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Quality Monitoring of Jar Water Collected from Different Spot of Chittagong Metropolitan City, Bangladesh

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Abstract: *A study has been conducted to evaluate physico –chemical parameters, heavy metal content and microbiological quality of jar water collected from Chittagong Metropolitan city,Bangladesh. Total twenty one(21) samples were collected from seven different densely populated areas under Chittagong Metropolitan city. Physico-chemical concentration of all the tested jar water were found in the permissible limits. In context with heavy metal only chromium concentration exceeded the permissible limits in few samples but other heavy metals concentration were within tolerable limits. More than 76% of the collected samples were found contaminated with pathogenic organisms which is a serious concern for the inhabitants of Chittagong Metropolitan city. The current finding will convey a strong message for the local authority and policy maker to take necessary steps in order to ensure safe water supply for mass people.*

Keywords: *Heavy metals, Microbiology, Concentration , Pathogenic organism and mass people.*

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I. Introduction:

Jar water is mainly that water which is carried out with twenty five liter jar from its production site and is sold in different middle class hotel, restaurant and street vendors. In jar water production industries, the jar is filled with underground water or water supplied by local government authority named Chittagong Water Supply and Sewerage Authority(CWASA) without any treatment or purification and doing any test like physico-chemical, heavy metal and microbial. Moreover, the jar used for this purpose is easily contaminated with microbes due to unhygienic and frequent use without proper cleaning. Water is an essential elements for life. The quality of drinking water is closely related to public health. Around 80% of all diseases and one third of total death toll in developing countries due to consumption of contaminated water[1]. The joint monitoring program for water supply and sanitation conducted by WHO and UNICEF reveal that 20-40% of urban water systems in the developing countries do not use safe drinking water sources. Polluted water, poor sanitation and unhygienic condition lead to water born diseases. As a result, thirty four million deaths happen a year throughout the world most of them are mainly children[2]Regarding the quality of drinking water, microbiological contamination is a major concern for developing countries. In addition, toxic metal contaminants like as Lead, Mercury and Cadmium etc are dangerous for human health, since these metal are carcinogenic and presence in the water also provide major concern both health and aesthetic aspects.

It is estimated that among 125 million citizens of Bangladesh near about 77 million are at high risk of unsafe drinking water [3]. Tube wells have been used as drinking water source in Bangladesh since 1940 in order to prevent morbidity and mortality from gastrointestinal disease[4]. Traditionally, underground water is a potent source of drinking water. Unfortunately this underground water has been tainted with micro-organisms due to improper collection and handling causing communicable diseases and mortality. Infants and children are more vulnerable by drinking contaminated water consequently they suffered from acute gastrointestinal disease. On the other hand, most of the installed tube wells were not tested for toxic metal and physico-chemical contamination in Bangladesh, However water may add natural contaminants particularly inorganic contaminants arise from geological strata via the water flow and anthropogenic pollution[4].

Jar water is mainly consumed by people when they went outside of residence for work and consequently took food from street vendors.. The quality of drinking water especially jar water in Chittagong city is an alarming situation. The significance of monitoring Jar water quality in Chittagong city is vital and still no study has been carried out about the impurity presence in jar water in Chittagong Metropolitan City. Therefore, sufficient pure drinking water is the primary prerequisites for a sound life along with a significant economic preference in many sub-critical economics. Specially it is at risk because there are many industries and a port as a result its economic growth increased and rural people migrated in the Chittagong City for earning money owing to suffer from inadequate of pure drinking water. For this reason, ensuring the safety of Jar water

and investigation was conducted to assess the chemical properties, heavy metals and micro-organism of the Jar water available .

II. Sampling Area and Sample Collection:

The sampling area was located within Chittagong Metropolitan city of Bangladesh. Jar water samples were collected from seven different points such as Oxygen ,Muradpur,Baddarhat,Shah Aanat bridge,New Market,GEC and Bayezid. Three samples were collected in each sampling sites from three different shops. In this way ,total 21 samples were collected from different seven places. These water samples were collected in sterilized bottles and prior to filling the sample bottles were rinsed two to three times with the jar water to be collected. Collected jar water samples were promptly brought in laboratory for analysis.

III. Experimental Analysis

Toxic metals such as Arsenic, Mercury, Lead, Cadmium, Chromium, and Iron were analyzed by Atomic Absorption Spectrophotometer (Thermo-scientific, iCE-3300,3000 series,USA).Total alkinaty, chloride, free chlorine and hardness were quantified by titrimetric methods[5]. On the other hand, sulphate, phosphate, nitrate, nitrite were analyzed by UV-Vis spectrophotometer[5].Total dissolve solid(TDS), electrical conductivity(EC) were determined by using EC meter (Model no. EC214) pH and turbidity were analyzed by pH meter(model no. pH5011) and turbidity meter(Lovibond, Turb Direct, SN 09/1275) respectively. Values of total coliform and Thermotolerant coliform of water samples were determined by Most Probable Number(MPN) method using brilliant green bile broth(BGB) media. Total viable count(TVC) was determined by total plate count using nutrient agar(NA) media. The pathogenic organism such as Salmonella spp., E. Coli and Vibrio Cholerae were identified using selective Bismuth sulphate agar(BSA), XLD, EMB and TCBS agar media then confirmed by selected biochemical test.

IV. Result and Discussion

Physico-chemical result of the twenty one water samples collected from seven different spot of Chittagong Metropolitan city were illustrated in table-1.

Table -1: Result of Physical parameters in Jar water collected from Chittagong Metropolitan City

Sample Location & Code		pH	TDS	Turbidity	EC	Chloride	Free chlorine	Total hardness	Total alkalinity	sulphate	Nitrate
Oxygen	J_1	6.91	25.0	0.31	40.2	5.50	BDL	7.85	4.80	0.60	BDL
	J_2	7.02	23.9	0.27	38.5	5.47	BDL	7.79	4.63	0.57	BDL
	J_3	7.08	87.5	1.09	141.1	22.10	BDL	33.17	8.37	0.72	BDL
Muradpur	J_4	6.88	37.8	0.41	61.0	11.36	BDL	15.21	5.22	0.61	BDL
	J_5	6.78	55.7	0.45	90.0	17.14	BDL	21.32	5.29	0.69	BDL
	J_6	6.85	30.0	0.21	48.3	6.87	BDL	11.39	3.19	0.64	BDL
Baddarhat	J_7	7.07	110.7	0.73	179.0	23.07	BDL	37.98	5.13	1.03	BDL
	J_8	6.97	65.8	0.47	106.2	18.25	BDL	24.73	7.11	0.74	BDL
	J_9	6.99	56.4	0.39	91.0	17.09	BDL	22.07	6.53	0.67	BDL
Shah Amanat Bridge	J_{10}	6.70	169.4	1.12	273.2	35.12	BDL	65.97	8.19	1.23	0.67
	J_{11}	6.90	72.0	0.62	116.2	19.86	BDL	29.33	7.41	0.68	BDL
	J_{12}	7.00	9.3	0.06	15.0	BDL	BDL	2.31	1.90	BDL	BDL
New Market	J_{13}	7.06	44.3	0.53	71.4	14.41	BDL	13.97	3.95	0.65	BDL
	J_{14}	6.74	65.2	0.49	105.2	18.49	BDL	23.51	5.86	0.73	BDL
	J_{15}	6.88	39.0	0.28	62.7	12.81	BDL	14.17	3.47	0.59	BDL
GEC	J_{16}	7.01	279.0	1.56	450.0	65.93	BDL	112.27	12.36	1.97	0.95
	J_{17}	6.95	16.0	0.11	25.3	2.09	BDL	6.18	2.27	BDL	BDL
	J_{18}	6.97	173.4	1.23	279.7	41.96	BDL	67.26	7.51	1.56	BDL
Bayezid	J_{19}	6.69	324.2	2.01	523.0	95.87	BDL	133.68	9.79	2.37	1.21
	J_{20}	7.05	27.3	0.26	44.0	6.67	BDL	8.78	2.61	0.39	BDL
	J_{21}	7.03	178.1	1.34	287.2	47.34	BDL	64.23	6.74	1.62	0.57

##BDL means Below Method Detection Limit

All physico-chemical parameters were found within the permissible range. The Total Dissolved Solid (TDS) values were found within acceptable range (500 mg/L for drinking water)(BDS 2001)) for all the tested sample. The minimum values of electrical conductivity(EC) and TDS were found 15 µS/cm and 9.3 mg/L for sample J_{18} and the maximum values were found 523.0 µS/cm 324.2 mg/L for sample J_{19}. The values of pH were varies from 6.78 to 7.08 and turbidity varies from 0.21 NTU to 2.01 NTU these two values indicate that all samples were apparently pure. All the samples tested were free from TSS and Chlorine (Table 1). Chlorine has

been used in positive sense in the distribution system because it kill all microorganisms present in the jar water. Although chlorine is effective in destroying pathogen and preventing the spread of communicable diseases, it might be an indirect non-infectious health problem caused by the chlorination process [6].In this study samples chlorine was not detected means they did not use chlorine in any step of their purification process. only four sample contained nitrate (Table 1)which were also within acceptable limit. Sulphate contents ranged from BDL to 2.37 mg/L which were also within permissible limit[7,8]. The level of total hardness have recorded from 7.79 mg/L to 133.68 mg/L and from total hardness values it is clear that all the samples except $J_{1,}$ $J_{2,}$ $J_{17,}$ J_{20}(Table 1) were good source of calcium and magnesium.

Six Heavy metals content of jar water samples were measured by an Atomic Absorption Spectrophotometer, analysis revealed that arsenic and mercury were not detected by AAS that indicate jar water were free from arsenic and mercury contamination. Lead and chromium were found only one and two samples (table-2) respectively but lead content (J_7-0.07 mg/L) exceeded acceptable limit[6,7]. Whereas, cadmium found in J_7 and J_{17} sample(table-3) which were within the permissible limit for drinking water[7,8]. Moreover, Iron were determined in all the jar water samples and ranged from 0.01 mg/L to 0.20 mg/L which were under the standard limit and the acceptable limit of iron is 0.3 mg/L for drinking water according to WHO[7]. All the samples contain chromium among them about 38 % samples were crossed the Bangladesh standard. The maximum and minimum concentration of chromium were found 0.13 mg/L in J_7 sample and 0.01 mg/L in J_{13} sample respectively. Permissible limit of chromium concentration is 0.05 mg/L for drinking water. Chromium is a toxic metal as a result it has numerous side effects like as Kidney disease, Liver disease, Diabetes, Allergy ,Behavioral or Psychiatric conditions such as depression ,anxiety or schizophrenia. The high concentrations of Cr was found in these water samples may be explained by several factors such as inadequate disposal practices of chromium contained waste water, poor storage and leakage and more[9,10].

Table -2: Heavy metal concentrations(mg/L) in Jar water Collected from seven different spot of Chittagong Metropolitan City, Bangladesh.

Sample Location & code		Pb(mg/L)	Fe(mg/L)	As(mg/L)	Hg(mg/L)	Cd(mg/L)	Cr(mg/L)
Oxygen	J_1	BDL	0.01	BDL	BDL	BDL	0.02
	J_2	BDL	0.05	BDL	BDL	BDL	0.04
	J_3	BDL	0.06	BDL	BDL	BDL	0.10
Muradpur	J_4	BDL	0.03	BDL	BDL	BDL	0.04
	J_5	BDL	0.02	BDL	BDL	BDL	0.06
	J_6	BDL	0.01	BDL	BDL	BDL	0.03
Baddarhat	J_7	0.07	0.20	BDL	BDL	0.005	0.13
	J_8	BDL	0.01	BDL	BDL	BDL	0.06
	J_9	BDL	0.01	BDL	BDL	BDL	0.04
GEC	J_{10}	BDL	0.05	BDL	BDL	BDL	0.04
	J_{11}	BDL	0.03	BDL	BDL	BDL	0.06
	J_{12}	BDL	0.02	BDL	BDL	BDL	0.02
New Market	J_{13}	BDL	0.03	BDL	BDL	BDL	0.01
	J_{14}	BDL	0.04	BDL	BDL	BDL	0.05
	J_{15}	BDL	0.02	BDL	BDL	BDL	0.05
Shah Amanat Bridgr	J_{16}	BDL	0.01	BDL	BDL	BDL	0.03
	J_{17}	BDL	0.01	BDL	BDL	0.002	0.12
	J_{18}	BDL	0.01	BDL	BDL	BDL	0.07
Bayezid	J_{19}	BDL	0.02	BDL	BDL	BDL	0.01
	J_{20}	BDL	0.07	BDL	BDL	BDL	0.08
	J_{21}	BDL	0.05	BDL	BDL	BDL	0.05
Bangladesh Standard		0.05	0.30	0.05	0.001	0.01	0.05

##BDL means Below Method Detection Limit

Out of twenty one samples sixteen samples were contaminated with total coliform(table-3). The acceptable limit of total coliform is 0/100 mL for drinking water. Moreover, all nine samples collected from Oxygen, Shah Amanat Bridge and GEC table-3) were carrying total coliform.Values of Thermotolerant coliform of water samples were determined by Most Probable Number(MPN) and the acceptable limit is 0/100 mL for drinking water[7].Out of all samples 33.33 percent samples were beyond the acceptable limit of Thermotolerant coliform(table 3) in the jar water tested from those seven spot. Each two samples of oxygen moor and Shah Amant Bridge moor contaminated with Thermotolerant coliform. The presence of coliform reveal that the water or jar were contaminated with fecal or adequate hygienic were not maintained during the filling or transportation. Acceptable limit of total viable count is 10^3/mL for drinking water[7]. The results of total viable

count were very alarming in thirteen samples which crossed the acceptable limit and in rest of the samples the values were near about acceptable limit. The pathogenic organism such as Salmonella spp. and Vibrio Cholerae were present in several samples but E. Coli was not detected all the samples(table-3).

Table -3: Result of Microbiological parameters in Jar water collected from Chittagong Metropolitan City

Sample Location & sample code		Total Coliform	Thermotolerant Coliform	E.Coli	Salmonella spp.	Vibrio Cholerae	Total plate count
Oxygen	J_1	32	21	---	+++	+++	$3.5X10^3$
	J_2	160	540	---	+++	---	$2.1X10^3$
	J_3	17	Nil(<2)	---	---	+++	$1.5X10^3$
Muradpur	J_4	Nil(<2)	Nil(<2)	---	---	---	$8.9X10^2$
	J_5	49	Nil(<2)	---	---	+++	$1.2X10^3$
	J_6	Nil(<2)	Nil(<2)	---	---	---	$8.7X10^2$
Baddarhat	J_7	Nil(<2)	Nil(<2)	---	---	---	$9.5X10^2$
	J_8	34	Nil(<2)	---	+++	---	$1.3X10^3$
	J_9	14	Nil(<2)	---	---	---	$1.6X10^3$
GEC	J_{10}	29	Nil(<2)	---	+++	+++	$1.7X10^3$
	J_{11}	18	Nil(<2)	---	+++	---	$1.4X10^3$
	J_{12}	44	Nil(<2)	---	---	+++	$2.4X10^3$
New Market	J_{13}	150	46	---	+++	+++	$2.7X10^3$
	J_{14}	Nil(<2)	Nil(<2)	---	---	---	$5.6X10^2$
	J_{15}	75	12	---	---	+++	$2.5X10^3$
Shah Amanat Bridgr	J_{16}	>1600	920	---	+++	+++	$6.5X10^3$
	J_{17}	920	320	---	+++	---	$5.5X10^3$
	J_{18}	12	Nil(<2)	---	---	---	$9.5X10^2$
Bayezid	J_{19}	Nil(<2)	Nil(<2)	---	---	---	$4.5X10^2$
	J_{20}	33	Nil(<2)	---	---	---	$2.2X10^2$
	J_{21}	67	9	---	+++	---	$2.5X10^2$

"+++" means present," ---" means absent

V. Conclusion

This article describes a survey carried out in the Chittagong Metropolitan City to assess the physico-chemical ,heavy metals concentration and microbial quality of available Jar water used by city dwellers for perspective. Present analysis of jar water reveals that the measured physico-chemical values such as TDS, TSS, Turbidity, Electrical conductivity, pH, Chloride, Hardness were wholly within the permissible range . In case of heavy metals level only chromium concentrations was higher than the BDS and WHO standard for drinking water[7]. This chromium level in jar water is a significant concern and an immediate step is required to prevent wider spread and long term exposure. It is necessary to clarify the origin of this element and removing the metal from jar water through different actions. Total Coliform was found in all seven locations and thermo tolerant coliform was found one third samples. The pathogenic organism such as Salmonella spp. and Vibrio Cholerae were present in few samples. To ensure improved microbial quality of the jar water and prevent contamination from faecal material it is essential to take proper steps. At present, many countries use disinfectant residuals to control the growth of microorganisms in distribution system and to act as a final barrier to help maintain the microbial safety of the water. Realistic residual concentrations at least inactivate the least resistant microorganisms like as E. Coli and the thermotolerant coliforms that are used as the main indicators of water safety [11] The authority should also conduct regular monitoring program to prevent possible contamination of water along its distribution network by cross connections, cross contamination by leaking pipes, improper domestic storage etc.Public consciousness can also play a vital role to prevent such problem . In addition, it helps to identify the major concerns considering the quality of jar water to reduce the observed contaminations and inspire to the local government and different organizations to plan for future interventions in this field.

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