STUDY ON THE COMMERCIALLY AVAILABLE BOTTLED WATER IN BANGLADESH: GENERAL SURVEY RESULTS, INORGANIC PHYSICO-CHEMICAL QUALITY AND RELATED ISSUES

Mala Khan
KM Mostafa Anwar
HQ Chowdhury

Edited by

Professor Dr. Syed Zahir Haider

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Dhaka, Bangladesh

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Proceedings of the Seminar on Study on the Commercially Available Bottled Water in Bangladesh: General Survey Results, Inorganic Physico-chemical Quality and Related Issues, organized by Bangladesh Academy of Sciences and cosponsored by University of Science & Technology Chittagong USTC at the auditorium of Atomic Energy Centre Dhaka, Kazi Nazrul Islam Avenue, Dhaka, Bangladesh, 2 February 2003 at 03:00 pm.

Study Report by

Mala Khan
KM Mostafa Anwar
HQ Chowdhury

Edited by

Late Professor Dr. Syed Zahir Haider

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ABOUT THE AUTHORS & EDITOR

Mala Khan

Born on 12 July 1977 Mala Khan is the first woman in Bangladesh working in the field of Laboratory Information Management System (LIMS), Laboratory Instrumentation and their applications. Mala Khan earned her B.Sc. Engg. (Hons.) in Computer Science & Engineering degree from the University of Asia Pacific and she is the recipient of the Chancellors Gold Medal from the Honorable President of the Peoples Republic of Bangladesh & Chancellor of the University as she scored the highest CGPA 3.90 out of 4.00 among all the students from all the department of the University of Asia Pacific in Spring 2000. As Application Engineer Instrumentation & Information Technology (I&IT) and Assistant Laboratory Manager Mala Khan served Plasma Plus Application & Research Laboratory & AQ Chowdhury & Co. (Pvt.) Ltd. from January 1998 to December 2003. From 2003 to 2006 she worked as a Scientific Consultant for WAGTECH International UK. In 2006 she received Prof. Dr. Nurul Absar Khan Post-Graduate Fellowship from BCSIR. Her present areas of interest are metrology in chemistry, analytical instrumentation, Laboratory Quality Management System as per ISO17025, LIMS and information technology (I&IT) with applications in water analytical environmental, industrial QAQC, science education and research. In 2006 she joined Bangladesh Council of Scientific & Industrial Research BCSIR within Ministry of Science, Information & Communication Technology. From 2008 being the initiator of a Government funded development project "Development of ISO/IEC 17025 Accredited Instrumentation & Calibration Service Laboratory for Chemical Measurements", Mala Khan Scientific Officer is serving BCSIR as the founding head of the Instrumentation & Calibration Service Laboratory ICSL as Project Director. Mrs. Khan is a certified EOQ Laboratory Manager & EOQ Laboratory Assessor for ISO/IEC 17025.

KM Mostafa Anwar

Born on 02 December 1967 KM Mostafa Anwar received his degree M. Sc. in Physics with First Class First from the University of Dhaka in 1989 and from then he served a number of public and private institutes including UN Agency e.g. The Monthly Computer Jagat, Dhaka University of Engineering & Technology (DUET), Bangladesh Council of Scientific & Industrial Research under the Ministry of Science, Information & Communication Ministry and Plasma Plus Application & Research Laboratory a private run national laboratory, Shimadzu Japan, WAGTECH International UK and UNIDO. As one of the Director lastly he held the position of Laboratory Manager of Plasma Plus+ and served as the Product Manager of AQ Chowdhury & Co. (Pvt.) Ltd. Being the team leader of an expert team in SMTQ, at present Anwar is serving UNIDO as National Project Coordinator (QMS Component) of Bangladesh Quality Support Programme BQSP working to strengthening Bangladesh national quality and conformity assessment infrastructure: Standards, Accreditation, Metrology, Testing, Quality. Anwar's present areas of interest are analytical instrumentation and sciences, laboratory quality management systems LQMS accreditation, chemical metrology with applications in pharmaceutical, water, analytical, environmental, industrial QAQC, science education and research. Anwar is also a musician, actor, poet & journalist traveled many countries and received extensive training and working experience in the area of science and performing arts. Anwar is a certified EOQ Laboratory Manager & EOQ Laboratory Assessor for ISO/IEC 17025

HQ Chowdhury

Being the founder of the South Asia's first private Application & Research Laboratory Plasma Plus+ in 1992 HQ Chowdhury played a significant role in the development of science and medicine in Bangladesh. Having expertise in analytical instrumentation and laboratory systems he has been working for more than thirty years in this area as CEO of AQ Chowdhury & Co. (Pvt.) Ltd. the country's leading company dealing scientific analytical medical imaging equipment from 1948. Graduated from the Department of Physics of the University of Dhaka in 1972 HQ Chowdhury traveled extensively throughout the world on the various occasions of scientific and business conferences, training and workshops. HQ Chowdhury born on 19 February 1953 is a Member American Association of Physicists in Medicine AAPM and also a Member American Water Works Association AWWA. He is a music connoisseur and writer.

Late Prof. Dr. Syed Zahir Haider

A renowned figure and scholar in science and education in Bangladesh Late Prof. Dr. Syed Zahir Haider was a Fellow Bangladesh Academy of Sciences and Fellow Islamic Academy of Sciences. He had contributed significantly through his pioneering scientific endeavours in the areas of water, molecular sciences, environment and higher education and was awarded the first medal of the Bangladesh Academy of Sciences (Senior Group) and the Third World Academy of Sciences Prize. Editors and authors of a large number of scientific monographs and papers Prof. Haidar was the Professor in Chemistry of the University of Dhaka and served many national and international scientific, regulatory and expert committee. He served BAS as the Member of BAS Council and also as the Editor of the Journal of Bangladesh Academy of Sciences. He died in September 2008.

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FOREWORD

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Date: 05 December 2008

On behalf of Bangladesh Academy of Sciences (BAS) I express my immense pleasure to forward this proceedings of the seminar held on 2 February 2003 for the first time in the country on the quality of the commercialized bottled water upon completion of an intensive scientific study by Mala Khan, KM Mostafa Anwar and HQ Chowdhury.

Being the national think tank BAS took the opportunity to promote and disseminate this scientific study to monitor the industrial QAQC practices, to understand the state of the national testing laboratories as well as to assume the status of the overall consumers protection mechanism instilled by the Government and regulatory bodies.

Mala Khan and her team have done a commendable work indeed as their study rightly came up with some recommendations to emphasize the essential need for improving the national quality infrastructure, reliable testing and measurement systems, and to establish an effective market surveillance and regulatory mechanism.

The most important issues have been raised by this study are to have national policy to protect water bodies and environment, to stop excessive use of ground water, to enact and enforce consumers protection legislation, to strengthen BSTI to be a functional national standards body, to establish an independent and central food regulatory authority and also to introduce the higher education in analytical and instrumentation sciences in the universities. To ensure sustainable growth in industrialization, the setting up of reliable standards, testing, calibration, quality and accreditation system have been recommended, widely discussed and accepted by the authors, discussants, participants, stakeholders during the seminar as well as during the follow-up meetings with industries.

At this particular juncture we would like to remember the great contribution from Fellow of BAS Late Prof. Dr. Syed Zahir Haider who worked hard in his last days as the Editor of this report. We do also remember another Fellow Late Prof. Dr. Kamaluddin Ahmed who was one of the discussants during the seminar on 2 February 2003.

I wish the authors success in communicating their findings to the people in the industries, in the consumers affairs, in the academia and in the concerned government departments. I hope a similar study would be conducted as a follow-up to make the recommendations operational and effective.

M Shamsher Ali

(Prof. Dr. M. Shamsher Ali)
President, Bangladesh Academy of Sciences &
Vice Chancellor, Southeast University

ACKNOWLEDGEMENT

At this very moment the authors are remembering the distinguished Fellow of Bangladesh Academy of Sciences Late Prof. Dr. S.Z. Haider who spent his invaluable time to edit and review the paper thoroughly with the utmost care even ignoring his physical conditions during his last days. The authors are grateful to the authority of Plasma Plus+ Application & Research Laboratory for conducting the research, providing financial support and laboratory infrastructure in planning and executing the study. Conducting research, running analysis with appropriate QAQC and collecting high-end analytical equipment is nothing but a big monetary pressure and management burden; and without their continuous support the work would not reach its present end. Authors hereby thanking all officers and staffs in AQ Chowdhury & Co. for their assistance in getting reagents and instrumentation, completion of the project as well. The authors are indebted to the main discussants of the article and at the seminar Prof. AH Khan and Dr. M. Khaliquzzaman and Late Prof. Dr. Kamaluddin Ahmed who spent their invaluable time to read thoroughly the script to make various comments as such to elaborate the subject. The authors are indebted to Prof. Dr. M. Shamsher Ali, President, Bangladesh Academy of Sciences who extended his continuous inspiration to the authors in advancing the work, imparting guidance and untiring effort to arrange this seminar and publishing this preceedings. From his extremly busy schedule he made time to go through the script and write down the foreword We do also acknowledge hereby Ex. President Prof. A.K.M. Siddiq and Ex. Secretary Dr. A.M. Chowdhury of Bangladesh Academy of Sciences and National Prof. Nurul Islam of University of Science & Technology Chittagong, in organizing and sponsoring the seminar and thus leaving a great opportunity for us to present the study for the first time publicly on 02 February 2002. Authors are thankful to Prof. Dr. Naiyyum Choudhury, Former Chairman, Bangladesh Atomic Energy Commission and Secretary of Bangladesh Academy of Sciences for his invaluable support as a host of the seminar at BAEC premises as well as publishing this report. The authors are also expressing their great debt to the bottled water producing industries as they have took part to serious discussions and ultimately taken the notes from the authors to implement the QAQC practices upon several follow-up meeting with the authors and Bangladesh Academy of Sciences. The authors are also thanking all participants, media people and audiences those who made the event a memorable one and helped disseminating to the mass people. The authors are indebted to Bappy, Biplob, Belayet, Mijan, Towkir & Aakash who worked hard in the printing press through type setting, designing, printing within a very limited time. Finally, the autors will remain indebted to their family members as without their constant support the study could not be conducted or presented at its present from at all.

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DISCLAIMER

The opinion expressed in this study is solely of the authors and discussants personal not necessarily of BAS and also made self-explanatory as much as possible. No deliberate and or intentional effort is made to denigrate any party: bottling company, government regulatory body, scientific society, supplier, service company, consumer or any person. The research methodology followed in the study is purely scientific in nature and the main objective of the authors was to help developing the way of interaction among people in industries, academia, government, scientific professionals, business communities and media in Bangladesh. Authors endeavor in this regard is not to point finger towards anybody concern rather to increase our knowledgebase on prevailing industrial and scientific practices so that the manufactures in Bangladesh may gradually achieve the competitive edges to capture the potential foreign and local market share with safe and improved products or services in this era of fierce competition. Sampling and experimentation have been done following valid, reliable international standards and or norms and detailed list of references are supplied for further reading. Within the constraints of resources, time and space the authors and other discussants have tried their best to exemplify the issues, but that should not be considered to be the last statement rather this should be assumed to be the starting point. There are many open questions still waiting to be illuminated through shading lights from various angles. Hence the responsibility of interpreting and using the data from this report for next action or further application is left fully to the reader of this report. No responsibility lies to the authors for any consequences or outcome arouse due to further application/interpretation made by any party or reader of this study.

DEDICATED

to

Late Professor Dr. Syed Zahir Haider
Fellow Bangladesh Academy of Sciences
Professor of Chemistry
University of Dhaka, Bangladesh

Late Professor Dr. Kamaluddin Ahmed
Fellow Bangladesh Academy of Sciences
Professor of Biochemistry
University of Dhaka, Bangladesh

&
to our respected and the dearest
parents

ABBREVIATIONS AND ACRONYMS

ANOVA Analysis of Variance
AO Aesthetic Objective
APEC Asia Pacific Economic Cooperation
APHA American Public Health Association
AQ Aesthetic Quality
ASTM American Society for Testing and Materials
AWWA American Water Works Association
BAS Bangladesh Academy of Sciences
BDS Bangladesh Standard
BSTI Bangladesh Standards & Testing Institution
°C Degrees Celsius
CAB Consumers' Association of Bangladesh
CC Consumer Council
CFR Code of Federal Register
cGMP Current Good Manufacturing Practice
CI Confidence Interval
COD Chemical Oxygen Demand
DWEL Drinking Water Equivalent Level
DWQ Drinking Water Quality Guideline
EC Electrical Conductivity
EEC European Economic Communities
EPA U.S. Environmental Protection Agency
EU European Union
FAAS Flame Atomic Absorption Spectroscopy
FAO UN Food and Agriculture Organization
FDA US Food and Drug Administration
GATT General Agreement on Tariffs and Trade
GFAAS Graphite Furnace Atomic Absorption Spectroscopy
GL Guide Level
GOB Government of Peoples Republic of Bangladesh
GV Guideline Value
HVG Hydride Vapor Generator
IBWA International Bottled Water Association
IDL Instrument Detection Limit
ISO International Standard Organization
L Liters

LGED Local Government & Engineering Department
LOAEL Lowest-observed-adverse-effect level
LOD Limit of detection
µg/L microgram(s) per liter (ppb)
µS/cm micro-Siemens per centimeter
MAC Maximum Admissible Concentration
MCL Maximum Contaminant Level
MCLG Maximum Contaminant Level Goal
MDL Method Detection Limit
mg/L milligram(s) per liter (ppm)
mL Milliliter(s)
MRC Minimum Required Concentration
MVU Mercury Vaporizer Unit
NAS US National Academy of Sciences
NGV No Guideline Value
NIST National Institute of Standards and Technology
NOAEL No-observed-adverse-effect level
NRB Non-resident Bangladeshi
OECD Organization for Economic Cooperation and Development
ppb Parts per billion (µg/L)
ppm Parts per million (mg/L)
PQL Practical Quantitation Limit
QA Quality assurance
QC Quality control
RfD Reference Dose
ROI Return Of Investment
SM Standard Methods for the Examination of Water and Wastewater
SPS WTO Agreement on Sanitary and Phytosanitary Measures
TBT Technical Barriers to Trade
TDS Total dissolved solids
TQM Total Quality Management
UV-VIS Ultraviolet - visible
WEF Water Environment Federation
WHO World Health Organization
WTO World Trade Organization

Study on the Commercially Available Bottled Water in Bangladesh: General Survey Results, Inorganic Physico-chemical Quality and Related Issues

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ABSTRACT

In Bangladesh the consumption of commercially available bottled water has increased dramatically in recent years. Millions of liters of bottled water are being consumed daily by the people without knowing much of the quality of the goods, relying on some declarations made by the manufacturers on their product labels. It appears that Bangladesh Standards & Testing Institution BSTI (Ministry of Industry) without having any updated modern QAQC based or accredited laboratory system is giving certification to the product before being marketed by the manufacturer. Furthermore, it is not publicly known yet whether BSTI and or any other government/regulatory body is continuously monitoring and controlling the quality of these drinking water products with systematic and appropriate methods, means and frequency of surveillance protocols. No reliable, valid and comprehensive study have been done or known publicly to date in this regard having vital health and public importance. Hence as a case study in this work a general survey result has been discussed on the pertinent practices followed by the manufacturers in declaring specifications and other information on the labels. The quality of the declared data/specifications has been investigated and expressed in terms of statistical Z-scores and found mostly to be inconsistent and unreliable. A total number of 58 manufacturers have been recorded to date who are commercializing bottled water in varied single-serving sizes and also in 20L refill multi-serving size. A total of twenty-two (22) inorganic physico-chemical parameters like temperature, pH, electrical conductivity, total dissolved solids, bicarbonate alkalinity, hardness,

chloride, fluoride, nitrite, nitrate, sulfate, phosphate, COD, free cyanogen and ammonium, sodium, potassium, calcium, magnesium, dissolved iron, dissolved manganese and total inorganic arsenic have been determined for eleven (11) brands representing ~ 29.7% of the total of known thirty-seven 37 available brands marketing products in single - service containers.

KEYWORDS

Arsenic contamination, Commercialized bottled water, Drinking water quality, industrial QAQC, international consumer rights, Laboratory accreditation, Laboratory QAQC, Surveillance protocol, TBT, Water quality monitoring

PRELUDE

The fisheries, specially the shrimp industries of Bangladesh are facing the biggest crisis in exporting their products to the EU and US markets due to problems with the quality of the exported goods (Sangbad, 2002 and Ittefaq, 2002). Frozen food product is number three in foreign exchange earning, as such, this information is alarming and a serious threat to our economy.

The problem did not appear suddenly. In 1997 EU stopped importing shrimp because the quality was not controlled and later on EU introduced Bangladesh in "rapid alert system" since pathogenic bacteria were found in the exported shrimp from Bangladesh. Very recently EU and USA warned again that if Bangladesh did not ensure the quality of the products they would stop importing from Bangladesh. All these events resulted in continuous decrease in the export of shrimp. Export earning of FY1997-98 from shrimp decreased by US$18.81 million from that of FY1996-97 and similarly earning of FY1998-99 decreased further by US$18.19 million from that of previous FY1997-1998 (Ahmed, 2002). Thus in two years Bangladesh lost US$37 million in export earning. An alarming situation surfaced in this area of business.

Similarly, in the leather sector, earning in FY2001-2002 (US$207) decreased by US$47 million compared to FY2000-2001 (US$254) (Ahmed, M., 2002). For the last few years Bangladesh could not increase its global market share even from a poor 3%. The ready made garment industry is also facing a crisis with regard to its export. Information Technology has been struggling for the last ten years to get its way into the global market, showing no significant achievement in fetching foreign

currency. "Arsenic crisis" (Smith et al., 2000, Lews et al., 1999, Tibbetts, 2000 and Dooley (Editor), 2000), which actually is the "Safe Drinking Water Crisis" affecting health of millions of people is probably the severest of all.

These are just some of the instances which apparently seem to be irrelevant but they are discrete instances of crises affecting the welfare of millions of people and threatening the country's export economy on the eve of a new economic globalization system under WTO in 2005.

From our view point, the above five cases bear something in common. The crux of the problem is the lack of *proper knowledge and ignorance to technology as well as management to introduce applicable Industrial Quality Assurance and Quality Control (QAQC) under the framework of Total Quality Management (TQM) System. The country does not have yet a developed quality and conformity assessment infrastructure comprising functional standards, metrology, testing,quality and accreditation systems embodying both legal and technical arrangements. Regulatory and technical environment yet to be developed to facilitate sustainable trade and industrial growth.* The country is virtually unaware of these practices.

This paper is a thorough scientific investigation on commercialized bottled water popularly called "mineral water" in Bangladesh which has been presented in the light of the above approach. As a case study, the present work is the first endeavor of its kind in the country to accumulate basic information on the quality of bottled water products.

Firstly, a general survey result has been discussed on the pertinent practices followed by the manufacturers in declaring specifications and other information on the labels. Secondly, the quality and or validity of the declared data/specifications have been investigated and found mostly to be inconsistent and unreliable. Quality of the products has also been investigated with reference to 22 inorganic physico-chemical parameters like temperature, pH, electrical conductivity, total dissolved solids, bicarbonate alkalinity, hardness, chloride, fluoride, nitrite, nitrate, sulfate, phosphate, COD, free cyanogen and ammonium, sodium, potassium, calcium, magnesium, dissolved iron, dissolved manganese and total inorganic arsenic. The study has been conducted with strict adherence to the laboratory QAQC protocols throughout the analytical process so as to produce valid, reliable and comparable data. Various statistical and chemometrical techniques like correlation checks, regression statistics (ANOVA) and others have been employed to establish the reliability of studied parameters and maximize the information on the quality of the

products. Finally, we have drawn conclusion and outlined some recommendations, which may help to get rid of the problems the country is facing with.

INTRODUCTION

Before going to the report in details it is worthwhile to note the status of the global drinking water supply. During the last century in particular, steps have been taken to develop the technology and social policy to address questions of access to potable water, adequate sanitation and means of improving water quality. Mainly in the developed countries, tremendous improvements have been made in terms of technology to treat effectively ground, surface, ocean water and wastewater for domestic, agricultural and industrial purposes. Although the number of people served by improved water supplies rose from 4.1 billion (79%) in 1990 to 4.9 billion (82%) in 2000, 1.1 billion people still live without clean, safe water (Murphy, 2001) and three billion lack adequate sanitation (Figuères, 2002). It is now a well-known fact that at the dawning of a new millennium, at least one-sixth of all people worldwide thus lacks access to safe drinking water. According to a 1999 United Nations comprehensive assessment of world water resources more than one-half of all people lack access to adequate sanitation. These problems will almost certainly get much worse as the earth's population grows from today's 6 billion to an expected 7.3 -8.3 billion people by 2025, according to the UN Population Division (Tibbetts, 2000). On the other hand, based on a 16-city review, it has been reported by the World Commission on Water for the 21st Century at its August 1999 meeting in Stockholm, Sweden that poor people in developing countries pay an average of 12 times more per liter of water than citizens connected to municipal water systems. Despite the price, these people get water of inconsistent quality- often bacteria infested-that they can seldom afford to sanitize. In Bangladesh, boiling

Bottled Water Brands Studied

water costs the poorest families a staggering 11% of their income. In Lima, Peru, where citizens are warned to boil their drinking water for 10 minutes due to outbreak of cholera, the cost has prevented many from doing so. A poor family typically pays street vendors US$3 per cubic meter (1000 liter) of water, more than 20 times what a middle-class family pays for water through a piped-in house connection. The cost of providing universal water access by 2010 is estimated to be US$25billion annually. The poorest developing countries are unlikely to be able to finance such development (Tibbetts, 2000 and Dooley (Editor), 2000). Oppositely, it has also been reported that some of the world's most serious water shortages are caused by government policies that encourage waste (Tibbetts, 2000).

Bottled Water Brands Studied

Like some other parts of the world Bangladesh is also facing the reality that arsenic poisoning in groundwater now threatens millions (Smith et al., 2000, Lewis et al. 1999 and Tibbetts, 2000) of people using groundwater as their primary source of drinking water. This severe crisis also simultaneously surfaced a number of questions on the overall policy, guidelines, regulations and other pertinent practices followed by the government, industries, national and international bodies to monitor and control the quality of the drinking water in the country.

In a separate study (Pedersen et al.; 2003, Murshid et al.; 2002) it has already been evident that the history of drinking water quality management in Bangladesh is nothing but a systematic lack of monitoring and controlling quality of water thus having far reaching consequences on Bangladesh leading to a calamity like arsenic poisoning. In the midst of this crisis rapid and dramatic growth of the market of the bottled water popularly called "mineral water" has been seen in the last few years.

It is not known exactly when the bottled water, popularly called "mineral water", started to come in the Bangladeshi market and hence it is assumed that some time in the late seventies or in the early eighties products of various brands have appeared in the market. But only recently the consumption of commercially available bottled water has increased dramatically.

The increase in the knowledge of waterborne diseases, fear of the presence of microorganisms and other contaminants in the water from the public piped systems, the knowledge of severe arsenic crisis extended throughout the country ultimately played the important role in expanding the market of these products. Bottled water served in varied sizes e.g. 500 mL, 600mL, 1000mL, 1.2 L, 2.0 L, 2.5L and 20L (in refill jar as multi-service container) is now available in almost all big cities and also in some district towns all over the country.

Diplomats and other foreign nationals staying in Bangladesh, non-resident Bangladeshis (NRBs) during their visits to Bangladesh and the well to do people are frequently using these products as occasional and regular sources of drinking water. Supplying "mineral water" is no more a fashion rather a common practice now a days in hotels and restaurants, in national and international seminars, workshops, conferences, in public and family gatherings and parties. Some domestic airlines and bus transport companies deliver bottled water to their passengers. Surprisingly, millions of liters of bottled water thus consumed daily by the

Bottled Water Brands Studied

people in Bangladesh without knowing almost nothing of the quality of the goods but only relying on some declarations/specifications provided by the manufacturers on their product labels which mostly are unreliable/ inconsistent to be investigated in this study.

It has primarily been appeared that Bangladesh Standards & Testing Institution BSTI (Ministry Industry) without having any updated modern QA/QC based or accredited laboratory and product certification marking system of their own is giving certification to the products prior to be marketed by the manufacturer. Under mandatory technical regulatory notifications, although Government of Bangladesh (GOB) defined standard for drinking water vide Bangladesh Gazzet Additional August 28, 1997, Tofcil-3, Rule-12: Allowable Limit of Drinking Water and Allowable Limit of Groundwater (GOB, 1997) and BSTI has defined standard (which in fact are two technical regulations) for drinking water to be BDS 1240:1989 (BSTI, 1990) and standard for natural mineral water to be BDS 1414:2000 (BSTI, 2000), but it is not publicly known yet whether BSTI and or any other government/regulatory body is continuously monitoring and controlling the quality of these drinking water products with systematic and appropriate methods, means and frequency of surveillance protocols to compare the quality criteria stated in BDS1240 and or BDS1414 two standards from BSTI for 'drinking water' and for 'bottled mineral water' respectively. No reliable, valid and comprehensive study appear to have been done or known publicly to date in this regard having vital health and public importance. No government act or consumer council or regulatory market surveillance is in operational to protect the consumer rights is present until to date in Bangladesh. It has been evident that the Pure Food Ordinance 1959 is, by and large, in adequate and ineffective to control food as the responsibility lying to a number of ministries i.e. it becomes many bodies business to be nobodies business. It is also publicly not known whether DOE, the Directorate of Environment (Ministry of Environment) or any other agency/ regulatory body is involved to monitor periodically and properly the practices followed by manufacturers detrimental to environment or not.

Furthermore in 2001 WHO and IAEA conducted an inter-laboratory comparison study for the first time in Bangladesh for analysis of arsenic in potable water to check the performance of 17 laboratories both from public and private sector (Aggarwal et al., 2001 and Khaliquzzaman, 2001). Unfortunately it has been evident that there is no laboratory in Bangladesh having intensive internal and or external QC system under the framework of documented quality management system in operation to

Bottled Water Brands Studied

produce consistent, reliable and valid data. In Bangladesh no accredited and or certified laboratory system as per, say, ISO17025 has yet beenestablished to serve the industrial, environmental or analytical purpose.

In view of the above considerations this study claims to be the first, not necessarily to be the last, one of its kind in the country. This study will be assumed to be a case study to accumulate, firstly, a general information on the quality and pertinence practices followed by the manufacturers in declaring specifications and other information on the labels and secondly physico-chemical quality of the commercially available bottled water in Bangladesh. Accordingly a basic idea on the prevailing situation of the quality culture observed in marketing these bottled water products will be obtained hereby. The overall quality of the data declared on the products may give an indicative status of the reliability of the testing laboratories and their results producing systems in the country. General status of the testing laboratories operating both in public and private sectors can be assumed to some extent from this study.

In the first part of this study a general survey result has been discussed on the practices followed by the manufacturers in declaring specifications and other information on the labels in the light of seven international consumer rights: right to safety, the right to be informed, the right to choose, the right to be heard, the right to redress, the right to consumer education and right to a healthy environment (Misra, 1989). In this portion the quality of the declared data /specifications has been investigated and expressed in terms of statistical Z-scores and found mostly to be

inconsistent and thus unreliable. It may be mentioned that Z-score calculation based on probability statistics is an effective scientific technique to check the reliability and validity of data produced from laboratory analytical systems.

And in the second part a basic aesthetic and inorganic chemical quality has been discussed. A total of twenty-two (22) inorganic physico-chemical parameters including three heavy metals constituents like iron, manganese and arsenic of forty-nine (49) samples consisting of field and laboratory replicates have been determined for eleven (11) brands representing ~ 29.7% of the total 37 bottling brands known to be available in single-service containers in Bangladesh. The authors will report the quality of the products in terms of microbiological and organic parameters through separate communication.

The study was conducted with strict adherence to the laboratory QAQC protocols depicted in AWWA (AWWA/APHA/WEF, 1998) and USEPA (USEPA, 1997, USEPA,1996) standards throughout the whole analytical process to produce valid, reliable and comparable data. Various statistical

KM Mostafa Anwar delivering the keynote speech. Sitting from left Prof. Dr. AM Chowdhury, Prof. Dr. Kamaluddin Ahmed, National Prof. Dr. Nurul Islam (Chief Guest), Prof. Dr. M. Shamsher Ali (Chair), Prof. Dr. A.H. Khan (Main Discussant) Dr. M. Khaliquzzaman (Main Discussant)

and chemometrical techniques like correlation checks, regression statistics (ANOVA) and others have been employed to maximize the information on the quality of the products.

EXPERIMENTAL

Sampling and pretreatment

To analyze twenty-two (22) inorganic physico-chemical parameters of each brand and thus to furnish an almost complete inorganic matrix pattern of the sample, on a single day (June 12, 2001) a total of 38 field samples collected comprising 26 samples, 7 field duplicates and 5 field triplicates of 11 brands available on that day from different stores located at the three different areas Dhanmondi, Mohakhali and Gulshan of Dhaka City (Table-1). Brands are coded as B01 (Ampang), B02 (Aqua Mineral), B03 (Duncan's), B04 (Everest), B05 (Fresh), B06 (Mountain), B07 (Mum), B08 (Pran), B09 (Samurai), B10 (Yes) and B11 (Trishna). Other available brands are coded and listed in the ANNEXURE - B.

Table-1 Field and laboratory sampling size

Brand	Sample (S)	Duplicates (D)	Triplicates (T)	Total
Brand 1	1	-	-	1
Brand 2	3	1	1	5
Brand 3	2	1	1	4
Brand 4	2	-	-	2
Brand 5	2	1	1	4
Brand 6	3	1	-	4
Brand 7	2	1	1	4
Brand 8	3	-	-	3
Brand 9	3	1	-	4
Brand 10	4	-	-	4
Brand 11	1	1	1	3
Total Field Samples	26	7	5	38
Total Laboratory Samples	38 (field samples)	8(lab duplicates)	3(lab triplicates)	49

All samples in polymer bottles were transparent and free from suspended particles so that no filtration was needed. As per standard methods (AWWA/APHA/WEF, 1998, USEPA, 1997 and USEPA, 1996) one portion of the sample is adjusted to pH<2 applying HNO_3 and stored at <4°C for the analysis of Na, K, Ca, Mg contents. One portion (~250 mL) is adjusted to pH<2 applying HCl and stored at <4°C for the analysis of dissolved iron (Fe), dissolved manganese (Mn) and total inorganic arsenic (As).

One portion (~200mL) is adjusted to pH<2 adding H_2SO_4 for COD and ammonium analysis. One portion of the sample (~200mL) is adjusted to pH>12 for free cyanogen (CN) analysis. And rest portion of the sample was kept untreated to analyze temperature (T), pH, electrical conductivity (EC), total dissolved solids (TDS), chloride (Cl), fluoride (F), nitrite (NO_2), nitrate (NO_3), sulfate (SO_4), phosphate (PO_4) and bicarbonate alkalinity (HCO_3). Storage condition were maintained at <4°C and analyses were done upon reaching the thermal equilibrium at room temperature (from 24.8°C ~ 27.1° C). All analyses were completed within the recommended timeframe stated in the standard methods. In addition to appropriate reagent blanks a total of 49 samples consisting of 38 field samples, 8 laboratory duplicates, 3 laboratory triplicates were analyzed as per applicable validation requirements (Table-1). Example of a hierarchy of the samples analyzed in the laboratory is structured in the Fig. 1 showing the samples and their field as well as laboratory replicates. As in Fig.1 samples S1 and S2 are two samples from two different batches of Brand 3.Sample S1is collected in triplicates (considered to be field triplicates produced in the same batch/lot) coded as B03G01 (with Lab ID 007), B03G02 (with Lab ID008) and B03G04 (with Lab ID 010). During analysis three separate aliquots were analyzed from sample B03G04 giving laboratory triplicates with Lab IDs 010, 010D and 010T.Sample S2 (B03G03) is analyzed directly with Lab ID 009. That means total of six laboratory samples (with IDs07, 08,10, 10D, 10T and 09) were analyzed in parallel to produce final data for Brand 03. Please refer to the ANNEXURE-A for detailed sampling structure of 49 laboratory samples analyzed from11 Brands. Statistical hypothesis testing and ANOVA analysis were done among replicate analyses and statistically significant (P<0.01) variations have been studied to check effects from batch differences, sampling, storing and laboratory analytical processes.

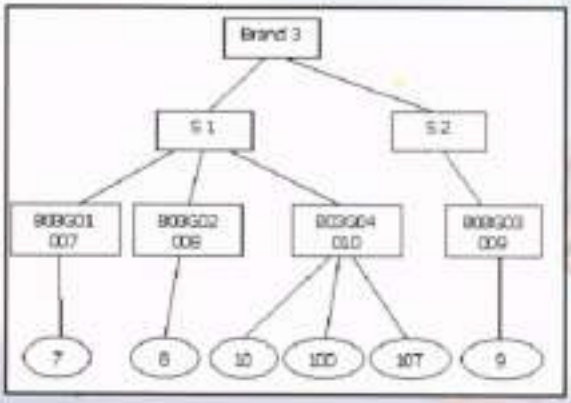


Fig. 1 Example of brand, field sample, laboratory sample and replicates structure

Reagents and apparatus

The glassware including burettes and pipettes were made of Class-I type glass (PyrexTM). The pH meters and the conductivity meters combined with temperature sensors were from Oakton, Singapore. Spectrophotometric analyses to determine non-metal constituents e.g. chloride (Cl^- at 360 nm), fluoride (F^- at 525.4 nm) , free cyanogen (CN at 612 nm), sulfate (SO_4^{-2} at 460 nm), phosphate (PO_4^{-3} at 709 nm) and ammonium nitrogen (NH_4^+ at 637nm) were conducted via UV-VIS spectrophotometer Model UVmini-1240 (Shimadzu, Japan) and Shimadzu Water Analysis Program Pack having built-in calibration curves using reagents and pillows from Kyoritsu Chemical-Check Lab., Corp., Japan. Metal constituents e.g. Na, K, Ca, Mg, Fe and Mn were determined using Flame Atomic Absorption Spectrometer Model FAAS-6601 (Shimadzu, Japan) with Hamamatsu Photonics K.K. Japan Hollow Cathode Lamps for individual elements to work at 589.0nm for Na, 766.5nm for K, 422.7nm for Ca, 285.2nm for Mg, 248.3nm for Fe, 279.5nm for Mn. Total inorganic arsenic (As) was determined by Flame Atomic Absorption Spectrophotometer (Shimadzu Model 6601) with Shimadzu Hydride Vapor Generator HVG-I unit following FAAS-HVG technique. The Hamamatsu Hollow Cathode Lamp for arsenic used at 193.7 nm. All reagents, buffers, and calibration standards and QC check samples were collected from Merck; Germany, Fisher Scientific; UK, Eutech Instruments; Singapore, Sigma; USA, BDH Chemicals Ltd.; UK Fluka; Germany, Lancaster; UK and Certiprex; USA. And finally CRM TMDA 53.2 was collected from Environment Canada, National Water Research Institute, Canada. Reagent grade water (ASTM Type-I) was used from Barnstead/ Thermolyne E-Pure system.

Sitting from left Prof. Dr. AM Chowdhury, Prof. Dr. Kamaluddin Ahmed (Main Discussant) National Prof. Dr. Nurul Islam (Special Guest), Prof. Dr. M. Shamsher Ali (Chair) Prof. Dr. A.H. Khan (Main Discussant) Dr. M. Khaliquzzaman (Main Discussant)

QAQC and statistics

Strict laboratory QAQC protocols have been followed as per AWWA and USEPA (AWWA/APHA/WEF, 1998, USEPA, 1997 and USEPA,1996) standards to produce and validate the data throughout the whole analytical process. In quality assessment anion-cation sums (expressed in meq/L) balance, consistency among calculated and measured TDS and electrical conductivity (EC) has been checked to meet the quality criteria (summarized in Table 5). Additionally cation sums and anion sums, EC and TDS from the analytical processes have been compared with the expected or calculated theoretical values from the individual constituents by regression statistics for N= 49 laboratory samples (Table 4, Fig.2, Fig.3 & Fig.4). Various statistical and chemometrical analyses like correlation checks, regression analysis among different parameters and brands have been conducted to maximize the information on the reliability of the data as well as quality of the samples themselves. To check the effect in uncertainty and statistical significant ($P<0.01$) variation due to batch differences, sampling, storing and other laboratory process statistical hypothesis testing (ANOVA) with the replicate studies have been done. For potable water matrices uncertainties, recoveries and precision limits were determined for individual parameters (Table 2 and 3) for the whole laboratory process via analyzing blanks, LFB, LFM, CRMs. As examples overall recovery scenario of metal constituents are shown in Fig.5 (for Na), Fig.6(for K), Fig.7 (for Ca), Fig.8 (for Mg), Fig.9 (for dissolved Fe), Fig 10 (for dissolved Mn) and Fig.11 (for total inorganic As) where most of the data for the QC check samples are lying within the 99%CIs considered as their prediction intervals (PI) and the linear regression lines have the slope ~0.98 with Pearson correlation coefficients R^2 ~0.99. For parameters studied by the UV-VIS spectrophotometer LODs are declared by Shimadzu for the built-in calibration curves for the specified experimental as well as the environmental conditions. For all other parameters, from the absorbance/ precision data for reagent blanks, laboratory fortified reagent blanks IDLs and MDLs are calculated and hence PQL values have been estimated and confirmed as well. It is worthwhile to note that the reliability of low level data (say data above MDL and below PQL) should be considered only as qualitative (not quantitative). Certified Reference Material TMDA 53.2 (prepared from Canadian Ontario Lake water) for metal constituents was collected from Environment Canada, National Water Research Institute, Canada. All analyses conducted and QAQC protocols followed as per standard methods AWWA, USEPA and JIS K0102.All spreadsheet, statistical and chemometrical analyses were conducted using Microsoft Excell TM and Mathcad 2000 Professional (Mathsoft Inc. USA) and MINITAB ver 11.12 (Minitab Inc. USA).

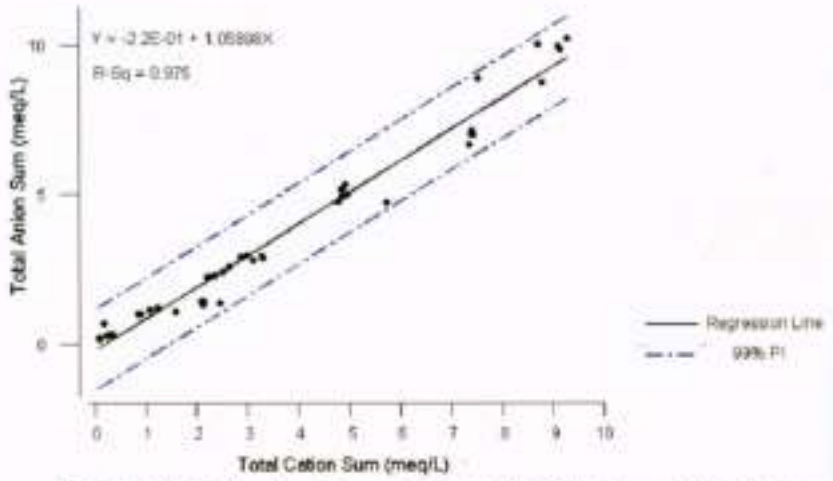


Fig.2 Fitted Line Plot by Linear Regression Analysis : Total Anion Sum vs Total Cation Sum

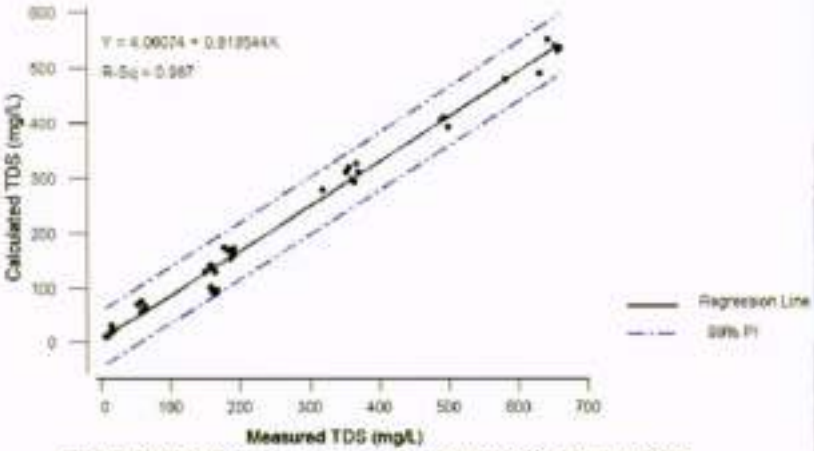


Fig.3 Fitted Line Plot by Linear Regression: Calculated TDS vs Measured TDS

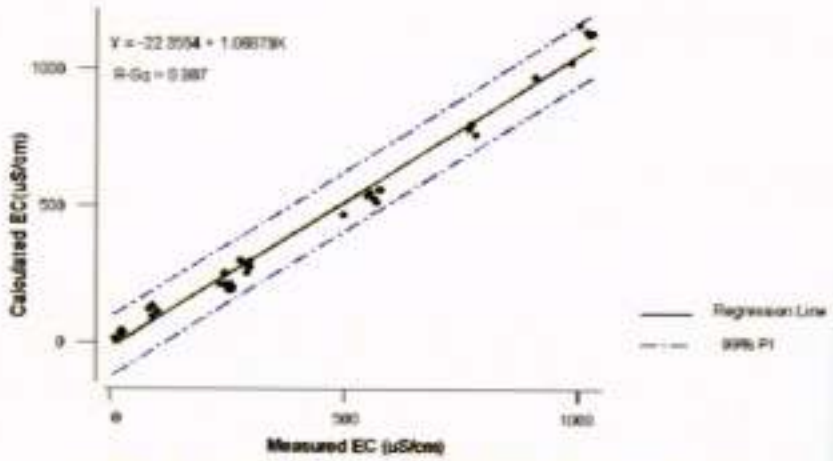


Fig.4 Fitted Line Plot by Linear Regression: Calculated EC vs Measured EC

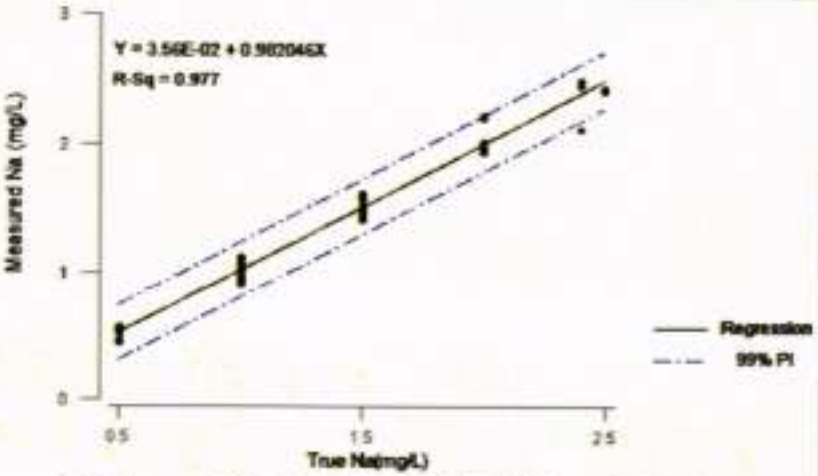


Fig.5 %Recovery of Na in LFB, LFM and CRM with 99%CI as prediction band

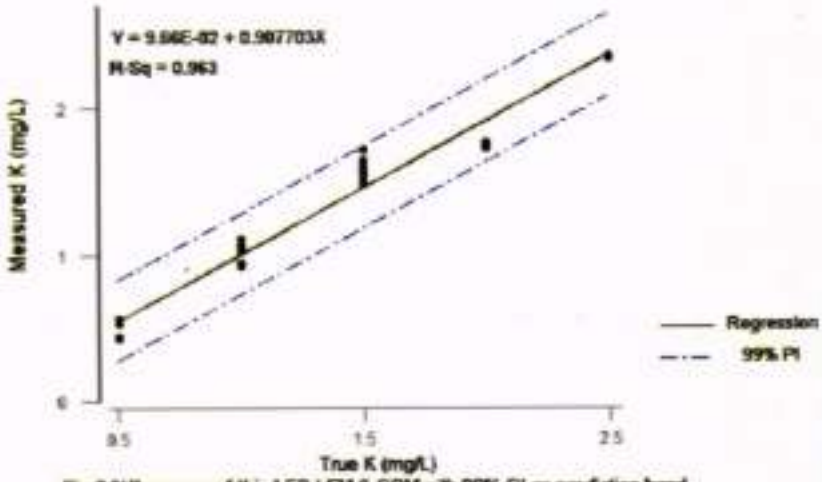


Fig.6 %Recovery of K in LFB,LFM & CRM with 99% CI as prediction band

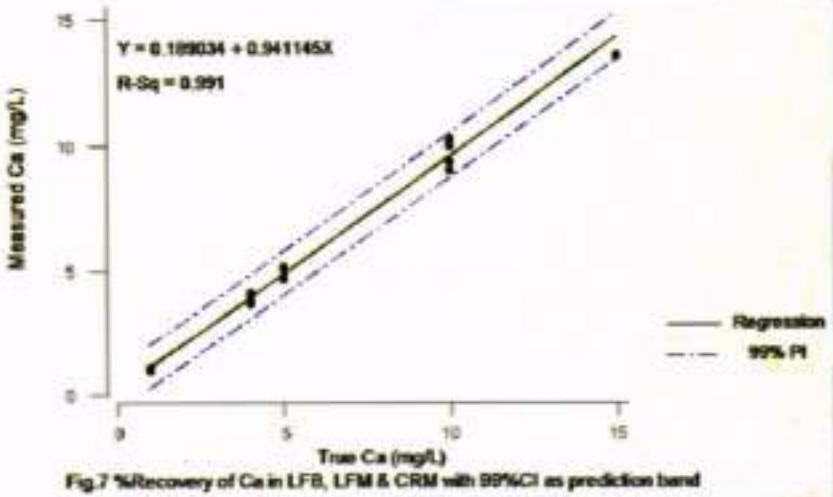


Fig.7 %Recovery of Ca in LFB, LFM & CRM with 99%CI as prediction band

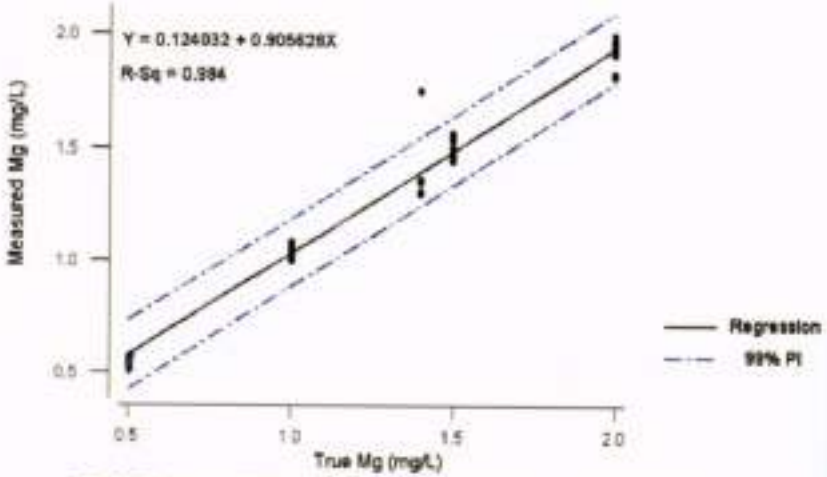


Fig.8 %Recovery of Mg in LFB, LFM & CRM with 99%CI as prediction band

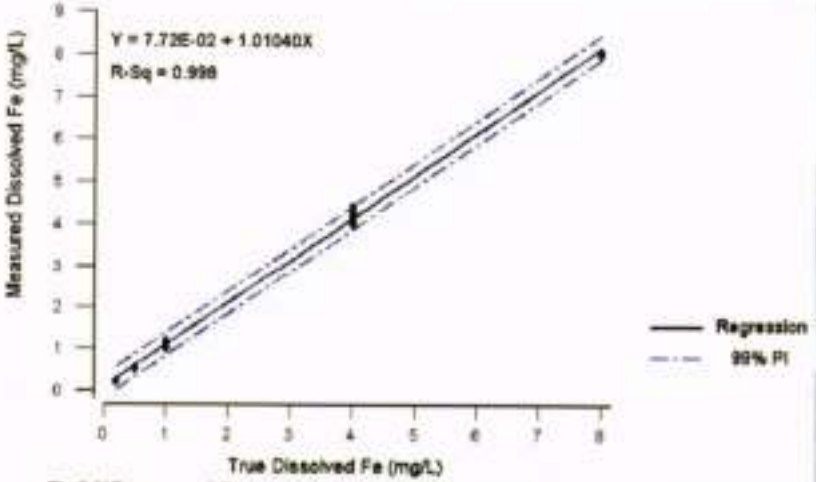


Fig.8 %Recovery of Dissolved Fe in LFB, LFM & CRM with 99%CI as prediction band

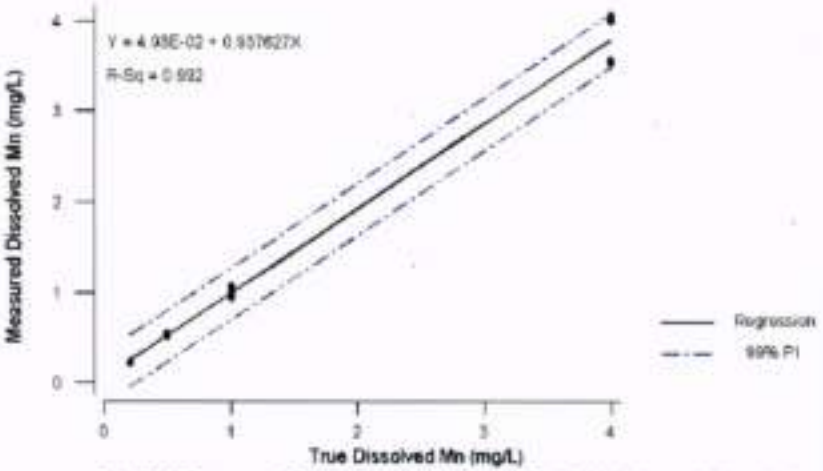


Fig.10 % Recovery of Dissolved Mn in LFB and LFM with 99%CI as prediction band

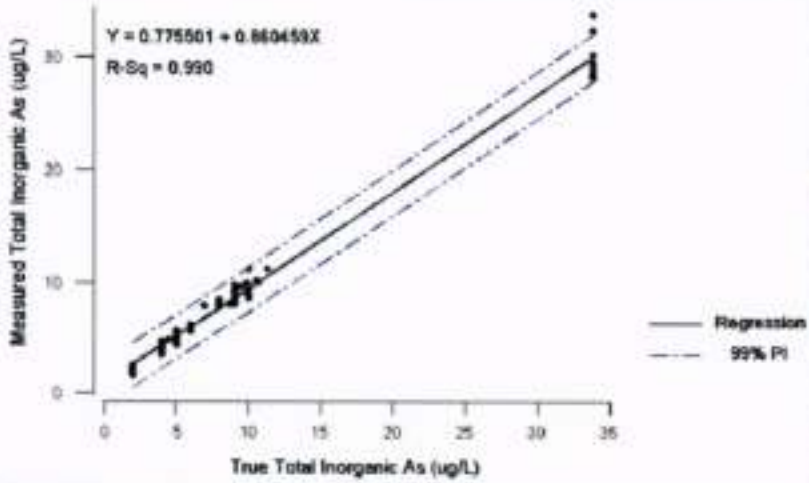


Fig.11 %Recovery of Total Inorganic As in LFB, LFM & CRM with 99%CI as prediction band

Table-2 PQL, Accuracy and Precision : Non-metal parameters

Parameter, unit and method	PQL	Accuracy 95% CI from recovery study	%RSD
TDS (mg/L) , TDS meter	0.1	85% - 115%	<10%
E. Conductivity (µS/cm), ISE	0.2	90% -110%	<8%
Ammonium (mg/L),SP	0.1	90% -110%	<8%
Nitrite (mg/L), SP	0.02	90% -110%	<8%
Nitrate (mg/L), SP	0.2	90% -110%	<8%
Sulfate (mg/L),SP	5	90% -110%	<8%
Chloride (mg/L)	0.6	90% -110%	<8%
Bicarbonate Alkalinity (as mg $CaCO_3$/L), Titrimetry	5	90% -110%	<8%
Fluoride (mg/L),SP	0.1	90% -110%	<8%
Hardness (as mg $CaCO_3$/L), Calc. from AAS data	1.5	85%-115%	<5%
Free Cyanogen (mg/L), SP	0.009	90% -110%	<8%
COD (as mg O_2 /L), CR Titrimetry	20	90% -110%	<5%
Phosphate (mg/L), SP	0.1	90 % - 110%	<8%
SP: UV-VIS Spectrophotometry, CR: Closed reflux			

Table-3 PQL, Accuracy and Precision : Metal parameters

Parameter, unit and method	PQL	Accuracy 96% CI %RSD	%RSD
Sodium (mg/L), FAAS	0.1	85% - 115%	<10%
Potassium (mg/L), FAAS	0.1	85% - 115%	<10%
Calcium (mg/L), FAAS	0.5	85% - 115%	<10%
Magnesium (mg/L), FAAS	0.05	85% - 115%	<10%
Dissolved Iron (mg/L)	0.2	85% - 115%	<10%
Dissolved Manganese (mg/L), FAAS	0.2	85% - 115%	<10%
Total Inorganic Arsenic (mg/L), FAAS-HVG	2.0	85% - 115%	<10%
FAAS: Flame Atomic Absorption Spectroscopy, HVG: Hydride Vapor Generation technique			

Table-4 Summary of multiple regression analysis (ANOVA results)
For all tests performed, the level of statistical significance was set at 1% (=0.01)

Observations N=49	Regression equation	Multiple R2 (Pearson)	Significance F
Anion sums vs Cation sums (in meq/L)	Y=1.05898*X -0.22	0.975	0.0000
Calculated EC vs Measured EC (in S/cm)	Y=1.06879*X -22.3554	0.987	0.0000
Calculated TDS vs Measured TDS (in mg/L)	Y = 0.813554*X + 4.06074	0.987	0.0000
Y = Predicted Anion sums (row 1), Predicted EC(row 2) and Predicted TDS (row3) X = Calculated Cation sums (row 1), Measured EC (row 2) and Measured TDS (row 3)			

Table 5 Summary of quality assessment for the experimental results of inorganic physico-chemical contents under study

Brand	EC (µS/cm)	Expected Order of magnitude	Anion sum (meq/L)	Cation sum (meq/L)	Anion/Cation Balance (%difference)	Anion/Cation Ratio	Measured TDSm (mg/L)	Calculated TDSc (mg/L)	TDS Ratio = (TDSm/TDSc)
B01	497.3	4.97	5.16	4.85	-3.30	106.83	318	280	1.14
B02	563.6	5.64	5.84	5.02	-0.16	100.33	361	310	1.16
B03	289.8	2.90	2.91	3.09	0.19	94.26	186	169	1.10
B04	245.2	2.45	2.36	2.34	-0.03	101.43	157	139	1.12
B05	980.3	9.80	9.58	9.05	-2.62	105.81	634	523	1.21
B06	90.4	0.90	1.12	1.14	0.02	98.32	58	68	0.88
B07	254.3	2.54	1.40	2.14	0.75	65.19	163	95	1.71
B08	260	2.60	2.57	2.42	0.05	96.05	168	136	1.20
B09	13.8	0.14	0.18	0.10	-0.08	177.81	8.8	5.4	0.91
B10	23.9	0.24	0.31	0.29	-0.02	105.98	15.3	16.2	0.84
B11	770.4	7.70	8.08	7.46	3.16	93.83	493	403	1.22

RESULTS AND DISCUSSION

General Survey Results.

To date [02 February 2003] some 58 manufacturers commercializing drinking water in the Bangladeshi market have been recorded of which 31 (~53.4%) producing only bottled water in the single-service poly containers of varied serving sizes e.g. 500mL; 600mL, 1000mL; 1.2L; 1.5 L; 2L; 2.5 L. Six (~10.3%) manufacturers commercializing water both in poly bottles of different sizes up to 2.5 L and in refill (multi-service) container of 20 L capacity and finally 21 (~36.2%) manufacturers supplying waters in 20L refill (multi-service) containers only. The last container type of capacity 20 liter popularly known as jar is being used for indefinite times via refilling and in the present physico-chemical study this type of supply has been excluded. As the distribution channel maintained in this case seemed to be unreliable and that no labels and or specifications are present on this container type. Therefore the study has been conducted only for the bottled water up to 2.5 L serving sizes and 11 brands representing ~ 29.7 % of the total 37 (= 30 +7) brands of bottled water in single-service containers known to be available in the country.

Out of recorded 37 brands full information of 32 brands have been achieved. Therefore the general survey results summarized in the Table 6 are based on these 32 brands. Firstly it is found that brand names along with the names of manufacturers/marketing companies are declared by all 32(100%) known manufacturers. Among them only 5(~15.6%) having manufacturers' full address on their labels verified to be existent and 1(~3.1%) declared the address on its label but verified to be non-existent and rest 26 (81.3%) neither published manufacturers' office address nor the factory address in full. These practices of not declaring factory and or manufacturers' full address may be considered to be as violation of two

international consumer's rights namely right to redress and right to be heard of customers' voice as well as complain against the product if arises. These practice is also clear deviation from the Bangladesh Standard BDS1414: 2000, Section 7.1 (c) (BSTI, 2000). The bottled water brands manufactured from Malaysia, Singapore, Thailand, France and Italy have been checked and compared that all the brands had declaration of the full manufacturers' addresses and or factory addresses or the address of the customer service department including telephone numbers, fax numbers, emails and or web addresses.

Table 6 Summary on general survey results on the commercially available bottled water brands in Bangladesh (List of Available Brands Surveyed in ANNEXURE-C)

Sl. No.	Field	No. of Brands
a.	Total available bottled water brands reported until todate	62
b.	Foreign brands reported (Thailand, France and Italy)	4
c.	Local brands reported (i.e. produced in Bangladesh)	58
	Brands of water only in single service containers	31/58 (~53.4%)
	Brands of water both in single & 20 L multiservice (refill jar) containers	8/58 (~13.3)
	Brands of water only in 20 L multiservice (refill jar) containers	21/58 (~36.2%)
d.	Reported total local brands of water in single service containers	37/58 (~63.8%)
e.	Brands of which physico-chemical quality studied in the present study	11/37 (~29.7%)
f.	Brands on which general survey is conducted	32/37 (~86.5%)
g.	Brands of which information unavailable & excluded from general survey	5 /37 (~13.5%)
	In formation of the product labels	
h.	Brand name & name of the manufacturing/marketing group present	32/32(~100%)
i.	Full address of manufacturer/plant/customer service department	
	Declared	5/32 (~15.6%)
	Declared but non-existent at the address supplied	1/32 (~3.1%)
	Not declared	26/32 (~81.3%)
j.	Source water information declared	
	Ground water	8/32(~25%)
	Spring water	1/32(~3.1%)
	Surface water or other	0/32 (0%)
	Not declared	23/32 (~71.9%)
k.	Source water information investigated	23
	Ground water	22/23 (~95.7%)
	Spring water/Surface water	0/23 (0%)
	Public community water supply system	1/23 (~4.3%)
l.	Treatment technology	
	Declared by	22/32(~68.8%)
	Unclear and or confusing statement	2/32(~6.2%)
	Not declared	8/32(~25.0%)
	Note: Three different types of technology declared: UV sterilization, Ozonization, RO	
m.	Certification declared by the manufacturer	32/32 (100%)
	BSTI certified only	30/32(~93.8%)
	BSTI, ISO9000 & ISO14000 certified	2/32 (~6.2%)
	BSTI licence number and the dates of its issue and expiry (BDS 1414:2000 Section 7.4) declared	0/32 (0%)
n.	Manufacturing date and or Batch No.	
	Declared	24/32(~75%)
	Not declared	8/32(~25%)
o.	Expiry date	
	Declared	26/32 (~81.2%)
	Not declared	6/32(~18.8%)

Out of the 32 brands only 8 (25%) declared ground water to be source water, 1 (~3.1%) declared spring water as its origin and rest 23 (~71.9%) brands do not supply any information on their labels in this regard. Based on the available information and reliable investigation made personally on 23 brands it has been reported that 22 (~95.7%) manufacturers using ground water as their source water. And 1 (4.3%) manufacturer taking their raw water from public community water supply system and source water type of rest eight (8) brands could not be confirmed. Excessive dependency on as well as over pumping of ground water considered as detrimental to environment (Hussain et al., 2002). Underground aquifers begin 30-100 feet beneath the land surface. Because water gravitates very slowly from the earth's surface to an aquifer- a fraction of an inch to a few feet per day- it usually takes many years for an aquifer to be refilled (Tibbetts, 2000). When enormous amounts of water are drawn quickly with powerful pumps, aquifers can be depleted. As water quantity shrinks, water quality can be affected, because declining supplies lose their capacity to dilute pollutants and salinity. As an instance in Bangladesh, the receding water tables in turn have exposed arsenic-laden sediments to oxygen, apparently converting them to a water soluble form and thus causing to severe environmental crisis like arsenic poisoning threatening the health of millions of lives.

Regarding the treatment technologies used by the different manufacturers it is observed that 8 (~25%) brands declared nothing and 2 (~6.2%) brands made unclear and sometimes confusing statement on their product labels on this issue. Rest 22 brands (~68.8%) declared the name either of three techniques viz. reverse osmosis, ozonization, UV sterilization and or combination of these as used by them. Verification of the validity of these statements made on the labels was not possible, as visiting plant area is restricted. It is worthwhile to note that as per Bangladesh standard BDS 1414:2000 Section 2.2: Definition of Natural Mineral Water is ".. f) It is not subjected to any treatment other than those permitted by this standard". Again Section 3.1 describes Treatment and Handling. In 3.1.1 : Treatment permitted include separation from unstable constituents by decantation and or filtration, if necessary accelerated by previous aeration. The treatments provided for in sections 2.2.1, 2.2.2. and 2.2.3, 2.2.4 and 3.1.1 above may only be carried out on condition that the mineral content of the water is not modified in its essential constituents which give the water its properties" (BSTI, 2000). But it is evident from the physico-chemical study that the treatment processes changed the water matrices in such a manner that they ultimately turned the water to be "almost demineralized type". We found that at least 54 % (six brands out of eleven) brands lost their natural properties and these

KM Mostafa Anwar delivering keynote speech

practices are clear violations of the BSTI standard BDS1414: 2000.

Out of 32 brands surveyed 24 (~75%) specified manufacturing date and or batch no. and 26 (~81.2%) brands have specified expiry date on their product labels.

All the 32 (100%) brands claimed to be certified by BSTI including 2 claimed to have additional ISO9000 and or ISO14001 certified quality system. According to BDS 1414:2000 Section 7.4 "... 7.4 Each container may also be marked with the BSTI Certification Mark, with license number and the dates of its issue and expiry. But unfortunately none (0%) of the bottling brand followed this Section (BDS 1414:2000 Section 7.4) to declare the license number, the dates of its issue and or expiry. They have declared only the Standard Number either BDS 1414 or BDS1240 along with the BSTI Certification Mark.

Almost none declared that industrial practices followed by them included affirmative actions to preserve the environment except one brand to have quality system certification as per ISO14001 which defines some environmental protection measures.

Minimum of four foreign brands from Thailand, France and Italy also have been reported to be available in the market. But the name of the distributor or importer in Bangladesh is not mentioned on the product label.

Quality of the data declared as specifications on the product labels.

The 11 brands under study have declared a total of 86 physico-chemical parameters on their labels including one brand that declared nothing on the label at all. Among these 86 the validity of 81 parameters has been challenged although additional parameters to be total 242 (= 22X11) in numbers have been analyzed to understand an almost inorganic physico-chemical matrix quality of the waters under investigation. Overall quality of the declared data /specifications have been investigated and expressed in terms of statistical Z-scores and they have been found mostly to be inconsistent and unreliable. To evaluate (s) the best estimate of the standard deviation of the population mean (m) Horwitz curve $s/m \times 100\% = 2^{(1-0.5 * \log_{10} m)}$ has not been used. A sufficiently large number of replicate data have been used from the samples and their replicate analyses. It is seen that Horwitz relation produces stringent value to give higher Z-Scores to prove much more manufacturers' data to be invalid. The manufacturer declaring the data on its product label has been given the benefit of doubt and hence the burden of proof lies with

Among the distinguished scientists & media personalities, HQ Chowdhury one of the authors, S. Murshed of Plasma Plus are visible

the authors those who are responsible to prove the hypothesis that the data declared by the manufacturers are invalid. The overall quality with respect to statistical Z - score has been detailed in Table 7 and Table 8 and in the figures (from Fig.12 to Fig.21).

Table 7 Statistical Z-Score to evaluate the reliability of the specifications declared on the label of different brands. Z-Score = (d-m) /s, where d = data declared by the manufacturer on their product labels, m = best estimate of the population mean calculated from the present study, s = best estimate of the population standard deviation calculated from the present study. The acceptance criteria: Satisfactory : for $|Z| \leq 2$, Questionable : for $2 \leq |Z| \leq 3$ and Invalid: for $|Z| > 3$

Brand Code	Z-pH	Z-TDS	Z-NO3	Z-SO4	Z-Cl	Z-HCO3	Z-F	Z-PO4	Z-Na	Z-K	Z-Ca	Z-Mg	Z-Fe	Z-Mn
B01	2.0	-54.8		1.0	1.0	-51.0	-49.0		17.4	2.3	-43.8	66.3	-6.0	
B02						-6.9	-11.0				3.8	3.9	-0.8	
B03			-3.0	0.0	-0.1	-7.8	-6.8	5.2	-1.5	4.3	3.1	0.4	-3.8	
B04			-17.4		-1.9	-0.2	-10.3			1.8	2.7	1.8		
B05			16.1		-8.0	-15.0	-22.0				-7.0			-1.5
B06			-4.9		78.4	21.0	-312.2		0.8	-1.3	-1.4	9.5		
B07	-18.8			0.0	-5.8	7.5	28.3		-2.8	3.4	-0.2	-4.2		
B08						-0.8	-15.5				0.8	-2.4	-2.3	
B09	4.0		-1.0		43.7					-0.8	-1.3	1.0	-1.8	
B10			-1.2	-2.8	24.1	103.8	42.0	2.0	1.7	92.3	186.3	71.8	-1.8	-1.5
B11														

Shaded Z-scores are having magnitude >3 and thus corresponding parameters declared are not satisfactory hence to be invalid.

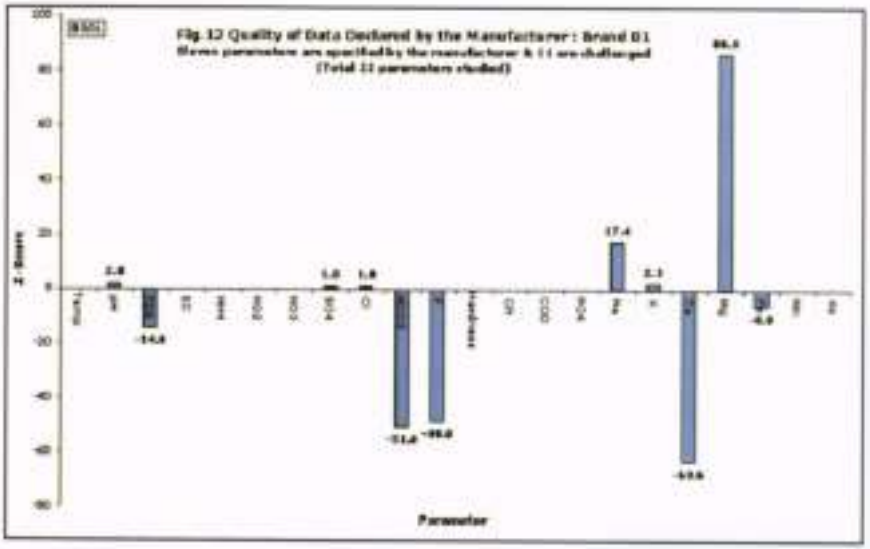
Table 8 Summary on the checking reliability as well as validity of the specifications declared by the manufacturers on their product labels

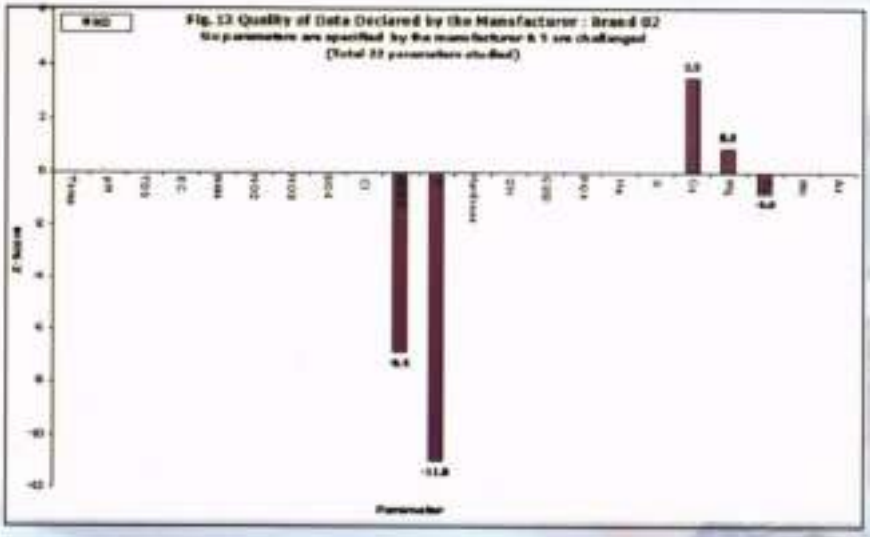
Brand Code	Parameter Studied	Parameter Declared	Parameter Challenged	Valid (%Valid) (nS |Z| ≤2)	Questionable (%Q) (nQ |Z| ≤3)	Finally Accepted (nS |Z| ≤3)	Invalid (%Invalid) (|Z|>3)	Z-Max
B01	22	11	11	3 (27.3%)	1(9.1%)	4(36.4%)	7(63.6%)	66.3
B02	22	6	5	2(40.0%)	0(0%)	2(40.0%)	3(60.0%)	-11.0
B03	22	11	11	4(36.4%)	1(9.1%)	5(45.5%)	6(54.5%)	-7.8
B04	22	7	7	4(57.1%)	1(14.3%)	5(71.4%)	2(28.6%)	-10.3
B05	22	7	6	1(16.7%)	0(0%)	1(16.7%)	5(83.3%)	-22.0
B06	22	8	8	3(37.5%)	0(0%)	3(37.5%)	5(62.5%)	-312.2
B07	22	9	9	2(22.2%)	1(11.1%)	3(33.3%)	6(66.7%)	71.5
B08	22	6	5	3(60.0%)	1(20.0%)	4(80.0%)	1(20.0%)	-22.4
B09	22	7	7	5(71.4%)	0(0%)	5(71.4%)	2(28.6%)	43.7
B10	22	14	12	5(41.7%)	1(8.3%)	6(50.0%)	6(50.0%)	186.3
B11	22	0	-	-	-	-	-	-
Total	242	86	81	32(39.5%)	6(7.4%)	39(48.8%)	42(53.1%)	-312.2

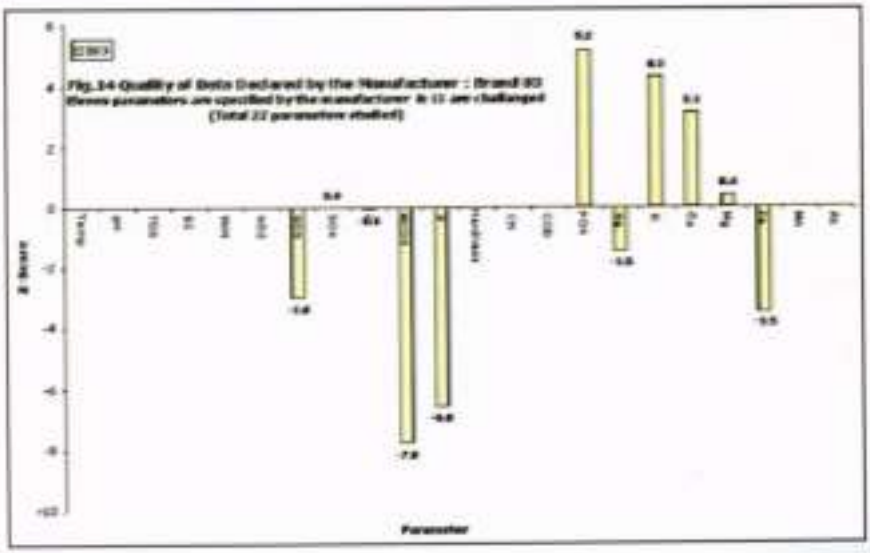
Out of 81 data challenged on the product labels only 32 (~39.5%) found to be satisfactory having Z-scores $|Z| \leq 2$ (95% CI) and 6 (~7.4%) data with Z-scores to be 2 (95%CI) $\leq |Z| \leq 3$ (99% CI) are questionable. That means only 38(~46.9%) data are acceptable to some extent. Rest 43(~53.1%) data being outliers are thus proved to be invalid, unreliable and inconsistent. One brand (~9 %) B08 have their maximum 80% data to be valid getting acceptable score and brand B05 positioned at the lowest having only 16.7% valid declared data on its label. 70% or above data found to be valid only for three brands (~27.3%) B04, B08 and B09 out of 11. Rest 7 (~63.6 %) brands do not even have the 60% data to be valid. One brand (~9 %) B11 declared nothing on its product label which may be assumed as a severe violation of consumer right to be informed. Severe inconsistency and errors in specifications are clearly visible from the Z-Scores of the outlier data. Some declared data even having error -312.2 or 196.3 times of standard deviation thus leading to overall 43 (~53.1%) data to be invalid. From the number of valid data 38(~46.9%) on the labels it is apparent that as a whole there is a very little chance of having acceptable QAQC system in the industrial practices.

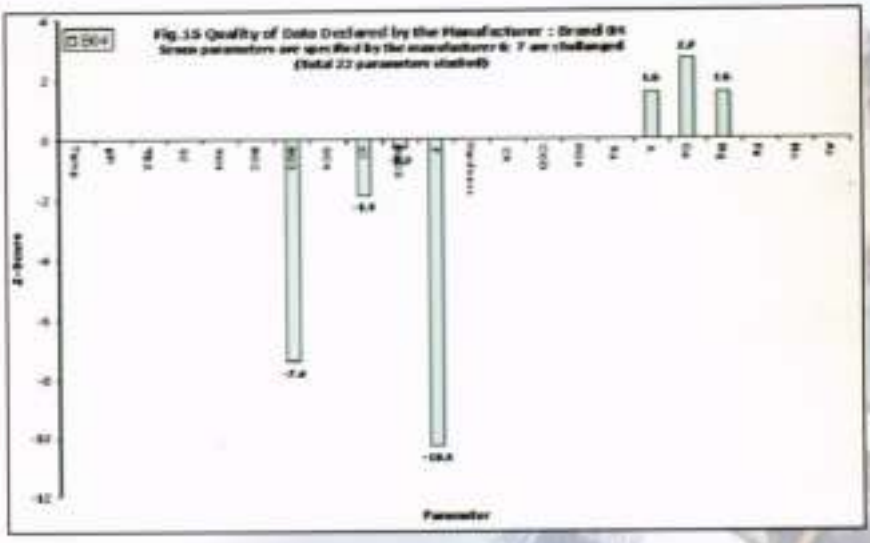
In general the quality of the declared specifications/data reveals three possibilities. Firstly, it may happen that the manufacturer has checked its product water quality just once prior to marketing (e.g. to get certification from the authority (ies) etc.) and that data came from a laboratory having no proper and valid laboratory QAQC in operation and thus producing unreliable data. And later on they did not check/verify the specifications and or variations in the specifications among the batches with applicable and valid methods. Secondly, in most of the industries either there is no QAQC system or existing Total Quality Management (TQM) system in operation is not effective at all to assure the continuous monitoring and controlling of the quality of products with systematic and appropriate methods, means. All manufacturers 11 (100%) claimed to be BSTI certified, 1 (~9%) claimed to be ISO 9002 certified and 3(~27.3%) claimed to be members of International Bottled Water Association (IBWA) and some claimed that they follow WHO/FAO/ISO/IBWA/FDA guidelines etc. But those seemed to be grossly ineffective to produce valid data indicating the quality of products. And no data has been specified as generated from any accredited laboratory. As an example one brand B03 claimed to be ISO9002 certified but out of the 11 data declared on the label only 5 (~45.5%) are found to be acceptable to some extent having Z-score $|Z| \leq 3$ (99% CI) with the rest 6 (~54.5%) data are far outliers and invalid thereby. Thirdly, the government regulatory measures

are not effective enough to monitor and control the quality of products continuously with systematic and appropriate methods, means and frequency of surveillance protocols.









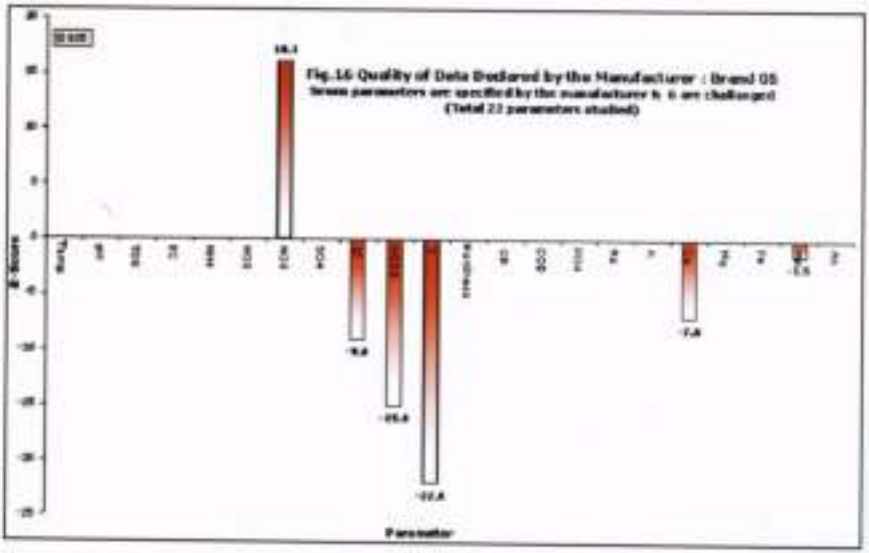


Fig.16 Quality of Data Declared by the Manufacturer : Brand 05
Z-Score
Parameter

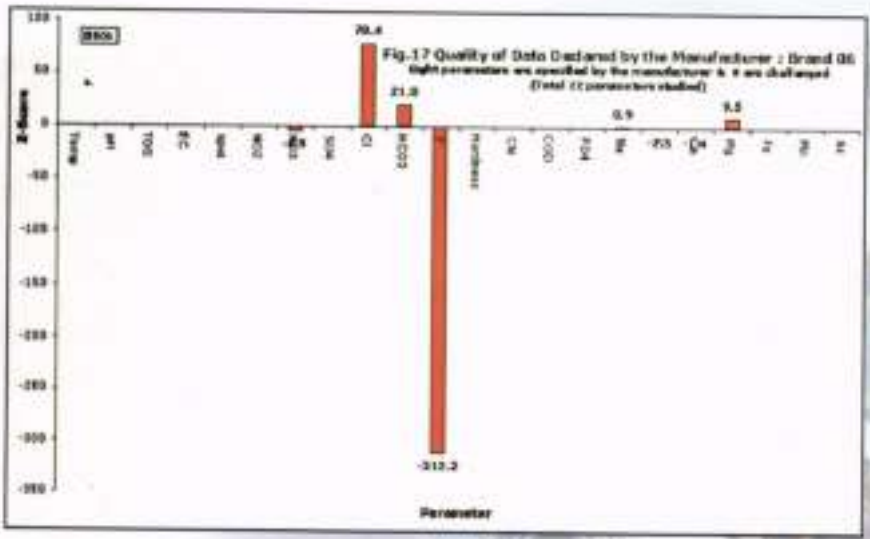


Fig.17 Quality of Data Declared by the Manufacturer : Brand 06
Z-Score
Parameter

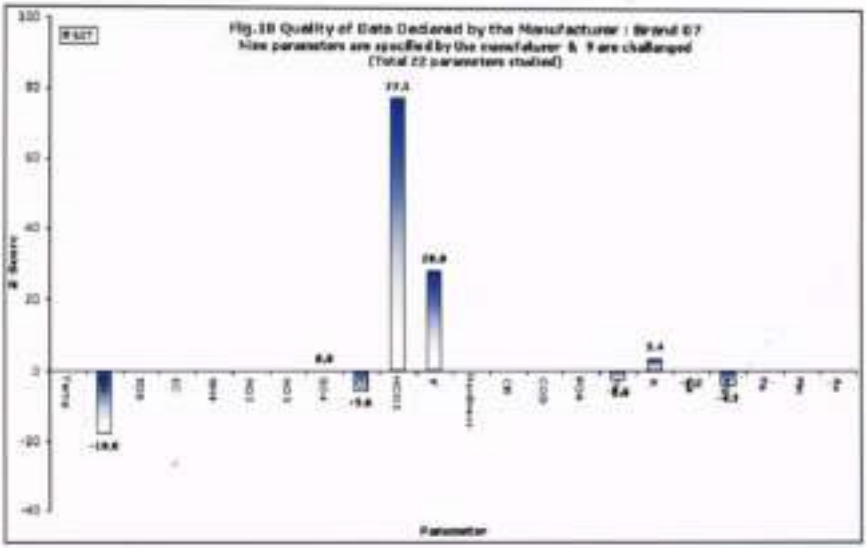


Fig.18 Quality of Data Declared by the Manufacturer : Brand B7
Nine parameters are specified by the manufacturer & 9 are challenged
(Total 22 parameters studied)
Z-Score
Parameter

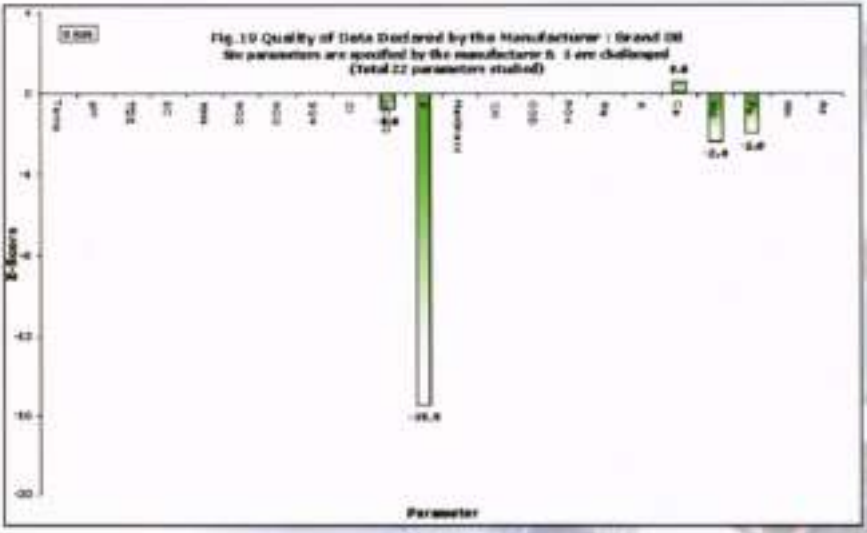
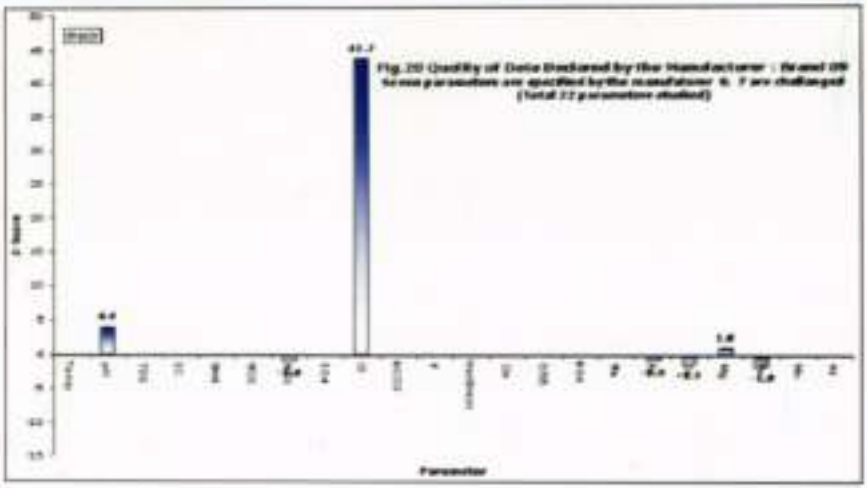
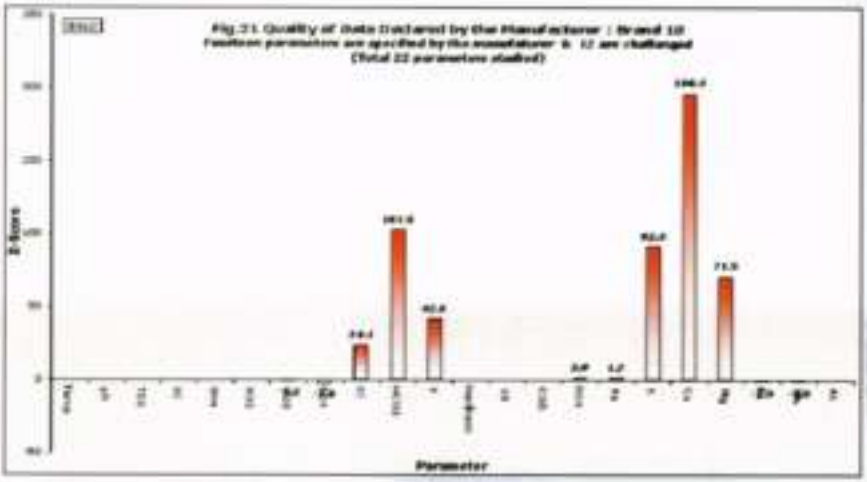


Fig.19 Quality of Data Declared by the Manufacturer : Brand B8
Six parameters are specified by the manufacturer & 1 are challenged
(Total 22 parameters studied)
Z-Score
Parameter





Inorganic Physico-chemical Quality

Results of 22 inorganic physico-chemical parameters of the 11 brands under study have been organized in the Table 9a, Table 9b and Table 9c. Regulatory guidelines and MCL values set by WHO (Cohn et al.1999 and Faust et al., 1999), USEPA (Cohn et al.1999, Faust et al., 1999 and USEPA, 2002), Canadian Authority (Faust et al., 1999), EEC (Faust et al., 1999) and GOB (GOB,1997) have been shown in the tables for convenience as most of the manufacturers claimed that their products met the international standards. Ranges of means for each parameter are also given in the tables. In the Table 10 percentages of the studied brands exceeding the regulatory limits and or ranges have been summarized.

Table 9a Non-metal constituents (m ± s, where m = best estimate of population mean and s = best estimate of population standard deviation)

Brand	Temp °C	pH	TDS (mg/L)	EC (µS/cm)	at Temp °C	Ammonium (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)
Brand 01	26.4± 0.6	7.3 ± 0.1	318 ± 14	497 ±22	26.2	0.24±0.02	<0.02	<0.2	<5.0
Brand 02	26.7± 0.6	6.9 ± 0.1	361 ± 11	564±16	26	0.14±0.05	<0.02	37 ±12	<5.0
Brand 03	26± 0.6	8.2 ± 0.1	186± 12	290± 19	25.9	0.13±0.03	<0.02	0.3±0.1	<5.0
Brand 04	26.2± 0.6	6.8 ± 0.1	157±5	245 ± 8	25.8	0.12±0.01	<0.02	9.7±1.1	<5.0
Brand 05	26± 0.6	7.9 ± 0.1	634± 31	990 ±49	25.4	<0.1	<0.02	0.28±0.1	<5.0
Brand 06	26± 0.6	7.2± 0.1	59± 5	93 ± 6	26.2	0.15±0.04	<0.02	3.4±0.7	<5.0
Brand 07	25.9± 0.6	9.2± 0.1	163±5	254 ± 8	25.3	<0.1	<0.02	3.4±0.1	<5.0
Brand 08	25.9± 0.6	7.5± 0.1	166 ±16	260± 25	25.6	<0.1	<0.02	0.8±0.7	<5.0
Brand 09	26± 0.6	6.4± 0.1	8.6±3.6	13.5 ± 5.7	25.7	<0.1	<0.02	0.8±0.7	<5.0
Brand 10	25.7± 0.6	6.7± 0.1	15.3±1.3	23.9± 2	26	<0.1	<0.02	0.3±0.1	<5.0
Brand 11	25.1± 0.6	7.8± 0.1	493 ±7	770 ±11	25.2	<0.1	<0.02	17 ±0.7	<5.0
Range of Means	25.1-26.7	6.4-9.2	8.6-634	13.5-990		<0.1-0.24	-	<0.2-37	-
WHO Guideline Value		6.5-8.5†	1000†					10	400†
EPA MCL		6.5-8.5‡	500‡					10.0 10.0[d]	400 or 500
Canadian DWQ[a] Guideline		6.5-8.5*	≤500					45[a]	≤500*
EEC		6.5-8.5		400[c]		0.05[c] 0.5[c]	0.1[c]	25[b] 50[c]	25[b] 250[c]
GOB	20-30	6.5-8.5	1000			0.5	<1	10	400

†AQ=Aesthetic Quality, ‡S=Secondary MCL, a = DWQ Canadian Drinking Water Quality Guideline, * AO= Aesthetic Objective, b GL=Guide Level, c MAC=Maximum Admissible Concentration, d GV= Guideline Value, NGV= No Guideline Value, GOB: Bangladesh Gazette Additional August 28, 1997, Table 3, Rule 12: Allowable Limit of Drinking Water (mg/kg [illegible]) and Allowable Limit of Groundwater

Table 9b Non-metal constituents (m ± s where m = best estimate of population mean and s = best estimate of population standard deviation) (contd.)

Brand	Chloride (mg/L)	Bicarbonate Alkalinity (as mg $CaCO_3$/L)	Fluoride (mg/L)	Hardness (as mg $CaCO_3$/L)	Free CN (mg/L)	COD (as mg O_2/L)	Phosphate (mg/L)
Brand 01	4.8± 5.8	302 ± 5.3	0.5± 0.01	162.9± 0.1	<0.009	<20	0.23± 0.02
Brand 02	65 ± 5	154± 4.6	0.47± 0.02	23.4± 7.0	<0.009	<20	0.17± 0.07
Brand 03	4.3± 2.2	165 ± 3.3	0.38± 0.03	94 ± 4.8	<0.009	<20	0.24± 0.07
Brand 04	24± 1.4	89 ± 4.6	0.43± 0.03	36± 13	<0.009	<20	0.13± 0.02
Brand 05	251 ± 24.5	146 ± 2.4	0.42± 0.01	253 ± 42	<0.009	<20	0.16± 0.03
Brand 06	3.27 ± 0.68	54.0± 4.2	0.38± 0.05	22.6± 4.2	<0.009	<20	0.4± 0.06
Brand 07	28± 3	29.4± 1.4	0.44± 0.02	83 ± 9.7	<0.009	<20	0.14± 0.02
Brand 08	5.1± 0.9	130 ± 6.7	0.56± 0.02	38 ± 6.8	<0.009	<20	0.26± 0.07
Brand 09	0.83± 0.1	5.63± 0.08	<0.1	1.6± 0.8	<0.009	<20	0.14± 0.04
Brand 10	1.1± 0.2	13.0± 1.1	0.11± 0.01	2.1± 0.8	<0.009	<20	<0.1
Brand 11	108 ± 7	275 ± 4.2	0.58± 0.01	249± 2.6	<0.009	<20	0.16± 0.07
Range of Means	0.83-251	5.63-302	<0.1-0.58	1.6-249	-	-	<0.1-0.26
WHO Guideline Value	250†		1.5	500†	0.1	-	
EPA MCL	250‡ (final)		4.0[c] 2.0‡ (final)		0.1 (MCLG) 0.2	-	
Canadian DWQ[a] Guideline	≤250	30[a] (MRC)	1.5[a]			-	
EEC	25[c]			60[c] (MRC) mg Ca or equivalent cations ‡	0.2[c]	-	
GOB	150-600[g]		1.0	200-500	0.1	4	6.0

†AQ=Aesthetic Quality, ‡S=Secondary MCL, a = DWQ Canadian Drinking Water Quality Guideline, * AO= Aesthetic Objective, b GL=Guide Level, c MAC=Maximum Admissible Concentration, d GV= Guideline Value, e MRC = Minimum Required Concentration, NGV= No Guideline Value, g = 1000 mg/L for coastal areas of Bangladesh

Table 9c Metal constituents (m ± s where m = best estimate of population mean and s = best estimate of population standard deviation)

Brand	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Dissolved Fe (mg/L)	Dissolved Mn (mg/L)	Total Inorganic As (µg/L)
Brand 01	34.6± 0.3	1.9± 0.04	36.5± 0.28	17.4± 0.03	<0.2	0.58± 0.01	<2.0
Brand 02	103..± 8.9	1.8± 0.39	9.1± 1.9	1.98± 0.57	<0.2	<0.2	<2.0
Brand 03	28.2± 3.5	2.2± 0.06	27.3± 1.5	6.3± 0.24	0.19± 0.05	<0.2	<2.0
Brand 04	34.8± 4.5	2.8± 0.57	7.9± 2.7	4.41± 1.52	0.28± 0.01	<0.2	<2.0
Brand 05	90.± 4.1	2.7± 0.04	68.0± 7.2	21.3± 5.88	0.19± 0.09	<0.2	1.8± 0.8
Brand 06	14.4± 6.3	1.6± 0.13	5.2± 1.2	2.34± 0.29	0.19± 0.13	<0.2	<2.0
Brand 07	9.9± 2.3	1.7± 0.1	30 ± 3.5	2.04± 0.24	0.11± 0.05	<0.2	<2.0
Brand 08	36.8± 1.5	1.1± 0.05	10.8± 3.2	2.98± 0.2	<0.2	<0.2	<2.0
Brand 09	1.3± 0.8	0.2± 0.11	0.91± 0.23	0.07± 0.06	<0.2	<0.2	<2.0
Brand 10	6.4± 1.4	0.3± 0.04	0.6± 0.16	0.14± 0.04	<0.2	<0.2	<2.0
Brand 11	52. ± 1.2	6 ± 0.1	68 ± 0.8	19.5± 0.32	<0.2	<0.2	<2.0
Range of Means	1.3 -103.	0.2 - 6	0.51- 68	0.07-21.3	<0.2-0.28	<0.2-0.58	<2.0
WHO Guideline Value	NGV				0.3†	0.1†	20^
EPA MCL	20**				0.3‡	0.05‡	10
Canadian DWG* Guideline	<20.0*				<0.3*	<0.05*	
EEC	20^	10^	100^	30^	0.09^	0.02^	50
GOB	200	12	75	30	0.20^ 0.3-1.0	0.05^	50

**DWEL= Drinking Water Equivalent Level, USEPA Health Advisories for Adult of weighing 70kg consuming water 2L/day^, MCL= (RfD) X DWEL. RfD = Reference Dose =1.75 for Na
RfD= (NOAEL or LOAEL)/Uncertainty factors, DWEL (mg/L) = (RfD X Body weight (kg))/drinking water volume (L/day)

‡AO=Aesthetic Quality, ES=Secondary MCL, a = DWQ Canadian Drinking Water Quality Guideline, * AO= Aesthetic Objective, SGL=Guide Level , †MAC=Maximum Admissible Concentration, d GV= Guideline Value, NGV= No Guideline Value

Table 10 Summary on the studied brands exceeding the regulatory limits/ranges

Parameter	pH	EC	NH4	NO3	Cl	HCO3	Hardness	Na	Fe
Above WHO Guideline Value (%)	18% (out of range)			27.3%	9 %				
Above EPA MCL (%)	18% (out of range)			27.3%				63.6% (Health advisory limit)	
Above Canadian DWG* Guideline (%)	18% (out of range)					27.3 % (>MAC)		63.6% (AO)	
Above EEC(%)	18% (out of range)	27.3%	45.5% (>GL)		45.5%		54.5% (>MAC)	63.6% (>GL)	36.4% (>GL)
Above GOB (%)	18% (out of range)			27.3%	91% (out of range)		81.8% (out of range)		

Table 11 Matrix of Pearson Correlation Coefficient (R) for some major parameters (calculated for N=49 samples). Other parameters i.e. nitrite, sulfate, COD, free cyanogen and total inorganic arsenic having values below PQLs and hence excluded from correlation coefficient calculation.

	pH	EC	NH4	NO3	Cl	HCO3	F	Hardness	PO4	Na	K	Ca
EC	0.244											
NH4	0.059	0.087										
NO3	-0.232	0.303	0.296									
Cl	0.157	0.911	-0.099	0.098								
HCO3	0.146	0.712	0.293	0.304	0.408							
F	0.517	0.586	0.280	0.363	0.378	0.673						
Hardness	0.429	0.854	-0.057	-0.073	0.804	0.626	0.479					
PO4	-0.229	-0.047	0.238	0.356	-0.205	0.252	0.399	-0.256				
Na	-0.091	0.827	0.166	0.623	0.694	0.642	0.534	0.429	0.399			
K	0.308	0.697	0.037	0.323	0.512	0.661	0.644	0.766	-0.034	0.443		
Ca	0.517	0.834	-0.060	-0.087	0.764	0.594	0.488	0.950	-0.354	0.366	0.763	
Mg	0.228	0.943	-0.020	-0.033	0.797	0.667	0.433	0.962	-0.199	0.466	0.737	0.912

Overall inorganic quality has been assumed in terms of three major areas of characterization namely: aggregate properties, non-metal constituents and metal constituents including heavy metals e.g. iron, manganese and arsenic.

Aggregate and aesthetic quality

pH, EC, TDS, bicarbonate alkalinity, hardness. Aesthetic components of drinking water quality include taste and odor, turbidity and color, mineralization, hardness and staining (Cohn et al., 1999 and Faust et al. 1999). Aesthetic problems can be caused by some natural or commercial

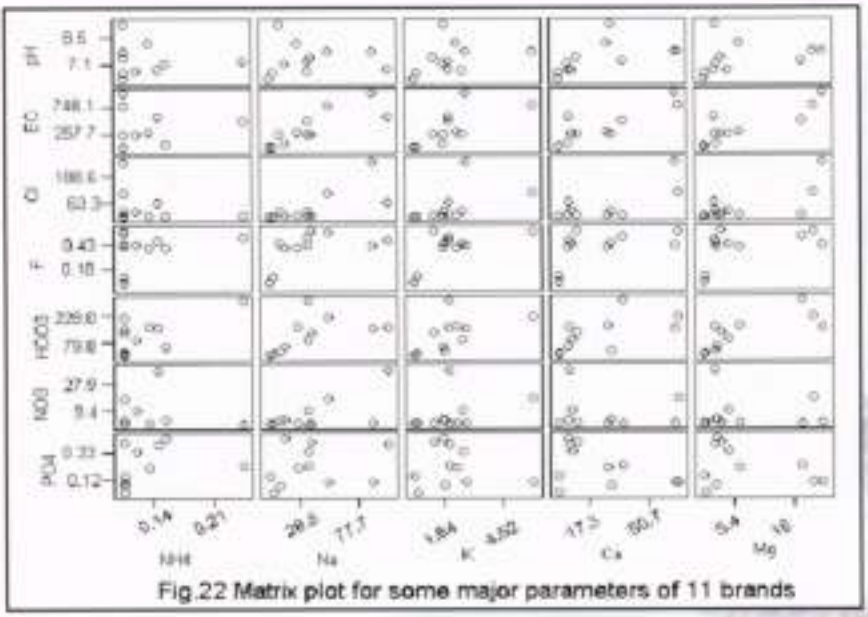


Fig.22 Matrix plot for some major parameters of 11 brands

inorganic and organic chemicals as well as by organisms. Apart from the organic components pH, EC, TDS, bicarbonate alkalinity, hardness, chloride, fluoride, sulfate, zinc, copper, iron, manganese are some parameters which affect the aesthetic quality. Electrical conductivity (EC), TDS, bicarbonate alkalinity, hardness are considered as aggregate properties. Present study found that pH of one (~9 %) brand B07 being 9.2 is above and that of another (~9 %) brand B09 (with pH 6.4) is below the WHO, USEPA (secondary) and GOB MCL limit (6.5-8.5). Electrical Conductivity (EC) of four (36.4%) brands B01, B02, B05 and B11 exceeding the EEC Guideline value 400 µ S/cm. For total dissolved solids (TDS) content, an important aggregate property contributing to aesthetic quality of water, WHO and GOB defined MCL value is 1000 mg/L

whereas USEPA secondary standard and Canadian DWQ Guideline specified 500 mg/L as MCL. TDS value of one (~9% %) Brand B05 is above the USEPA and Canadian DWQ guideline value. Rest 10 (91%) have TDS values below 500 mg/L. In general TDS less than 1200 mg/L are acceptable to consumers, although levels less than about 650 mg/L are preferable (Cohn et al., 1999). It is worthwhile to note that 3 (~27.3%) brands B06, B09 and B10 containing extremely low TDS contents to be only 57.9 mg/L, 8.6 mg/L and 15.3 mg/L respectively. Current Good Manufacturing Practice (cGMP) guideline USFDA 21 CFR Parts 110 and 129 and 21 CFR Part 165.110 Bottled Water, Section (a) (2) Nomenclature (iii) (USFDA, 2002) defines that if the TDS content of mineral water is below 500 mg/L making statement like "low mineral content" on the bottled water product label is recommended. Such kind of declaration is not observed on the labels of these three products.

Prof. Dr. A. H. Khan as main discussant analysing the findings of the study reported

Hardness is generally defined as the sum of the polyvalent cations present and expressed as an equivalent quantity of calcium carbonate ($CaCO_3$) and Ca and Mg are main contributors to hardness. Waters having less than 75mg $CaCO_3$/L are generally considered soft. Those having between 75 and 150 mg $CaCO_3$/L are said to be moderately hard. Those having from 150-300 mg $CaCO_3$/L are hard and waters having more than 300 mg $CaCO_3$/L are classified as very hard. In the report from US National Academy of Sciences Safe Drinking Water Committee in 1980 it is evident that an inverse relationship has been postulated between the incidence of cardiovascular disease and the amount of hardness in the water. A protective effect from either the major or minor

constituents of hard water, or, conversely, a harmful effect from elements more commonly found in soft water. Many investigators attribute a cardiovascular protective effect to the presence of calcium and magnesium. Considering the human health requirement EEC Guideline recommended minimum required concentration (MRC) for hardness as 60 mg $CaCO_3$/L. With respect to the above classification it is clear that 6 (~54.5%) brands viz. B02, B04, B06, B08, B09 and B10 are soft with hardness values <75 mg $CaCO_3$/L. Two brands 2 (~18.2%) brands B03 and B07 are moderately hard and 3 (~27.3 %) brands B01, B05 and B11 are hard. Surprisingly two (~18.2 %) brands B09 and B10 have extremely low values of hardness as 1.6 and 2.1 mg $CaCO_3$/L respectively thus being a demineralized water type. The result is also supported by the fact that these two brands have low pH values 6.4 and 6.7 respectively, low Ca content to be 0.51 and 0.6 mg/L respectively, low Mg content to be 0.07mg/L and 0.14 mg/L respectively and very low TDS to be 8.6 and 15.3 mg/L respectively. An expected strong positive correlation between hardness and bicarbonate alkalinity found in this study with Pearson Corr Coeff. R = 0.625 (Table 9) for 49 samples. And the fact supports that although the nine brands have bicarbonate alkalinity values above the MRC 30mg $CaCO_3$/L set by the Canadian DWQ Guideline, those very two brands B09 and B10 have bicarbonate alkalinity values 5.6 mg CaCO3/L and 13.0 mg $CaCO_3$/L far below this MRC level. And thus total 6 (~54.5%) brands classified above as "soft" having hardness values far below the EEC recommended MRC (60 mg $CaCO_3$/L) level and also with low TDS values can be assumed as "low mineral content" type and it is suggestive that continuous intake of these brands may cause harmful effect to the health.

Non-metal constituents : Chloride, fluoride, nitrite, nitrate, sulfate, phosphate, COD, free cyanogen and ammonium. Table 9a and Table 9b containing the experimental results. In general, with respect to non-metal contents of all 11 (~100%) brands are seemed to be acceptable. Brand 05 has chloride levels (251.32 mg/L) around the WHO guideline value 250 mg/L. Five (~45.5%) brands B02, B04, B05, B07 and B11 have chloride contents above and or around the EEC Guide Level at 25 mg/L. It can be noted that GOB set the standard with a wide range for chloride as 150 - 600 mg/L. And for the coastal areas of Bangladesh this limit is further extended to be 150- 1000 mg/L. Thus 10 brands (~91%) having chloride levels out of the GOB defined range. Fluoride, nitrite and sulfate contents of all the 11 brands are below the regulatory limits hence may be considered to be safe with respect to these parameters. But three (~27.3%) brands B02 (37. mg/L), B04 (9.7 mg/L) and B11 (17. mg/L) have nitrate levels near to and or high above the WHO, USEPA and GOB

standard 10 mg/L. As EEC specified the Guide Level at 0.05 mg/L for ammonium content, at least 5(~45.5%) brands B01, B02, B03, B04 and B06 exceeded this limit. Rest six brands (~54.5%) have ammonium contents below PQL 0.1 mg/L so it is not confirmed whether they have any values higher than EEC Guide Level. But no brand exceeded EEC defined Maximum Admissible Concentration (MAC) and GOB MCL at 0.5mg/L in terms of ammonium concentrations. As all of the manufacturers are using ground water as source water, higher values of nitrate and ammonium contents are indicative of contamination due to application of nitrogen based fertilizer for agriculture purpose or due to other possible industrial activities. All the 11 brands (~100%) have COD, free cyanogen and phosphate contents to be much below the international regulatory guidelines.

Dr. Azharul Haq Managing Director of Dhaka WASA validating the research out come presented

Metal constituents: Sodium, potassium, calcium, magnesium, iron, manganese and arsenic. As calcium and magnesium are two major contributors to hardness it has already been discussed above that at least 6 (~54.5%) brands found "soft" in terms of hardness with low mineral contents and thus continuous accumulation of these type of water is not safe for human health any way. Especially two brands found almost demineralized type in nature. In general potassium, dissolved iron, dissolved manganese and total inorganic arsenic contents of all these 11 (100%) brands are within the acceptable limits with a few exception. At least four (~36.4%) brands B03, B04, B05 and B06 have dissolved iron contents to be higher than the EEC defined Guide Level (0.05mg/L) and even they have values around and higher than the maximum admissible concentration (MAC) limit at 0.2 mg/L. But with respect to sodium concentrations found in the water under study, restriction appears for some

brands. There is strong evidence that there is an at-risk population of persons predisposed to high blood pressure (hypertension) from dietary sodium. Coronary heart diseases and stroke and certain other diseases are aggravated by high blood pressure. Hence USEPA Health Advisories (calculated for an adult of weighing 70 kg consuming drinking water 2 L/day) set 20 mg/L as DWEL (Drinking Water Equivalent Level). Although WHO has no guideline value for sodium. Canadian DWQ Guideline for aesthetic objective (AO) and EEC recommended Guide Level at 20 mg/L. In consideration of the above recommendations, only four (~36.4%) brands B06, B07, B09 and B10 have sodium concentrations below 20 mg/L level. Rest 7 (~63.6%) brands have Na concentrations high above this limit and maximum Na concentration is obtained in B02 to be ~103.2 mg/L. It is important to note that GOB set the standard for Na at high above 200 mg/L and all the 11 (100%) brands seemed to have Na contents below this line. Maximum total inorganic arsenic level found at 1.91 ± 0.8 ug/L in B05 which is below the new USEPA set MCL limit 10 ug/L and also below the limits specified by other international regulatory bodies.

CONCLUSION AND RECOMMENDATIONS

It is not within the scope of this study to categorize and to promote or to degrade publicly any brand as per the overall findings. This study presented the scientific and statistical fact on the quality of commercialized bottled water and the prevailing culture in producing and marketing the bottled water.

From the general survey result, it is evident that consumer rights are not preserved by the practices followed by the manufacturers and regulatory measures are not enough and effective to protect the public health and environment. Severe inconsistency and errors in specifications declared on the labels are clearly evident from the Z-Scores of the outliers data thus leading to overall 53.1% data to be invalid. The number of valid data is only ~39.5% on the labels. It is apparent that there is very little chance of having acceptable and or effective QAQC system in this industrial practice.

From our point of view, the problem is the lack of proper knowledge and ignorance to technology and management to introduce applicable industrial Quality Assurance and Quality Control (QAQC) under the frame of Total Quality Management TQM system. The country is far behind these practices to be introduced and followed strictly. Having TQM in the industrial sectors neither an ambitious program nor a culture only

practicable in the western or developed countries. The neighboring country India recognized the importance of TQM in industrial practices at least 15 years ago realizing the fact that there is no alternative way to survive in the global economic/market challenge in the 21st Century without having quality culture in practices. And as such First Asian Congress on Quality and Reliability was held on 30 October - 2 November in 1989 at New Delhi with a view to have a comprehensive guidelines and recommendations on the issue "Quality for Progress and Development" (Bose et al., 1989). No body will disagree that India is now prepared enough to enter WTO regime and it took them 15 years or more. It may be mentioned that Bangladesh has a considerable experience in QAQC culture in pharmaceuticals sector to learn which originated from the Drug Policy (following a Drug (Control) Ordinance 1982) developed in the early eighties.

Current global economic situation demands in some cases even mandatory introduction of quality assurance program in producing and delivering products, services and education etc. Most traded products require proof that they comply with specifications and safety regulations

Bottled Water Brands Surveyed

before they are released in the market. Most customers also require objective evidence that specifications are met. This evidence is usually in the form of valid test data produced by reliable laboratories. The reliability of test data is a critical factor in making plausible decisions on purchase and usage. Consumer products, packaged or frozen foods, drugs, textiles etc. are nowadays traded almost entirely on the basis of technical specifications. International demand is increasing for test data and other technical information in the interests of community health.

Examples of toxicity of drugs, safety of food additives and measurements of environmental pollution are to name a few. Technical test data can also provide essential information about the design and performance of products, materials and processes. Lack of acceptance of laboratory test data across the national borders has been identified as a significant barrier to trade. The WTO has adopted two major new agreements to ensure that technical requirements do not restrict trade:

The Agreement on Technical Barriers to Trade (TBT) and The Agreement on Sanitary and Phytosanitary Measures (SPS) (ILAC, 1996).

TBT replaces the old GATT Standards Code and SPS deals with animal and plant health and food safety. Other international measures such as OECD Code of Good Laboratory Practice and EU's policies on testing and certification encouraging cross-border acceptance of test data and Asia Pacific Economic Cooperation (APEC) have given priority to conformity assessment issues.

To protect health, safety, welfare or environment all governments have regulations that products must meet before they enter the country. Previously, governments could regulate foreign goods coming into their market through using subsidies or quotas. Within the framework of WTO, free trading is introduced and tariffs are being systematically reduced and quotas and subsidies are being phased out. This leaves technical requirements as the major means by which government can regulate access to their markets. Technical barriers to trade are now increasing rapidly. They include product specifications, packaging and labeling requirements, consumer standards, health and safety standards, security measures and environmental requirements. In the past, technical specifications usually applied only to products. Recently, standards have been developed for processes and systems also. In the competitive global market thus TBT in turn put pressure on the manufacturers to introduce TQM system in practice and to have conformity assessment from accredited laboratory system. The TBT Agreement defines conformity assessment that includes *"... sampling, testing and inspection; evaluation, verification and assurance of conformity; registration, accreditation and approval as well as their combinations"* (ILAC, 1996).

All these are in fact bringing all economies towards implementing and establishing quality and conformity assessment infrastructure comprising standards, metrology & calibration, testing and quality control, certification and inspection in line with international best practices. Promoting

accreditation and creating legal as well as technical arrangement for quality infrastructure is seemed to be critical to have sustainable trade and industrial development.

Mr. Selim Jahangir of Reman Drugs Industry Representative taking part to the discussion on the study

In view of the above the following recommendations are proposed hereby:

a. The government should take emergency measures to have A Safe Water Act within which a Safe Water Regulatory Body will be formed. This body will design Action Plan having initiatives for protecting and restoring natural water bodies and aquifers (surface, stream, ocean and ground water sources etc.) to reduce public health threats, to improve the stewardship of natural water resources, to strengthen the control of polluted runoffs and to make water quality information more accessible to the public. This body will in turn devise Safe Drinking Water Regulations etc. to regulate the drinking water use and to ensure that all agencies, industries, laboratories are bound to abide by the laws of the Body. To avoid further deterioration of ground water aquifer the Body must devise the way of stopping groundwater use via promoting surface water option as a safe drinking water source upon treatment. The Body must monitor and stop the industrial practices detrimental to environment. Private entrepreneurs may come forward to establish drinking and agricultural water utilities via piped and or any other means for the rural people after treating surface water that will be ultimately safe, cost effective and environmentally friendlier option. Different Ministries comprising LGED, Science & Technology, Environment, Commerce and Industry, Water Resources, Public Health Engineering, Education, Health and Sanitation, Agriculture, Fisheries and Livestock, public and private universities, government and private laboratories and industries can work together in a network in this regard.

b. Bangladesh Academy of Sciences can form an Academy of Sciences Committee on Safe Water to provide technical and scientific assistance with GOB for having a Safe Water Act and forming the Regulatory Body and its proposed action plan and or initiatives.

c. GOB should enact regulations including the consumer's right protection laws and so as well as to enact and enforce product safety and liability regulations from any central line ministry or authority. This authority will in turn run periodic mandatory market surveillance actions to play the policing/regulatory roles.

d. GOB should take immediate action to convert BSTI to be a fully independent accredited modern QAQC based laboratory having TQM system in operation with state-of-the-art scientific instrumentation and technology management system meeting ISO 17025 or other international standards. It should issue product Certification Mark scheme accredited as per international standards and or guidelines. It should operate to be a fully functional national standard body as well as technical conformity assesment body not to be a regulatory operator or policing authority to avoid the potential conflict of interests. BSTI must be made free from its regulatory functions to perform only the technical operations.

e. In general appropriate regulatory as well as technical environment should be created in the country or major reform should be brought into the testing and certification and metrology area. This is indeed a mammoth task to be taken by the whole nation to formulate a comprehensive testing and measurement infrastructure strategy. The setting up national metrology infrastructure in line with international best practices and establishing national system of measurements in chemistry namely the chemical metrology infrastructure are all indeed knowledge based scientific, technical venture needs study, research and deep understanding in this areas of specialization. Nation should prioritize and allocate resources and also should have a planned motion to have these systems with sufficient and appropriate reference laboratories under different departments having expert knowledge and experience. Network of these reference laboratories in different areas of chemical

BSTI high official Mr. Lutfor Rahman Khan admits the situation & expecting allout cooperation from all concern to strengthen BSTI & other regulatory bodies

measurements will serve the backbone of the chemical metrology of the nation. Need for setting up designated national reference laboratories for chemical measurements has been envisioned for quite a many years. But no initiative has been taken so far in this area of vast technically intensive venture. These designated national reference laboratories would be running periodic inter-laboratory or proficiency testing actions to check the national testing status. They will also conduct training in analytical sciences as well as develop the think tank for laboratory quality management system for the nation with close interactions among academia-industries and scientific communities. Accreditation, metrology and or calibration always go hand-in-hand. Quality infrastructure can not be facilitated without taking this in consideration. National strategy for accreditation and metrology should be formulated with participation from all concern in both private and public.

f. GOB should take immediate measure to develop a comprehensive Food & Agro-based Industrial Products Policy similar to the Drug Policy developed in early eighties of last centuries. This will form a separate and independent Food Administration to introduce and regulate the industrial QAQC practices in foods, beverages. This is more important now for export oriented industrial sectors. This regulatory body will operate controlling and policing actions to control foods, drinks and beverages. Cosmetics and other chemicals products are also should be controlled as these items are coming in direct contact with the body. But this role can be designated to Drug Administration if required.

g. Providers of services, education, industries especially food, beverage and textiles, private or public, should introduce TQM in practice having valid QC laboratory in operation. Initial investment to introduce TQM is apparently seemed to be high and cumbersome but in the long run the ROI is good enough giving in-built sustainability and profitability to the establishment.

h. In addition to establishing the modern laboratories as declared by the government to serve the fisheries and other food industries by the GOB own, private entrepreneurs should come forward to establish fully accredited laboratories for fisheries, foods and other industrial QAQC meeting international standards e.g. ISO 17025 etc. GOB should promote and support in all respect in substantiating this goal without hindrance. Industries as well Chambers, private and or public universities can help taking initiative in this regard. International community like EEC etc. is now ready to help building these facilities.

i. Understanding that "technical barriers to trade (TBT)" is nothing but an understanding of integrated science, technology and management. There is no alternative without increasing the knowledge base and

developing experts having sufficient technical and management skills from the soil. Only launching intensive educational program immediately throughout the country (from the high school level to higher educational levels) may help in this regard. To develop human resources and to provide technical and scientific assistance to industries as well as to help establishing accredited private and or public laboratories in the country Bangladesh Academy of Sciences can form an Academy of Sciences Committee on Industrial and Laboratory QAQC. This committee may also help introducing countrywide Quality Circles among the people working in the industries at different levels. This Quality Circles concept originated in Japan worked in many developed as well as developing countries including India where it came at least twenty years ago having tremendous success with many instances (Rajasekaran et al., 1989, Murty et al.1989, Sundaram et al.1989, Venkataram et al.1989, Sharma, 1989, Bhargava, 1989, Setty, 1989, Ranganathan, 1989) in quality improvement and adapting quality culture in the industrial arena. This Committee can also work in collaboration with industries, GOB, UGC, private and public universities and research establishments and other foreign groups etc. to introduce academic programs on Industrial QAQC in undergraduate, graduate, postgraduate, vocational and or certificate course curricula. As a part of this human resource development program the Committee can work on teachers training and can host Proficiency Testing (PT) Program/Competition countrywide annually or biannually to help developing competency/proficiency in QC laboratory practices among teachers and students in sciences. Award and or other form of appreciation can be introduced to encourage the academic/laboratory bodies, teachers and students participating the program. Also the Committee can initiate R&D in this area, as definitely we have to start from the early stage of the science education. And the next generation must be tuned to adapt the Quality culture. In other words this very Committee may work as a National Commission on Quality.

Dr. M. Khaliquzzaman of World Bank as main discussant exemplifying the study out come

j. To enhance awareness on quality of products, services and education and to help adapting quality culture among mass people Bangladesh Academy of Sciences may form an Academy of Sciences Consumer Guidance Committee. In collaboration with the media, civil society, industries, universities and or any other group like Consumer Association of Bangladesh (CAB) working on consumer rights etc. this Committee will conduct, publish and disclose survey, scientific study and or monitoring on various commercialized products, services and education having public health, environmental and economic interest. Just like the study we completed hereby, the program held today and promoted by the BAS. The activities of this Committee may be assumed as a kind of Customers' Voice to be indirectly a monitoring process on behalf of general consumer society to keep awake all the stakeholders. It is good to know that GOB has already decided to establish a Consumer Council within the next year, which may assume a similar nature to serve this purpose.

k. Media can play a vital role in having a country with quality culture in industries, services and education sectors to pave the way of ensuring meaningful and sustainable development in future.

l. Finally it is recognized hereby a dire need of a National Commitment to Quality of products, services and education to have an all round improvement. It is also worthwhile to note that the commitment to quality has to generate from the top and move downwards. The reverse will bring nothing but the waste of time and money. The country is already lagging behind to keep pace with the increasing pressure of globalization.

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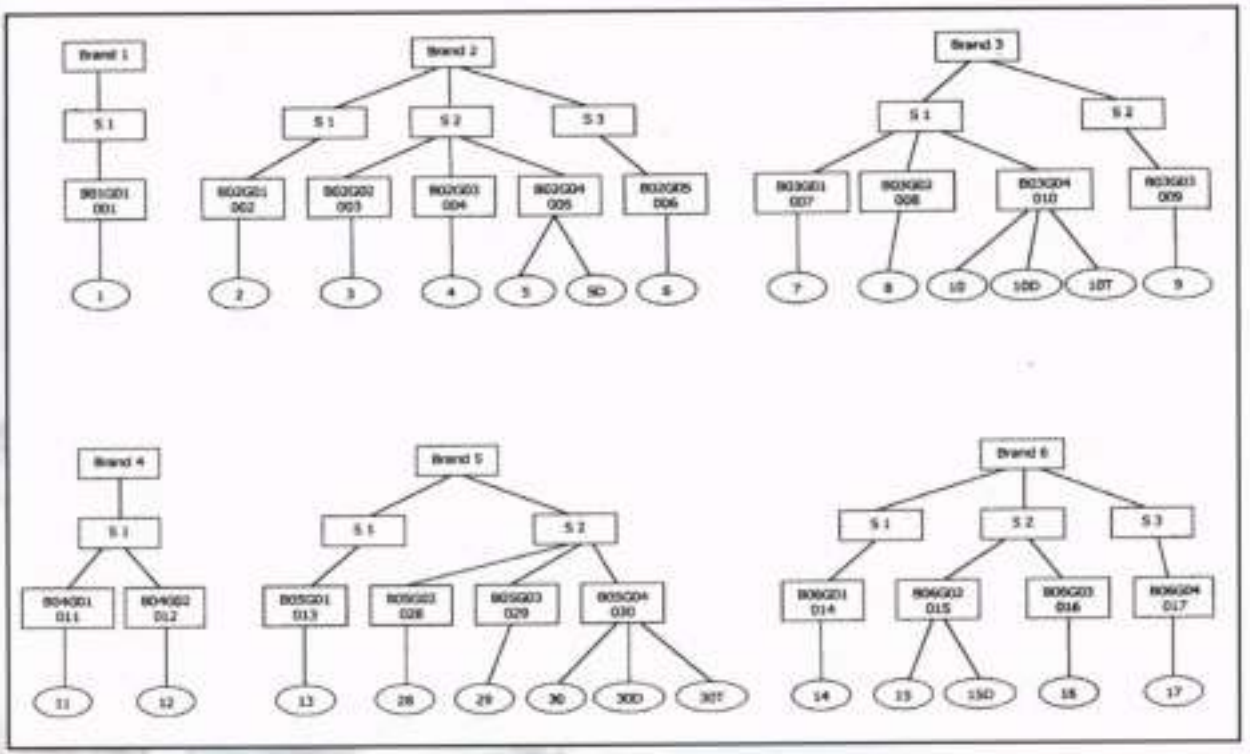
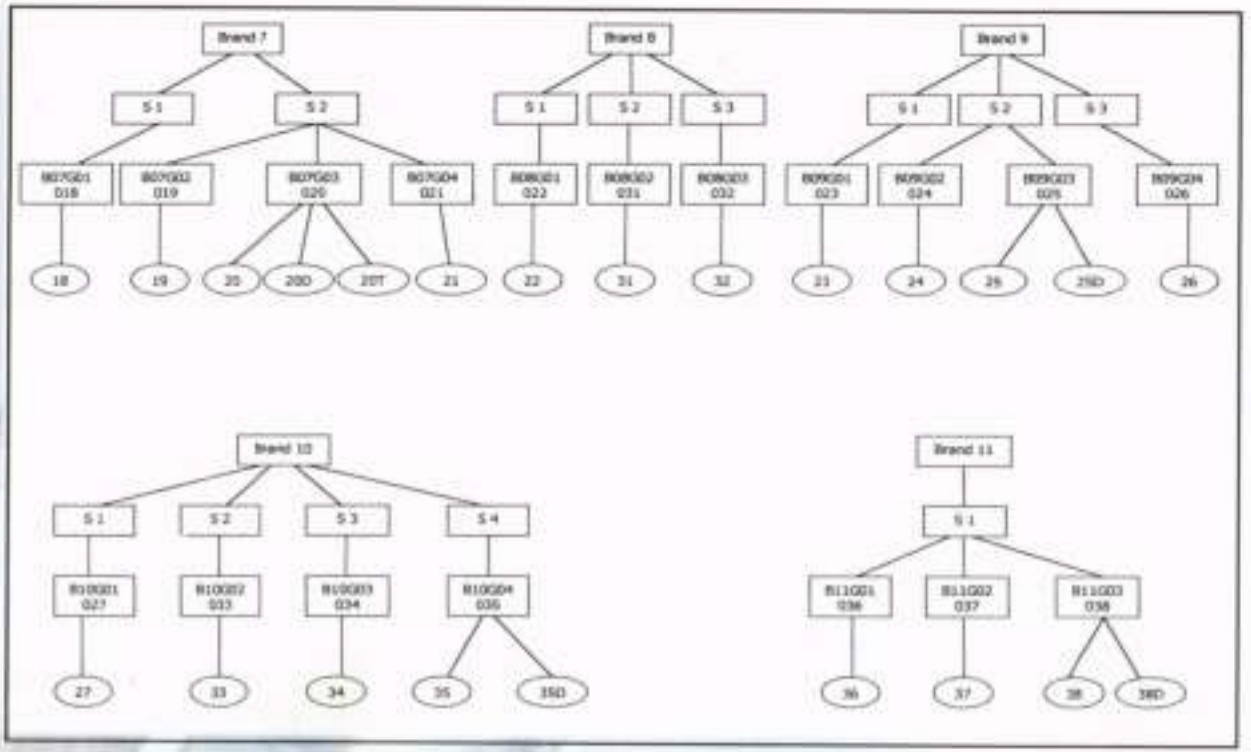
ANNEXURE - A : Sampling Structure of 49 Laboratory Samples of 11 Brands (marketed in single service container ssc) Studied



ANNEXURE - A (contd.) : Sampling Structure of 49 Laboratory Samples of 11 Brands (marketed in single service container ssc) Studied



ANNEXURE - B : List of Commercially Available Bottled Water Brands Surveyed

Brand Code	Brand Name	Product Type	Brand Code	Brand Name	Product Type
B01	Ampeng	sac* & r)**	B32	Sezan	sac
B02	Aqua Mineral	sac & r)	B33	Aqua Fresh	Sac & r)
B03	Duncan's	sac	B34	Alfa Miners	sac
B04	Everest	sac	B35	Savoron	sac
B05	Fresh	sac	B36	Friends	sac
B06	Mountain	sac	B37	Dhaka Drinking Water	r)
B07	Muni	sac	B38	Alpine	r)
B08	Pran	sac	B39	Padma	r)
B09	Samurai	sac & r)	B40	Crystal	r)
B10	Yes	sac	B41	Solve	r)
B11	Trishna	sac	B42	Paani	r)
B12	Shaad	sac	B43	Kawsar	r)
B13	Swad	sac	B44	Reliable	r)
B14	Safa	sac	B45	Shitol	r)
B15	Tide	Sac & r)	B46	Osmo	r)
B16	Pin	sac	B47	Osmosis	r)
B17	Pure	sac	B48	Family Water	r)
B18	Zamzam	sac	B49	Savera	r)
B19	Libra	sac	B50	Choice	r)
B20	Hopper	sac	B51	Abe JamJam	r)
B21	Active	sac	B52	Him Fresh	r)
B22	Polarice	sac	B53	Fountain	r)
B23	Yummy Yummy	sac	B54	Ice Water	r)
B24	Jibon	sac	B55	Acqua Guard	r)
B25	Rasa	sac	B56	Sahara	r)
B26	Miss Acqua Vera [FB] ***	sac	B57	Dolphin	r)
B27	Fu-Wang	sac	B58	Oranta	r)
B28	Sony	sac	B59	CleanUp	r)
B29	Ice Berg	sac	B60	Evian [FB]	sac
B30	Energy	sac	B61	Spinnis [FB]	sac
B31	Today	sac & r)	B62	Aura [FB]	sac

* sac: Single Service Containers: 500 mL, 600 mL, 1000 mL, 1200 mL, 2L, 2.5 L etc. ** r): 20 Litre Refill Jar
*** FB : Foreign Brand. Note: Brands available in the markets are recorded until 02 February 2003

	Total available bottled water brands reported until todate (02 February 2003)	62
	Foreign brands reported (Thailand, France and Italy)	4
	Local brands reported (i.e. produced in Bangladesh)	58
	Brands of water only in single service containers	31/58 (~53.4%)
	Brands of water both in single & 20 L multiservice (refill jar) containers	6/58 (~10.3)
	Brands of water only in 20 L multiservice (refill jar) containers	21/58 (~36.2%)
	Reported total local brands of water in single service containers	37/58 (~63.8%)
	Brands of which inorganic physico-chemical quality studied in the present study	11/37 (~29.7%)
	Brands (single service container sac) on which general survey is conducted	32/37 (~86.5%)
	Brands of which information unavailable & excluded from general survey	5/37 (~13.5%)

Note: For detailed survey results , please refer to Table 6.

ANNEXURE - C: Programme

Date : **02 February 2003 Time: 03:00pm**
Venue : **Bangladesh Atomic Energy Centre Dhaka**

3.00 pm	:	Introduction by Dr. A.M.Chowdhury [Guests take their seats]
3.05 pm	:	Recitation from the Holy Quran
3.10 pm	:	Opening Remarks by Prof. M. Shamsher Ali, Fellow Bangladesh Academy of Sciences, Professor in Physics, Vice-Chancellor Southeast University
3.15 pm	:	Presentation of paper by KM Mostafa Anwar
3.45 pm	:	Discussion by (1) Prof. Kamaluddin Ahmed , Fellow BAS, Professor in Biochemistry. University of Dhaka (2) Prof. Amir Hossain Khan, Fellow BAS, Professor in Chemistry, University of Dhaka (3) Dr. M. Khaliquzzaman, Consultant (Environment), World Bank, Dhaka
4.05 pm	:	Address by the Special Guest National Professor Dr. Nurul islam, USTC
4.20 pm	:	Discussion from the floor (1) Prof. Dr. A. K. M. Siddiq, Fellow BAS (2) Dr. Azharul Haq, MD, Dhaka WASA (3) Prof. Dr. Naiyyum Chowdhury, Chairman, BAEC (4) Lutfor Rahman, BSTI (5) Anisuzzaman, ALPINE Bottled Water Company (6) Md. Selim Jahangir, General Manager, Reman Drug Laboratory Ltd. (7) Masuma Anwar, Libra Infusions Ltd. (8) M.B. Chowdhury, PSO, BCSIR Laboratories Chittagong (9) Sharmeen Murshid, Chairperson, Plasma Plus+
5.00 pm	:	Presentation of Rapporteur Mala Khan
5.05 pm	:	Vote of thanks by Dr. AM Chowdhury, Secretary, Bangladesh Academy of Sciences
5.10 pm	:	Refreshment
5:30 pm	:	Close

ANNEXURE - D: Brief Transcript of the Seminar

Session Chair: Prof. Dr. M. Shamsher Ali

Introduction & Vote of Thanks by: Dr. A.M. Chowdhury

Dr. A.M. Chowdhury: [Introduction] Dear all, I would like to request Prof. Dr. M. Shamsher Ali to take his chair to preside over the session. And also I would like to request our distinguished Special Guest National Prof. Nurul Islam, President of the sponsoring institute University of Science & Technology Chittagong, USTC, and three other distinguished discussants Prof. Dr. Kamaluddin Ahmed, Prof. Dr. Amir Hossain Khan and Dr. M. Khaliquzzaman to take their sits on the dais.

[Guests take their chairs]

To start the session with recitation from The Holy Quran I would like to invite Dr. Mustafizur Rahman, PSO of Bangladesh Atomic Energy Centre Dhaka to recite The Holy Quran.

Dr. Mustafizur Rahman:

[Recitation from The Holy Quran done]

Dr. A.M. Chowdhury: Now I would like to request the Session Chair Prof. Dr. M. Shamsher Ali kindly to make his opening remarks and to continue the session.

Prof. Dr. M. Shamsher Ali : [Opening Remarks] Bangladesh Academy of Sciences BAS is organizing the seminar, sponsored by the University of Science & Technology Chittagong USTC whose President National Prof. Dr. Nurul Islam is on the dais. The interest of BAS on water is very elaborate. We are the first who organized the seminar on arsenic pollution in the country first. Then we also thought that we should be talking about the quality of water that we are drinking in the name of "mineral water", "spring water" whatever it is and we should tell you what are the drinking waters, what are the constituents of drinking water apart from the pure H_2O. What are the standards that has been set by the BSTI ? Are the standards being followed by the industries? If not, what should we do? What are the problems of QA and QC? There are several other problems. Is it right that you go on pumping ground water the only source of water we have and nature takes thousands of years to replenish these natural reservoirs?

These are some of the questions that we should address. And I thought that the Ministry of Commerce and Industry would be happy to start thinking of setting up accredited laboratory and to introduce QAQC. We already know in the three other sectors: the ready made garments RMG, fresh foods & fisheries, the leather, we are suffering because of problems in QA & QC. We are living in a very highly competitive world. So if we want to sell our products to our people or to the people abroad we would have to ensure the quality by adequate measures.

Before giving the floor to the keynote speaker Mostafa I would like to tell you one story. The story is: once US President Kennedy was offered to drink a glass of water. He said: what is the big deal about it and why do you asked me to drink it? [His people] said: this water is produced from the sewerage water. President Kennedy was little hesitant and said: I have to take the water, which is produced from the sewerage water ! [They said:] Sir, your are the President of the USA the most technologically advanced country. You have to drink it because this is the best possible water on the earth. History has it that the President Kennedy drank that glass of water produced from the sewerage water.

Anwar responding to the questions from the participants. From left Dr. A.M. Chowdhury Secretary of BAS, Fellow of BAS & Main discussant Prof. Dr. Kamaluddin Ahmed, National Prof. Dr. Nurul Islam.

Very recently Singapore has refused to pay Malaysia for increased price for the supply of drinking water and Singapore has decided to produce their drinking water from the sewerage water. The point I am trying to make is that the chemistry and engineering are now producing clean water from the surface water .The technology reached such a point that it is giving us a new thought that should we drink water from the underground? And if we do what is its quality and what its quality should be.

Prof. Dr. M. Shamsher Ali along with Prof. A.H. Khan & Dr. M. Khaliquzzaman leading the open dicussion

With these opening remarks I would like to ask the presenter KM Mostafa a favorite student of mine to present the work and the recommendations are being made by Mala khan incidentally both of them are working for Plasma Plus+. They will present the whole work and I am very proud to say that they have done the work at the Laboratory of Plasma Plus+ and they have done it a wonderful job. Over to Mostafa, the floor is yours.

KM Mostafa Anwar: [Keynote paper with title "Study on the Commercially Available Bottled Water in Bangladesh: General Survey Results, Inorganic Physico-chemical Quality and Related Issues" presented]

Dr.A.M.Chowdhury: Among three distinguished discussants at first I would like to request Prof. Kamaluddin Ahmed, Fellow Bangladesh Academy of Sciences and founder Chairman of Department of Biochemistry of the University of Dhaka to discuss the issue.

Professor Dr. Kamaluddin Ahmed: Assalamualikum. In Bangladesh we are facing water quality problem always. In early seventies we struggled with microbial contamination and suffered from waterborne diseases: Diherrhea, cholera, typhoid etc. We take away our look from bacterial contaminated surface and pond water and went on pumping ground water using tube wells. We do not introduce and maintain the quality monitoring process for these practices. Millions of tube wells we sunk so far. Now we are suffering with arsenic poisoning. I visited some areas having arsenic contamination especially in Rajshahi, Meherpur etc. People are dying. Government is spending crores of taka to introduce some kinds of filters etc. I do not believe that what they are doing is enough to solve this sever problem. They are still sinking tube wells

without even testing properly. We have not yet reached permanent solutions on this issue. We are now buying bottled water to save our health but we do not know actually what we are drinking in the name of so called "mineral water" bottled by the manufactures. That we are talking here today and presentation raised a lot of questions in my mind on the subjects. Rightly, the presenter pointed out that our practices in the industries should be strictly regulated and proper quality control and monitoring is a must to save our national health at any cost. It is the right time that BAS has organized this seminar. Thank you all.

Prof. Dr. M. Shamsher Ali: Thank you Professor for your comments. Now I am presenting to you two pioneers and excellent workers Professor A H Khan and Dr. Khaliquzzaman and would like request to make their valuable comments and clarifications on the paper presented by Mostafa Anwar. Prof. Khan is in the Department of Chemistry University of Dhaka. Dr. Khaliquzzaman now is with World Bank. Both Prof. Khan and Dr. Khalliquzzaman were with Bangladesh Atomic Energy Commission for many years where we developed analytical facilities with advanced instruments like PIXES, Van de Graph Accelerator etc. to check the analytical quality of the water, foods and other. They are excellent analytical workers and both of them are well known not only in Bangladesh but also throughout the world for their contribution in the area of analytical sciences. I invite Professor Amir Hossain Khan first.

National Prof. Dr. Nurul Islam delivering speech as Special Guest

Prof. Dr. Amir Hossain Khan: Assalamualikum. Respected President of the Bangladesh Academy of Sciences, distinguished fellows of the BAS, my colleagues from the university and from BAEC, experts and guests present. First of all I would like to thank BAS to invite me on this seminar to be a discussant of the paper on the topic.

From my brief observation, which I would like to mention here that, the presentation has basically raised four vital questions to us. Who is giving me the drinking water? How good is this drinking water? Is it affecting myself? If it is affecting how can I protect my own interest?

The major concern discussed in the paper is regarding the protection of environment. The water is an environmental resource and it is never be adjustable, including ground water. It is such a resource you cannot market it. If we destroy our environmental resources we cannot be able to restore it again to its original form. If we go on pumping continuously the ground water to have our drinking and agricultural purposes we will be loosing this valuable natural resource for good. The authors clearly mentioned from their survey results that almost all (95.7%) 23 out of 24 manufacturers are using ground water as source water and after treatment they are bottling them for marketing. Rightly he mentioned that excessive pumping should be restricted anyway by introducing the regulatory measures to protect the environment. We must consider the using groundwater as source water to be a criminal act.

Ms. Mala Khan one of the authors recording the discussion & recomendations. Dr. Azharul Haq Managing Director of Dhaka WASA is present

Everywhere in the world there are drinking water supply authorities responsible for managing the water supply and their quality. WHO along with UNICEF works globally as per UN Agend 21 on the drinking water issues. In Europe there are nearly 20 private groups are working together and responsible for supplying drinking water to the European Communities, in USA there are AWWA, US EPA and other to handle the water issues. In Bangladesh DPHE (Ministry of LGED), Dhaka WASA, BSTI is the government regulatory body responsible for supplying drinking water in Dhaka and other parts of the country. Actually regarding

the quality control and monitoring issue under the Ministry of commerce and Industry, BSTI is the regulatory body having responsibility and they are the designated authority inside the GoB for commercialized products.

What quality to control ? BSTI have two standards one for drinking water and another for mineral water. According to the BSTI standards there are 34 inorganic, organic and microbiological parameters mentioned for checking the quality of drinking water. In the papers authors studied 22 inorganic parameters. There are some other organic and microbial parameters, which should be reported accordingly to have the complete picture of the quality of the water. And I find that there is no single laboratory in Bangladesh yet to run all these 34 parameters. For microbiological parameters I would say there is only two laboratories: one is ICDDR'B and the other is the Microbiology Department of the University of Dhaka have the proper facilities to run analysis. The authors have rightly mentioned the issue that in Bangladesh there is no accredited laboratory. Even BSTI themselves have no quality laboratory systems to check/monitor the quality of the products marketed. There system is not yet accredited. Once I asked them that you have given the seal on a bottle water brand to be arsenic free do you have the facility to analyze arsenic in drinking water and they answered: no we do not have. This is the condition of BSTI. Then who will work as watchdog?

Of course regarding the quality of the study and the analytical methods, standards used in this study and the QAQC procedures followed by the authors are reliable and good. I have no doubt about their competency and the data quality reported in the study. It is a very good work they have done. I know the Plasma Plus+ as one of the good laboratories in the private sectors trying to do well in this area. Here I have a little comment on the anion-cation balance checking they have used because there are some limitations in applications of anion-cation balance.

Next point is on the management issue mentioned in the paper. I must say that there are two issues to be considered: engineering aspects and chemical aspects. As Prof. Shamsher Ali rightly said that chemistry and engineering both merged here to give us the water treatment technology to its modern advanced phase. Water chemistry and treatment of water is one kind of job and distribution of water to the communities or throughout the country and managing /monitoring the quality is another kind of job to be managed consistently. We have to introduce carefully the applicable technologies with appropriate knowledge and management skill in our industrial practices to protect our health, environment and consumer

rights as well. Appropriate QAQC protocols should be introduced maintained monitored implement without any fail.

The authors also mentioned rightly that the national water policy is necessary to be developed where we have to consider all the natural water resources: lake, river, estuarine and coastal water whatever it is to be managed efficiently and environmental friendly. Everything we have to taken into account for in the policy matter to identify, control and monitor the sources: point and non-point sources of pollutions etc. with due quality management system. Ten years almost gone on arsenic issue. But we do not know why we are still using ground water for drinking with arsenic. Source water must be surface water now. We should address these national needs and scientific knowledge must be updated to tackle the problem we are facing now and the problem definitely will be more sever in future. I have finished everything I had to discuss.

Prof. Dr. Naiyyum Choudhury Chairman of Bangladesh Atomic Energy Commission BAEC taking part to the discussion

I would like to thank you very much for listening to me. I would like to thank actually the scientists of Plasma Plus. And you have done a very commendable job and it is a very good beginning you have made. We will be trying to follow up the findings you have given us today, the points, limitations identified in the industrial practices mentioned in the presentation. They cannot go in future unchecked and uncontrolled and we should also keep watching who is the responsible for monitoring them and for policy matter etc. Thank you very much.

KM Mostafa Anwar answered: Yes I do agree with Khan Sir that without checking microbiological and organic quality of the water the study is incomplete. As our study is going on we must report the microbiological and organic contents in the separate communications, here from the title you will see that we are disclosing in this paper first the inorganic physico-chemical quality of the bottled water.

Prof. Dr. M. Shamsher Ali: Thank you very much for this presentation. I am sure you will be working much more closely with Plasma Plus+ now. Over to Dr. Khaliquzzaman. He is no longer with us [BAEC] but he is with World Bank. World Bank makes interventions some wrongly some rightly. I hope he does help the World Bank making interventions rightly in the health sector that would be very much appreciated.

Dr. M. Khaliquzzaman: Mr. Chairman, honb'le members and fellows of the BAS, colleagues, assalamualaikum. Today I would like to speak in a slightly different way as I have seen many young scientists here.

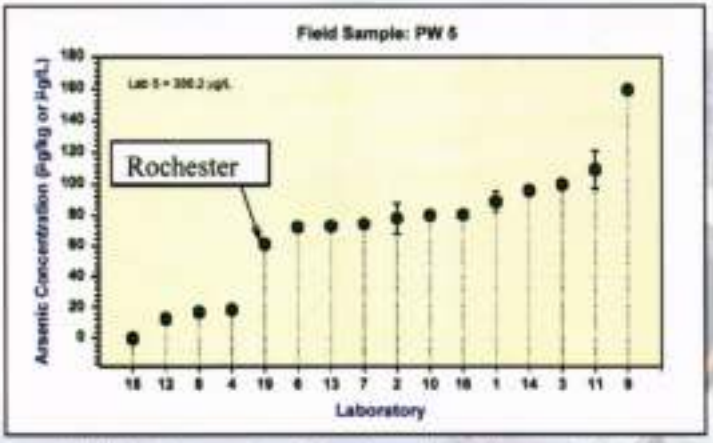
In the study they have analyzed 22 parameters of 11 brands available in the market. Quality of the analytical data declared on the labels is very important point discussed. They have noted the non-compliance with BSTI standards in parameters pH, chloride, nitrate. Actually the higher nitrate values may be from the contamination in the ground water. I would like to mention here that the commercially bottled water in Bangladesh is actually the filtered ground water. According the definition of mineral water they are not "mineral water" at all.

What are the key issues the study discussed? Analytical Quality Assurance. Compliance of the Production to the standards (COP). And how to improve the situation. These are the main three issues raised. To improve the above situation one should do the institutional reform, do better resource mobilization, and to improvement of human resources. Institutional reform is important: if the institution is not right and if one man is changed then whole system would collapse but if the institution is right then from an average quality people the system can produce better results. Last of all you need actions: one action is better than thousand words.

In the study the authors have verified the quality of the data declared on the labels of the brands. They have done it by comparing the concentrations they find in their laboratory. They have compared the data in terms of statistical Z-scores. I would like to explain the concept and application of Z-score little bit to our young scientists as it is not explained in details in the paper. From statistics as you know that the analytical results/data of a particular parameter from a same analytical procedure is distributed randomly and the data followed the Gaussian distribution pattern. Any analytical result or data (say, declared on the bottle's label) away (with error) from the estimated mean (or population mean) can be compare via checking whether the result (value declared on the label) within the 95%CI or 99%CI or outside. Z-Score is the value

comes from the ratio of error (difference between estimated mean and data declared) of the result/data declared on the bottle with the standard error of estimated mean (or population) calculated from a large number of sampling. If the Z-Score for a particular data is within 0 and 1 then the data is reliable, if Z-Score is within 2 and 3 it is acceptable. But if Z value is >3 then it is invalid and it is most likely that the analytical system has severe problems to be corrected and the data is not reliable. From this consideration the study have shown that most (53%) of the data declared by the bottled water manufacturers are invalid and hence not reliable. It is clear that either they have not analyzed or the laboratories where they tested their waters did not followed the proper analytical protocols.

This QA is a problem persisting in our whole industrial areas. The problem also exists in the laboratories. In 2001 WHO and IAEA conducted an inter-laboratory comparison study for the first time in Bangladesh. We analyzed arsenic in potable water to check the performance of 17 laboratories both from public and private sector. Unfortunately it has been evident that there is no single laboratory in Bangladesh having intensive internal and or external QAQC system under the framework of documented quality management system in operation to produce consistent, reliable and valid data. As an example, shown in the graph, we have given them the water with As: 68 g/L. We have obtained the result accurately from the reference laboratory Rochester University to be ~ 68 g/L As. But instead of 68 g/L arsenic all 17 laboratories in Bangladesh produced data from 0 g/L to even 356.2 g/L As. So this is the condition of our laboratories in Bangladesh giving analytical services. The presenter rightly pointed the issue in his paper.



Interlaboratory comparison study shows wide variation in results from the different labs of the country (Khaliquzzaman, 2001)

Then I would like to mention the fact that there is a difference between the WHO Guideline values and the national standards. This aspect is generally not understood properly. We have to set the national standard values from the assessment of the risk benefit ratio and other considerations for the particular country. This standard would be followed strictly by the product manufactures without fail. This is enforceable. But WHO Guideline is to be understood just merely as the guide prior to setting the national standards. It is not enforceable.

According to the definition of "mineral water" it should come out naturally from the spring. But as I mentioned above, in Bangladesh these bottled water brands are not "mineral water " at all, commercialized bottled water in Bangladesh is actually the filtered ground water. Because these people without knowledge take ground water and then do treatment with various technologies: ultrafiltration, nanofiltration with less than 0.2 micron filter, reverse osmosis, ozonization, UV sterilization etc. Using reverse osmosis technique they are actually taking out all the minerals from the water for having TDS far less than 500 mg/L and labeling them as "mineral"(!) water. It is absolutely ridiculous to declaring reverse osmosis and naming "mineral water". Using reverse osmosis and declaring mineral water is not correct at the same time. These are our industrial practices followed! In the study the authors have fond that at least 10 (91%) brands out of 11 brands have TDS values below 500 mg/L. Among them 3 (~27.3%) brands containing extremely low TDS contents to be below 60 mg/L.USFDA defines that if the TDS content of mineral water is below 500 mg/L making statement like "low mineral content" on the bottled water product label is recommended. And in USA you cannot even

High Official from BSTI are present among distinguished scientists, industry representatives & media people

advertise that mineral water is beneficial to the health. Because natural mineral water contains some minerals with profuse in quantity but they may not be essential or beneficial to health always.

Another point I would like to mention here. As water is now a commodity and business in the international market is now rapidly growing it is necessary to introduce the process of product quality rating systems so that the common people can understand the quality easily. As in Romania there are 5 point rating system for bottled water products. If the product gets rating R within 0 and 2.5 it is NOT SO GOOD, if the rating R is within 2.5 and 3.5 the water is GOOD, if R is between 3.5 and 4.5 the product is VERY GOOD and finally if the R is above 4.5 the product is EXCELLENT. This is useful and is international rating system for the products having global market. We should consider the system.

To cope with problems as I mentioned it is necessary to introduce the institutional reform in BSTI and other. Institutions are facing problems with lack of capacity , lack of resources, lack of human resources and lack of professional management. What are the solutions? If BSTI want to do everything they not have the capacity in terms of manpower, in terms of other resources. But other laboratories have the capacity. What they should do? Basically they should certify the other private or public institutions or laboratories having the proper manpower, technology, knowledge for doing the job. Thus the national decentralized capacity can be utilized. Carrier structure should be changed and professional management should be introduced to improve the institutional competency. As an example for controlling and monitoring of water quality in terms of all the inorganic, organic, microbiological, physical and radiological properties there are nearly 80 parameters to be analyzed and which simply impossible from a single laboratory setup.

Compliance of the Productions (COP) to the standard. In industrial practices it is necessary to introduction of standard practices and concepts: implementation of ISO procedure, introduction of water rating system, application of protocols as stated in HACCP, introduction of Total Quality Management TQM. And to achieve the above improvement the introduction of effective government regulation is a must. The authors rightly pointed out towards the TQM. It is not mysterious at all. This is basically a management system to be introduced where all the problems within the production process are identified and listed. The most serious problem is at the top of the list. Using the rule "SLAY THE DRAGON FIRST" the problem is removed from the process. Gradually all the problems down the list are removed by taking the corrective measures.

To do the job there are various tools: Ishikawa Diagrams, Fishbone Diagram, Pareto Charts etc. to be used.

Finally we should gain wisdom on water handling because:

" All Water has a perfect memory and is forever trying to get back where it was

" We will only know the worth of water when the well is dry.

" If water is too clear it will not contain fish: people who are too cautious will never gain the wisdom.

Thank you very much.

Prof. Dr. M. Shamsher Ali: These are what matters. And let this is done and your [pointing to the BSTI people present at the seminar] seal will not be taken seriously. Any body wants to discuss will be allowed. We are washing dirt (dearth) from our own. We are not washing the other peoples' scores we are washing our own peoples' scores and we should do that. This is our own country. Of course you [pointing to the BSTI representatives] will have the chance to say. And before that I think today's sponsor National Prof. Dr. Nurul Islam, you have something to say.

National Prof. Dr.Nurul Islam: Dear President of Bangladesh Academy of Sciences, Fellows & Members of BAS, dear discussants and friends.

Dr. A.M. Chowdhury Secretary of Bangladesh Academy of Sciences conducting the seminar

If sponsorship is only qualification to be a discussant than I am safe. Because sponsorship means bring some money and spending them and nothing else to do. But If as a doctor I am considered to be one of the discussants then from me a very brief comment should be.

Firstly, I was upset and was in depress when I heard about the paper that all the analysis is done on physical and chemical constituents of bottled water. And I was frightened because at the right of me is the most prominent man [pointing to Prof. Dr. Kamaludin Ahmed] in biochemistry and at the left the man [pointing to Prof. Dr. M. Shamsher Ali] of physics and at the middle I am the man of medicine. Somehow the discussants influenced me to say something.

It is a very important topic no doubt. Because no body can be alive without water. That water is to be safe. Safe water has applications and it is useful. Safe water can cure diseases. Unlike water drug can cure diseases and also can kill. When we first introduced the drug policy in 1982 we have addressed some issues which have been discussed in the today's seminar. We have clearly mentioned the need of the quality control and quality assurance in the production of pharmaceuticals and water as well. For pharmaceutical industries some criteria have been set to produce the safe water with controlled constituents beneficial for health. In Bangladesh what I find? I find that a phenomenal development in the water industries specifically in the bottled water industries. As mentioned by the discussant one can easily realize from the taste that the bottled water is nothing but the tube well water. And also just from the naked eye observation you will see that the iron deposition is there. People are getting water with the cheapest prices in 20 litre jar or bottle.

As doctors we do always work in the area of drugs, pathogens, diseases, illness, life, and death etc. and sometimes I was in thought that I should analyze the constituents of these waters we are consuming as bottled waters etc. And we should have proper guideline and standards for the water industries for the way they collect, for the way they process and for the way they bottle them. We should have due regulations and monitoring for these industries. QAQC is the most important and also difficult thing in our country to be introduced. Similar to the drug industries we should have to introduce the culture. I do not know that to what extent the BSTI have their capacities to handle the issue of QAQC of the industries. They should work more as a regulatory body and testing should be decentralized to utilize the capacities of other institutions, public and private laboratories, and universities. Similarly the drug-testing laboratory should work to utilize the capacity of the other and the testing should be

distributed to the universities. I believe that all the universities would take the responsibilities to achieve this goal also.

Bangladesh Academy of Sciences is doing good things by introducing the systems. I think it is a very good beginning of a great work. Nothing is perfect. I do not want to criticize the industries. They have done some good things for our country and they will learn more to protect our health. Definite policy should be there. Firm determination with political will is essential for this, many good things can be done if we have the proper political will. We do believe that we all will work together to have a water policy to have the safe water for all. We do not want to say: Water Water Everywhere Not a Drop to Drink. We want to to say : Water Water Every where a lot of Drops to Drink. Thank you all.

Prof. Dr. M. Shamsher Ali: Yes I have seven people to say something from the floor. Of course I would certainly like to have BSTI people to react and should make comment if there is any factual errors made in the paper presented here. So first Prof. A.K.M. Siddiq Fellow and President of Bangladesh Academy of Sciences.

Prof. A.K.M. Siddiq: The topic discussed in this program is really a very important one. I am very glad to mention that I did not realize that the response would be so great. In this seminar we are talking of a very vital issue of our life. We say "Paneei Jibon" "Water is Life". It is good that BAS has timely organized this seminar with a support from National Prof. Dr. Nurul Islam the President of USTC. The primary responsibility goes to the government to supply pure water to the people. And they supply the tape water. In Europe or in America you can have the tape water with out any hesitation they are safe for your health. But in Bangladesh it is not. Now we are talking of bottled water or we call it as "mineral water" whatever it is commercially available in the market produced by the manufactures. Is it safe for drinking? We do not know the quality of these products. It is very good that BAS initiated this kind of program to address the issue. Although the BAS does not have its own laboratory for doing analysis but BAS can obviously cooperate with the other universities for working in this field. I would like to thank all my colleagues who organized this important program , and I am thanking the sponsoring authority and thanking all the participants for their cooperation. Thank you very much.

Prof. Dr. M. Shamsher Ali: Now the Managing Director of Dhaka WASA.

Dr. Azharul Haq: I am Azharul Haq the Managing Director of Dhaka

WASA. I am not qualified enough to make any comment on the presentation made here and probably I am representing the suppliers of the most contaminated (!) water in the world. With due apology I would say: in the bottling industries it is confirmed and reconfirmed over and over again that none of the 37 brands bottled water manufactures in Bangladesh meets all the quality parameters that is required to make the water fit for the human consumption. As I lead these groups with an apology to the consumers I would like to mention that there is an urgent need of a regulation from a very strict quality regulatory body to ensure the quality of water in this country whether it is in bottle or it is in the pipe. People cannot survive in the country like Bangladesh where the price of one litre of water is much more than that of one litre of diesel.

Prof. Dr. M. Shamsher Ali: Now over to Dr. Naiyyum Choudhury, Chairman of Bangladesh Atomic Energy Commission BAEC. He is our host has given us this auditorium.

Dr. Sultanul Aziz & other participants from Bangladesh Atomic Energy Commission

Prof. Dr. Naiyyum Choudhury: Dear President and colleagues. We are talking of quality. We are talking quality water, quality drug, quality shirt, quality foods, quality husband, and quality wife. But we must not forget the fact that how much money we can afford to pay for the quality. We are here raising questions against the ground water usage. We must not forget the time in early seventies when we were suffering from water borne diseases like diarrhea, cholera etc. Millions of lives were taken away by these killer diseases. We had to move towards ground water. Now we have to think of safe water at least free from bacterial and arsenic contamination. Our industries have done many good things we

should appreciate them. As National Prof. Islam said that they have at least supplied drinking water free from microbes using less than 0.2 micron filtration devices or reverse osmosis etc. We should think all these. Yes many things to be improved no doubt about it. Another point I would like to mention that one of the discussants Prof . Khan has mentioned that there are only two laboratories in Bangladesh have the facilities to run microbial analysis. But I do not agree with him there are many other laboratories: BCSIR, BAEC, AERE, many private laboratories can do analyze microbiological tests. Also it is true for organic or inorganic analyses. There are a number of public and private laboratories providing good services in the analytical area. It is not possible at all for a single laboratory to run all the analyses from same facilities for all chemistries. Nowhere in the world such kind of laboratory is established. It is not also the right concept that BSTI should have all the laboratory facilities to do the all sort of analyses: chemical, physical, biological for foods, drinks, fisheries, textile, ceramic, leather, paper, electrical, electronics, metallurgical samples. You have to be selective. Also Prof. Khan mentioned that all parameters to be analyzed. There are so many parameters and so many samples. Think of analyzing residual pesticides in foods let alone the cost of instrument and or the cost of expertise, the cost of reagent is so high that it is not always possible to do the analysis. You have to be very selective.

Dr. Khaliquzzaman mentioned that there are nearly eighty (80) parameters for drinking water quality monitoring. Therefore BSTI should better play the role of a regulatory body and they should certify other laboratories. This is the way to utilize the decentralized capacities of the country. It is necessary to have proper guideline and policy to handle these very important issues. In these type of discussions we should also discuss on safe water not only bottled water. We should talk of other water and environment related problems to save our community. Thank you very much.

Prof. Dr. M. Shamsher Ali: Now the representative of BSTI

Lutfor Rahman from BSTI: First of all I would like to let you know how BSTI works. All the standards are prepared and set by the respective expert committee where experts: scientists, professors and renowned persons from all the research institutes and universities from all over the country are present. We have two standards: one for drinking water and another for natural mineral water. It is our honest confession that we do not have sufficient manpower and we have only 15 field inspectors for monitoring quality of all the products throughout the country.

When any group comes to BSTI for permission with a proposal that they want to establish, say, a mineral water factory. Our inspector visits the industry and firstly he checks the environmental issues: whether the industry is creating any problem to the environment or not. Then he takes water samples randomly and we analyze them at the laboratories of BSCIR, Dhaka University and DPHE. As we do not have the sufficient facilities we do rely on these three laboratories mainly for analyzing samples. Then we certify the industry if they meet the quality criteria. So far we have given license to 47 manufactures for bottling drinking water. We do check whether they have the trade licence, trade mark. And on the label they must use the BSTI Certification Mark with the Standard numbers BDS 1240 or 1414 at the bottom of the BSTI mark.

Here I would like to say that Mr. Anwar wrongly pointed out that the license number should be mentioned on the label. On the label there is no provision for mentioning the license number, issue date or expiry date of the license number.

Apart from this according to the BSTI standards it is mandatory that on the label full address of the manufacturer should be printed clearly.

KM Mostafa Anwar answered: I do not agree with your statement. Please refer to your BSTI Standard BDS 1414: Section 7.4: page 8 where it is clearly mentioned that "Each container may also be marked with BSTI Certification Mark with license Number and the dates of the issue and expiry". Unfortunately in our survey we have seen that not a single Brand is following this Section 7.4 of BSTI standard BDS1414: 2000 for whom it is applicable. And also we would like to pointed out that from our survey it is evident that out of 32 Brands 26 brands ~81%) have not declared at all full address of their manufacture or plant or customer service department. This another clear example of non - compliance to the BSTI Standards

Prof. Dr. M. Shamsher Ali: In front of you on your table there is a bottled water can you show us that they have maintained your standards. Have they declared the expiry dates? Is there any BSTI Mark, License number, full address on that label? What is the standard number it follows?

Lutfor Rahman from BSTI: [Taking and checking the Bottled Water] No Sir there is no expiry dates. Yes BSTI Mark Seal is there but no license number. BDS1414: 2000. No address is on the label. BDS 1414 is for natural mineral water.

Prof. Dr. M. Shamsher Ali: BSTI Mark is there means you certified them. If they do not follow your standard then why do not you ban them? Why do not stop certifying? Are they decaled the source of water? Why they are not giving the address in full on the labels? Why they are maintaining such secrecy? Why do you allow them to call them as natural mineral water? So far I know in Bangladesh there is no natural spring , hot spring, thermal spring etc. with drinkable quality water. Madhavkunda and Sitakunda are the only springs in Bangladesh but the waters from them are completely undrinkable and bacteria infested. Then how these people make statement on the labels: "it comes naturally" or "from natural spring owned by the company"?

One Person from the Floor: We want to know the origin of these waters in bottles. From where these people are marketing or producing such waters, we want to know the address in full on their labels. Why your BSTI is not acting properly to maintain the standards set by you?

Lutfor Rahman from BSTI: In BDS 1414: 2000 water from direct drilled deep tube well is allowed to be considered as natural mineral water. Sir, the top scientists and experts of the country prepare these standards, BSTI people do not prepare the standards themselves. On implementing we have so many limitations. We have to work within a very limited legal framework with limited manpower and facilities. Only 15 persons cannot control the millions' activities. Little actions we can take against these

Prof. A.K.M. Siddiq President Bangladesh Academy of Sciences informally interacting with one of the Authors HQ Chowdhury, K.M. Sultanul Aziz & S. Munshid

manufactures. We are given legal power only to file a case against them and in the court they can pay a penalty maximum of Taka 2500 and after three years they can be again free. There are nearly 125 cases filed against the manufacturers but the judicial process takes two, three even four years to settle one case. All blame should not go only to BSTI and all responsibilities should be shared by the other various organizations not playing their respective roles. Apart from BSTI there are City Corporation, Dhaka WASA, DPHE, Department of Environment and other government bodies to be responsible. Media can play a vital role. Honestly speaking, we are trying our best to have a collaborative effort with these organizations to cope with the problems and to improve our conditions. We are also utilizing radio, television, newspapers, electronic media to create mass awareness among the consumer regarding the quality etc. We must seek your cooperation in terms of all.

Prof. Dr. M. Shamsher Ali: Thank you. Then he has mentioned and agreed on the issue. Once I was with BSTI to develop their organogram and arranged 40% incentives for their people working in this area. There are many limitations and also it is true that BSTI is the only organization we have to make them powerful enough. All out support we should provide towards them for strengthening these very institution so that it can play its vital role effectively for the betterment of the society. Now the chance should be given to one of the bottle water company representatives present here.

Annisuzzaman, Bottled Water Manufacturer Alpin Brand: We are marketing actually 20 litre refill jar not the single service containers .We received the invitation letter lately.

Firstly, here on this occasion discussions are going on regarding the commercialized bottled water. Many advices and suggestions are given here. But we would be happy if the manufactures were invited and the experts and scientists would talk to them closely on the subject. Then the industries could realize their drawbacks, limitations etc. and later they could upgrade their quality.

My second question is to Dr. Khaliquzzaman. He mentioned that ground water with minerals is not always good for health. Why? I do not know actually what is bad thing what is good thing in the ground water. In our factory of ALPINE we can not take the minerals individually by selection. We do take them all out of the ground water and make them mineral free first as such pH becomes low. And then to increase the pH we do inject some minerals to restore the taste of the water. Therefore we call them

"purified water" we do not call them "mineral water". Actually I do agree with you that all over the world these type of treated water is called "purified drinking water", but only in Bangladesh we do call them as " mineral water".

It is my opinion that we would be happy if the scientists, experts in BAS can sit together with the manufacturers so that we can improve our quality etc.

S. Murshid of Plasma Plus+ thanking all

Prof. Dr. M. Shamsher Ali: Mostafa can you explain why the bottling companies are not present? Are they not invited?

KM Mostafa Anwar: In our survey we have clearly mentioned that we have so far recorded 58 bottling brands available in the market. But among them 80% did not declare their full addresses on their labels.If there is no address then how can we reach them? Using yellow pages and other sources we have tried our best to identify their locations and we have invited them although the number is a few. And here we see that people from Pran, Alpin, Libra are already present here, although the number is a few.

Prof. Dr. M. Shamsher Ali: OK. One person from the manufacturers said and he is fairly representing them. We appreciate that he is very sincere. BSTI is also sincere. This is only the beginning. We will do the series of investigations. This will not going to end here. In the interest of public health the BAS is going to have a Think Tank of the government. We will sit with all the recommendations. We must sit together with all parties, manufacturers, and organizations to discuss the issue for the improvement and for the betterment of the society. This is a kind of brainstorming we did. It is just a beginning.

I would like to thank Sharmeen Murshid, Chairperson of Plasma Plus+ and HQ Chowdhury, Director of Plasma Plus+ are sitting silently in the audience. They are so nice. This wonderful study has been done at the laboratory of Plasma Plus+. They are businessmen. But they have sponsored the research and have come forward in doing such a research. I think it is a wonderful step and this should be highly appreciated. Now Md. Selim Jahangir from a pharmaceutical industry please go ahead.

Md. Selim Jahangir, General Manager, Reman Drug Lab.: I am extremely grateful to you, Bangladesh Academy of Sciences for giving me the opportunity to say some thing on the issue.

Being a Pharmacist and a Plant Manager of a pharmaceutical industry I have a number of points to make on the subject and paper presented by my friend Mr. Mostafa Anwar. Rightly he pointed out that in Bangladesh pharmaceutical industries have earned wide experience on implementation of QAQC in their industrial practices.

It is the only industrial sector, which is matured enough in introducing and practicing quality management system in the industrial production processes. Due to the development of the drug policy in 1982 under the leadership of National Professor Nurul Islam [today's sponsor] this industrial sector earned a huge improvement in the last 20 years. In Bangladesh we have nearly 250 pharmaceuticals now and among them above 20 have shown good performance in capturing the overall market share from home and abroad. We are producing live saving drugs and we do also follow some definite criteria producing drinking water beneficial for health. Without water and controlling quality of that water we cannot imagine the production of pharmaceuticals. We have guideline and standards as per say USP, BP to be followed for production of pharmaceutical grade water, water for inject WFI and also drinking water.

From our experience it is clear that to have the QUALITY practices in the industries there is no alternative without having a National Water Policy similar to the drug policy. We are taking drugs only when we are sick but we are taking foods and water three/four times a day. We have a good Drug Policy but surprisingly we DO NOT HAVE a food and water policy yet ! We do not know what we are taking everyday in food and drinks. Only BSTI cannot do this job. There should be a separate Food and Water Administration. In USA you see that Food and Drug Administration is a single organization. My friend Mostafa clearly and rightly mentioned this issue in his paper. Strictly regulated Quality Management System should be introduced immediately for water and food industries. We are ready to share the knowledge and experience gained from the pharmaceuticals to help developing this sector having vital health importance.

Another important point which my friend Mostafa noted in his paper: almost all bottling company are using reverse osmosis, ultra filtration, nanofiltration etc. to take out all the minerals and bringing the TDS value much below 500 mg/L. Their hardness values are much below 60 mg/L. These brands are almost mineral free, demineralized type. Continuous consumption of this mineral free water is not good at all for health.

Especially those whose are suffering from cardiovascular diseases and mineral /iron /calcium deficiency. To control the quality of water this type of industrial practice should be stopped. To have safe water free from bacterial, arsenic and other organics contamination, we should not go for ground water and should not use reverse osmosis etc. to treat them. We should rather introduce simplest technology to harness our plenty of surface water and rainwater. If the treatment makes the water mineral free, then we have to add some minerals to control pH, taste, TDS etc. Proper fortification and mineralization should be done to have the safe water. We do working on rainwater harvesting where we have seen that some nitrate contents are there above the safe limit but it is pathogen free. As because rainwater is naturally mineral free therefore we are fortifying them with mineral before bottling and consumption. We must appreciate BAS for organizing this seminar and we would be happy to work with them on developing, promoting our technologies and sharing our knowledge and experiences with other industries. Thank you all.

Prof. M. Shasher Ali at a follow-up dicussion among authors & industry representatives from ACME Pharma, Essential Drugs Co., Navana Pharmaceuticals

Prof. Dr. M. Shamsher Ali: To the representative from another bottling company.

Masuma Anwar, Libra Infusions Ltd.: Thank you all. I am a pharmacist working with Libra infusions Ltd. Libra Is producing bottled water strictly maintaining its quality following standards. We have our quality management system. We can assure that we have both the QA & QC department where quality policy is followed properly in our whole production process. And I would like to say that BSTI is not only organization responsible for this water quality monitoring issue. Other

organizations like WASA should also be responsible. I would like to say that the bottled water brands some times have their expiry dates on the cap at the top. Checking microbial contamination is very important. And my request is for bottling company BSTI should not issue any certificate, license if they do not have proper QA & QC department at all. Thank you.

M.B. Chowdhury, PSO, BCSIR Laboratories Chittagong: I have three important points to say. One is regarding the sampling practice followed by BSTI. When they send bottled water to our BSCIR Lab for testing microbiological quality they send us only one sample. But to have quality, reliable and valid data they should send us ten samples from different batches. But they do not follow their own sampling method stated in their standards.

Second thing I would like to share information gained from my observation on the microbial quality of the spring waters from Sitakunda and Madhavkunda. By definition, spring water is the actual mineral water. There is no spring water in Bangladesh from where we can have quality drinking water. In our BCSIR Chittagong laboratory we have tested this natural mineral waters (from the springs) where we have seen that there are 500 to 600 cfu fecal coliform present and the water is turbid and cannot be used as drinking water directly without treatment.

Third point is on the comment from Prof. AH Khan. I would say that we have also a very good laboratory in BCSIR Chittagong to test the microbiological parameters. Thank you.

Prof. Dr. M. Shamsher Ali: Over to Sharmeen Murshid, Chairperson of Plasma Plus+.

Sharmeen Murshid, Chairperson, Plasma Plus+: Assalamualaikum. Thank you Mr. President. It is too complicated for me to make any comment on the study or on the parameters regarding the quality assurance and quality control. We do not want to point the finger towards any body responsible. We wanted just to create awareness among us and to realize the urgent need of TQM system. We need improvement in every sector and we are in need of introduction of Total Quality Management system for the industrial practices. It is necessary not only in the water sector only but also in other sectors. Water is just an example we discussed as a case study. We would like to thank Prof. Dr. M. Shamsher Ali of Bangladesh Academy of Sciences. We would like to

thank National Prof. Dr. Nurul Islam of University of Science & Technology Chittagong, distinguished discussants and all in Bangladesh Academy of Sciences for giving us the opportunity to present this study. Thanks to the authority of Bangladesh Atomic Energy Commission for providing us the auditorium and its infrastructure. Thank you all.

Prof. Dr. M. Shamsher Ali: Now it is clear that our proverbs and wise sayings are going to be wrong (!) with time because "Paani Moteii Sojaa Naa" : understanding water is "not simple" and "Paanir daamoo kom naa": water is "not cheap" at all. We have to be very strict that we must stop over pumping our ground water and we should not destroy this invaluable natural resource. It will take thousands of years to have this underground aquifer with its original conditions restored. Now we are facing arsenic problems. Deposition of calcium and mineral degrading the soil quality due to cementing effect. Land subsidence is now becoming a frequent event. In Bangladesh we have plenty of rain and surface water why we could not yet solve our drinking water problems utilizing this natural resources. Whereas the advanced water treatment technology reached the such a point that even from sewerage water we can produce clean drinking water then why we are still depending on ground water both for drinking and irrigation purposes. Why we are not utilizing rainwater? If we cannot have an integrated national water policy to consider all these issues then what will happen? Earlier time we thought only for controlling microbes, subsequently went on sinking tube well. Now we are thinking only to solve arsenic issue to give a short term solution. In future new poisons say, Na, or Ba, or K or other unknown things may hit us severely. By having partial solutions we will go on damaging our environmental resources one by one. We must think all these matters as a whole. If there is no alternative without using ground water certainly we have to have a proper policy to maintain the quality of this groundwater resource anyway.

That is all. We will summarize all the recommendations prepared by Mala Khan and will sit together with all concern. We will talk to the bottled water industries, to BSTI, to the government. Bangladesh Academy of Sciences will do the follow up investigations future to work as a Think Tank of the Government. Thank you all participants, thank you.

Dr. A.M.Chowdhury, Secretary, BAS: [Vote of Thanks] Thank you Mr. President. On behalf of BAS I would like to thank the presenter of the keynote paper Mr. KM Mostafa Anwar and rapporteur Ms. Mala Khan for they have conducted this important study. We are grateful to our Special Guest and sponsor of this seminar National Professor Dr. Nurul Islam of University of Science & Technology Chittagong USTC for his presence to

grace the occasion and his support. I would like to thank all the distinguished discussants: Prof. Dr. Kamaluddin Ahmed Fellow BAS, Prof. Dr. AH Khan Fellow BAS, Dr.M. Khaliquzzaman of World Bank for their valuable discussions on the issue. I am thanking also our distinguished Fellow Prof. Dr. SZ Haider, present in the seminar, for he has spent his invaluable time to edit and review the paper thoroughly with utmost care. I am thanking President of BAS Prof. Dr. A.K.M. Siddiq. We are grateful to Prof. Dr. M. Shamsher Ali for his continuous support and help organizing this seminar. BAS is thankful to Dr. Naim Choudhury, Chairman, Bangladesh Atomic Energy Commission as a host of the seminar at BAEC he has given us permission to use the auditorium. We are also grateful to Sharmeen Murshid and Mr. HQ Chowdhury of Plasma Plus+ and AQ Chowdhury & Co. for they have financed the research to run the analysis at their laboratory. We are thanking all the discussants, Fellows & Member of BAS, representatives from BSTI, representatives from bottled water companies and pharmaceutical industries for their sincere comments, discussions and participation. You have made this event live and successful. We see many friends from news media, ministries and pharmaceuticals are present here and they have also made this event a memorable one. We are grateful to them and thanking hereby. I am also thanking all officers and staff of BAS and BAEC those who worked hard for organizing this seminar. And finally I am thanking you all participants, distinguished guests, fellows, professors and scientists from different organizations, officers from ministries and others for your kind presence. Thank you very much. After this session you are invited to have refreshment.

[End of Session]

Prof. M. Shasher Ali at a follow-up dicussion with Mala Khan & KM Mostafa Anwar

ANNEXURE- E: Editorial published in the national daily The Bangladesh Observer n 04 February 2003

THE BANGLADESH OBSERVER
DHAKA TUESDAY FEBRUARY 4 2003

Overcoming Technical Barriers To Trade

The Bangladesh Academy of Sciences organised a seminar on Sunday, showcasing a study on the physico-chemical quality of commercially available bottled water in the country. Sponsored by the University of Science and Technology, Chittagong, the keynote paper questioned the validity of the declared data and specifications on the bottled products. But it was done, as the organisers were quick to point out, not so much to condemn those selling such water, nor to castigate those testifying to their quality, but rather to subject all stakeholders to honest scrutiny, brainstorming, as it were, in the hope that it will help us wake up to the merciless demands of globalisation.

This is an imperative if we are to measure up to the WTO Agreement on Technical Barriers to Trade and the Agreement on Sanitary and Phytosanitory Measures (SPS), by the year 2005, when all preferential treatment towards least developing countries like Bangladesh are set to go. The study, which is the result of over a year's work by scientists of Plasma Plus, a private application and research laboratory dedicated to analytical sciences, instrumentation and laboratory management systems, presented findings with reference to 22 inorganic physico-chemical parameters. These were tested, avowedly, with strict adherence to established 'QA/QC protocols throughout the analytical process so as to produce valid, reliable and comparable data'.

In most of the samples tested, the data and specifications on the labels were found to be 'inconsistent and unreliable'. Many did not even have the address of the producer nor an expiry date and almost all companies bottled ground water. We are told, only 39.5 per cent of data was valid as per the lab's QA/QC system, which, needless to mention, is internationally recognised, and this fledgling facility has been advocating the system for every lab worth the name.

If we educated ourselves thoroughly and acquired the means and methods of internationally accepted standards, and understood the necessity of introducing applicable Industrial Quality Assurance and Quality Control (QA/QC) under a Total Quality Management framework, we could easily avoid the kind of crises that our shrimp or ready made garments export face from time to time on account of delivering unsatisfactory quality.

The paper pointed out that earnings from shrimp in 1997-98 went down by US$18.18 million compared to that of 1996-97. Around the same amount was lost in 1998-99 compared to the previous year, bringing the total loss in two years to US$37 million. Other export items suffered as well when we lapsed from our buyers' standards of quality from time to time. With world class quality assurance and control mechanisms in place, and applied to all tradable products and packages manufactured in Bangladesh, we could avoid such unnecessary hurdles. And that was precisely what the BAS was advocating through this seminar on water quality.

With respect to exploiting water sources, both for piped supplies and bottling, it called on the govern-

ANNEXURE - F: List of Invited Guests, Discussants & Participants

Session Chair: Prof. Dr. M. Shamsher Ali

Special Guest: National Prof. Dr. Nurul Islam

Keynote Paper : Mala Khan, KM Mostafa Anwar, HQ Chowdhury

Editor : Prof. Dr. SZ Haidar, Fellow BAS

Main Discussants: (1) Prof. Dr. Kamaluddin Ahmed, Fellow BAS

(2) Prof. Dr. AH Khan, Fellow BAS

(3) Dr. M. Khaliquzzaman, World Bank

Discussion from the floor by:

(1) Prof. Dr. A. K. M. Siddiq, Fellow BAS
(2) Dr. Azharul Haq, Managing Director, Dhaka WASA
(3) Prof. Dr. Naiyyum Choudhury, Chairman, BAEC
(4) Lutfor Rahman, Bangladesh Standards & Testing Institution BSTI
(5) Anisuzzaman, ALPINE Bottle Water Company
(6) Md. Selim Jahangir, General Manager, Reman Drug Laboratory Ltd.
(7) Masuma Anwar, Libra Infusions Ltd.
(8) M.B. Chowdhury, PSO, BCSIR Laboratories Chittagong
(9) Sharmeen Murshid, Chairperson, Plasma Plus+

Vote of Thanks: Dr. A.M. Chowdhury , Secretary, BAS

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