level of pesticide in different processing stages of Green Chilies

Type of Vegetables	Name of Pesticide	Residue level (mg/kg)		mg/kg	
				MRL	ADI
Green Chilies (KuvPvgwiP)	Chlorpyrifos, Cypermethrin, Fenitrothion, Fenvelerate, Lambada-Cyhalothrin, Abamectin, Carbaryl, Carbendazim, Carbosulfan, Cartap, Chlorantraniliprole, Diazinon, Dimethoate, Emamectin benzoate, Imidacloprid, Carbofuran, Indoxacarb, Iprovalicarb, Malathion, Metalaxyl, Profenophos, Propiconazole, Quinalphos, Spinosad – A, Spinosad – D, Spinosad (sum of A & D), Thiamethoxam, Methomyl, Thiodicrab	Fresh raw	BLQ (LOQ: 0.010)	0.5	0.01-.03
		Washed	BLQ (LOQ: 0.010)		
		Cooked	BLQ (LOQ: 0.010)		
	Dithiocarbomates	Fresh raw	BLQ (LOQ: 0.050)		
		Washed	BLQ (LOQ: 0.050)		
		Cooked	BLQ (LOQ: 0.050)		

Residue analysis was also done in cooked mixed vegetable only for pesticide Carbendazim. Finding revealed a level of acceptance of residue (0.027 mg/kg) against MRL of 0.5 mg/kg (Table 24).

Table 24: Average residue level of pesticide in cooked mixed vegetables

Type of Vegetables	Name of pesticide	Residue level (mg/kg)		mg/kg	
				MRL	ADI
Mixed vegetable (Bitter gourds, Ladies finger, Broccoli, Cauliflower, Tomato, Long yard bean, Brinjal (oval and long), Country bean, Corianders leaf and Green chilli)	Carbendizam	Cooked	0.027	0.5	0.03

11.3. Development of communication materials for wide awareness building

Based on the findings of the current research, with a view to create awareness and motivate the consumers towards nutrition consciousness, the research came out with a number of effective tools as means for Behavior Change Communication (BCC) device. Such BCC tools were:

- i. Food Plate
- ii. Digital display board
- iii. Mugs
- iv. Slogan Stones
- v. Stickers
- vi. T-shirts

All these tools contained summary information and key messages on importance, role, sources, process of handling, and nutrition safety related matters (Plate 4). In addition to that, the project also produced two research based leaflets (Plate 5) and generated information in the respective areas those are summarized as follows:

- Bottle and jar drinking water quality: A threat to public health.
- Pesticide use in vegetables: Food safety and risks.
- Level of pesticide residue contamination in various stages of vegetable production and processing (in Bangla).
- Health effects of bottled and jar drinking water (in Bangla).

Plate 4. Awareness Creating BCC Tools on Balanced Diet and Safe Food



Food Plate



Mug



Mug



Mug



Stickers



T-Shirts



Slogan Stone



Slogan Stone

Plate 5: Leaflets produced under the research project



12. Research highlights/findings:

- The amount of TDS, chloride and NO₃ in bottled drinking water was found to be at a concentration below the BDS level (8-240 mg/l for TDS as against the maximum BDS value of 500 mg/l; 1.97-55 mg/l for chloride as against the maximum BDS value of 250 mg/l and 0.17-0.22 mg/l NO₃ as against the maximum BDS value of 4.5 mg/l)
- Concentration of TDS and chloride in jar water was found to be below the BDS level (62-474 mg/l for TDS and 3.99-91.97mg/l for chloride) which was little bit higher than the bottled water.
- P^H value of water from both the sources was around acceptable range of BDS standard (6.4-7.4).
- Presence of Coliform and Faecal Coliform in the jar water was recorded to be 17-1600 MPN/100 ml and 11-240 MPN/100 ml respectively indicating that the jar water is not safe for drinking however, no harmful bacteria were detected in the bottled water.
- Pesticide residue level was recorded to be 62.5%, 37.5% and 18.75% in the raw (unwashed), washed and cooked vegetable samples respectively however, residue level measuring above MRL was found in 12.5% and 6.25% of the raw and washed vegetables samples respectively.
- No pesticide residues were noticed in any of the cooked vegetables other than Carbendizim, Cypermethrin, Chlorpyrifos and Dimethoate but, for all those pesticides the residue level was found to be below MRL.

B. Implementation Position:**1. Procurement:**

Not applicable

2. Establishment/renovation facilities:

Not applicable

3. Training/Study tour/Seminar/Workshop/Conference organized:

Not applicable

C. Financial and Physical progress:

Items of expenditure	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for variation
A. Contractual Staff Salary	706272	1231005	706272	524732.7	57.4	-
B. Field Research/ Lab expenses and supplies	2813774	2881183	2813774	67409.12	97.7	-
C. Operating Expenses	663409	375977.2	553016	-177038.8	147.0	-
D. Vehicle Hire and Fuel, Oil & Maintenance	328182	282690.4	155682	127008.4	55.1	-
E. Training/ Workshop/ Seminar etc.	267500	144255	0	144255	00.0	-
F. Publications and printing	357675	424035.5	275212	148823.5	65.0	-
G. Miscellaneous	574227	56926.05	502983	-446056.9	-	Excess expenditure was made for the interest of the project with the concurrence of the PIU authority
H. Capital Expenses	40361	120000	37566	82434	31.3	-
Grand Total (TK)	5751400	5516072	5044505	471567		-

D. Achievement of sub-project by objectives (Tangible form):

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)
i. Evaluation of microbial, chemical and biochemical assessment of different types of bottled/jar drinking water in Bangladesh market	<ul style="list-style-type: none"> • Development of survey tools; • Collection of bottle and jar water sample and related information; • Analysis of chemical properties of drinking water samples; • Microbial study of the water samples; 	<ul style="list-style-type: none"> • The amount of TDS, chloride and NO₃ in bottled drinking water was found to be at a concentration below the BDS level (8-240 mg/l for TDS as against the maximum BDS value of 500 mg/l; 1.97-55 mg/l for chloride as against the maximum BDS value of 250 mg/l and 0.17-0.22 mg/l NO₃ as against the maximum BDS value of 4.5 mg/l) • Concentration of TDS and chloride in jar water was found to be below the BDS level (62-474 mg/l for TDS and 3.99-91.97mg/l for chloride) which was little bit higher than the bottled water. • P^H value of water from both the sources was around acceptable range of BDS standard (6.4-7.4). • Presence of Coliform and Faecal Coliform in the jar water was recorded to be 17-1600 MPN/100 ml and 11-240 MPN/100 ml respectively indicating that the jar water is not safe for drinking however, no harmful bacteria were detected in the bottled water. 	Knowledge generated through this study will help increasing awareness of consumers regarding the quality and health safety of marketed drinking waters
ii. To determine the residue level of pesticide at market, washed and cooked samples of major indigenous vegetables	<ul style="list-style-type: none"> • Collection of vegetable samples; • Laboratory analysis of vegetable samples for determining pesticide residue level at various stages of processing (viz., fresh raw, washed and cooked form); • Heating effect on removal of residue from cooked vegetables; 	<ul style="list-style-type: none"> • Pesticide residue level was recorded to be 62.5%, 37.5% and 18.75% in the raw (unwashed), washed and cooked vegetable samples respectively however, residue level measuring above MRL was found in 12.5% and 6.25% of the raw and washed vegetables samples respectively. • No pesticide residues were noticed in any of the cooked vegetables other than Carbendizim, Cypermethrin, Chlorpyrifos and Dimethoate but, for all those pesticides the residue level was found to be below MRL. 	Knowledge generated through this study will help increasing awareness of consumers regarding the pesticide residue level in the vegetables and how to make them safe for consumption
iii. Development of communication materials for wide awareness building for pesticide and healthy water for public health	<ul style="list-style-type: none"> • Preparation of research finding based awareness building, communicable extension materials and research papers; 	<ul style="list-style-type: none"> • Production of <ul style="list-style-type: none"> ii. Leaflets : 2 iii. Food Plate : 2 types iv. Sticker : 3 types v. Digital display: 1 vi. Mugs : 2 types vii. T-shirts : 200 pc 	Key message of the tools will increase safe use and consumption of vegetables and marketed drinking water due to increased awareness of the consumers

E. Materials development/publications made under the sub-project:

Publications	Number of publications		Remarks (e.g. Paper title, name of journal, conference name etc.)
	Under preparation	Completed & published	
Technology bulletin/booklet/leaflet/flyer etc.	-	02	<ul style="list-style-type: none"> • Bottle and jar drinking water quality: A threat to public health; • Pesticide use in vegetables: Food safety and risks;
Journal publication	02	-	<ul style="list-style-type: none"> • Under process of drafting
Information development	-	02	<ul style="list-style-type: none"> • Level of pesticide residue contamination in various stages of vegetable production and processing (in Bangla); • Health effects of bottled and jar drinking water (in Bangla);
Other publications, if any	-	-	-

F. Technology/Knowledge generation/Policy support (as applied)

i. Generation of technology (Commodity & non-commodity)

Not applicable

ii. Generation of new knowledge that help in developing more technology in future:

Generated knowledge about the quality status of widely marketed bottled and jar drinking water and residue level of different pesticides in selected vegetable items at different forms of the product.

The generated information on drinking water will inspire to carry out further research for development of low cost technology to ensure production and supply of safe drinking water reachable for mass people of the country.

iii. Technology transferred that help increased agricultural productivity and farmer's income:

Not applicable

iv. Policy support:

Require more diversified research to generate package of information for policy support. However, information so far generated through the present research may provide feedback to the policy people to amend/modify the existing related policy guideline to ensure quality standard of drinking water production in the country through framing of necessary regulation on compliances of water quality standards and pesticide production and application.

G. Information regarding desk and field monitoring:

i) Desk monitoring (Description & output of consultation meeting, monitoring workshop/seminars etc.):

Two internal desk monitoring of the project work was carried out during the project period and one half yearly progress review workshop and one project completion workshop was held at the end of the project.

In both the cases, desk monitoring and review workshop came out with positive comments on the work progress (both for technical and financial) as per activity plan of the project.

ii) Field monitoring (Time & no. of visit, team visit and output):

During the study period, field activities like sample and data collection were done by the enumerators. Activities at field level were time to time monitored by the Principal Investigator and the project scientist on a regular basis. Dates and places of visits and outputs are presented in the following table.

Dates and Places	No. of Visits	Name and designation of officers visited	Output
<ul style="list-style-type: none">• 6/7/17-7/7/17: Chattagram• 5/8/17-7/8/17: Noakhali, Chandpur, Cumilla• 4/11/17-5/11/17: Jashore• 25/11/17- Brahmanbaria• 27/11/17-29/11/17: Chapainawabganj• 10/12/17-12/12/17: Khulna• 13/12/17-14/12/17: Noakhali• 27/12/17: Manikganj• 1/1/18-3/1/18: Chattagram	09	Dr. Md. Monirul Islam Director, Nutrition Unit & Principal Investigator	Data generation in the respective area of research reflects the prevailing status of consumption and marketing of commercial drinking water in the surveyed areas.
<ul style="list-style-type: none">• 27/09/17- 29/9/17: Sylhet• 4/5/18 - 6/5/18: Khulna• 21/6/18- 23/6/18: Rajshahi	03	Tamanna Toma Khan Scientific Officer Nutrition Unit, CRG Project	

H. Lesson learned/Challenges (if any):

None

I. Challenges (if any):

None

Signature of the Principal Investigator

Counter signature of the Head of the
Organization/Authorized representative

(Dr. Md. Monirul Islam)
Principal Investigator
Date: 28.01.2019
Seal:

(Dr. Md. Kabir Ikramul Haque)
Executive Chairman
Date: 28.01.2019
Seal:



বাংলাদেশ কৃষিগবেষণাকাউন্সিল
পুষ্টিইউনিট

ঢাকামহানগর ও পার্শ্ববর্তী অন্যান্য বিভাগীয়শহরেরবিভিন্নসড়কপার্শ্বে, চা-দোকান ও খাবারের দোকানেসরবরাহকৃত ও ব্যবহৃতজারের ও
বোতলেরপানিরব্যবহারউৎপাদন ও উৎসসংক্রান্ত তথ্য সংগ্রহ ফরম।

- ১। ক. তথ্য সংগ্রহকারীরনাম ও পদবী.....
খ. তথ্য সংগ্রহেরতারিখ
গ. তথ্য সংগ্রহেরএলাকার/ স্থানেরনাম
- ২। ক. তথ্য প্রদানকারী ব্যক্তির নাম
- খ. দোকানেরধরন: চায়ের দোকান/ খাবারের দোকান/ অন্যান্য
গ. দোকানেরনাম (যদি থাকে) ও ঠিকানা
- ৩। দোকানেব্যবহৃতখাবারপানিরউৎস: সরবরাহকৃতজার/বোতল/ সিটিকপোর্শেশনসাপ্লাই/ অন্যান্য
- ৪। দোকানেপানিফিল্টারেরব্যবস্থা আছেকি?:হ্যাঁ/ না
- ৫। জারবা বোতলেরপানির ক্ষেত্রেপ্রস্তুতকারী ও সরবরাহকারীপ্রতিষ্ঠানেরনাম ও ঠিকানা
.....
- ৬। দৈনন্দিন ব্যবহৃত পানিরপরিমাণ.....লি: (.....বোতল/জার).....
প্রস্তুতকারীপ্রতিষ্ঠানেরজন্য প্রয়োজ্য:
- ৭। প্রতিষ্ঠানের নাম ও অবস্থান.....
- ৮। প্রস্তুত কাজেব্যবহৃতপানিরমূল উৎস.....
- ৯। পানি শোধনেরকিপ্রক্রিয়াকরায়: শুধুফিল্টার/ শুধুরাসায়নিক যোগে/রাসায়নিক ও ফিল্টারযোগে /
ইলেক্ট্রনিক/ অসমোরেগুলেশন/অন্যান্য প্রক্রিয়া:.....
- ১০। ক. কোনরাসায়নিকপদার্থ ব্যবহারহয়কিনা
- খ. রাসায়নিকপদার্থ ব্যবহৃতহলেনামওব্যবহারেরমাত্রা (গ্রা/লি:):.....
- ১১। পানি শোধনেফিল্টারব্যবহারহলেকিধরনেরফিল্টার: সনাতনী/ আধুনিক/ সাধারণছাকনী/ অন্যান্য
- ১২। দৈনিকউৎপাদিতপরিশোধিতপানিরপরিমাণ (লি:)
- ১৩। জার / বোতলেরগায়েপ্রতিষ্ঠানের লেবেললাগানোহয়কিনা: হ্যাঁ/ না
- ১৪। লেবেলেপানিরপ্রকৃত উপকরণ ও ব্যবহারেরবিভিন্নশর্তাবলি পৃথকভাবে লেখাআছেকিনা,
ক) যদি আংশিক থাকে, তবেকিবিষয়উল্লেখআছে :.....
খ) অনুমোদিত কর্তৃপক্ষেরসীলআছে কিনা.....
গ) আমদানীকৃত বাজারজাতকৃত পানিহলেনামউল্লেখকরেন.....

১৫। দেশের কোন কোন স্থানের বরাহকরাহয় (এলাকা/ জেলা/ উপজেলাভিত্তিক কাজ)
.....

১৬। উক্ত কাজের জন্য উপযুক্ত কর্তৃপক্ষের অনুমোদন রয়েছে কিনা? হ্যাঁ/ না

১৭। কোম্পানীর/ ফ্যাক্টরীর কোন শাখা আছে কিনা? হ্যাঁ/ না
(হ্যাঁ হলে কয়টি ও কোথায় কোথায়).....

১৮। পরিদর্শনকৃত বাজারে প্রাপ্ত ব্র্যান্ড বোতল জাত পানির নামসমূহ

- ১.
- ২.
- ৩.
- ৪.
- ৫.

১৯। অন্যান্য/ মতামত.....

তথ্য সংগ্রহকারীর স্বাক্ষর

যাচাইকারীর স্বাক্ষর

তারিখ: