



Micro-Biological Contamination of Drinking Water in Western Delta of West Godavari District, Andhra Pradesh, India

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Available online at: www.isca.in, www.isca.me

Received 27th October 2015, revised 19th September 2016, accepted 12th October 2016

Abstract

Drinking water contamination with micro-organisms is a big problem to the people. Most of the diseases are due to water contamination. The major health problem in developing countries is the diarrhea. Other health problems are typhoid fever, cholera and bacillary dysentery. The main contaminant in the drinking water is fecal matter of human and other animals. Fecal indicator bacteria are measured to know the biological contamination of drinking water. Total coliform are the standard by which microbial contamination is measured. Some of the microorganisms present in the water are *Escherichia Coli*, *Cryptosporidium*, *Anabaena*, *Rotifers*, *Copepods*, *Vibrio*, *Salmonella*, *Shigella*, *Helminthes* etc. which are responsible for various health problems. Their cysts and eggs are also causing various health disorders. Chlorine is generally added to drinking water as a disinfectant to kill the pathogenic bacteria. Improper treatment, insufficient dosage and lack of proper maintenance of distribution pipes in many villages and towns make the public water unfit for drinking. In this study to know the presence of microbiological contamination of treated drinking water; the parameters measured are- Most Probable Number (MPN), Total Fecal Coli form (TFC) and *Escherichia Coli* (*E.Coli*) of water supplied by public and private systems to consumers. The results of the present study shows that only 23% of the Public treated drinking water samples (Panchayat and Municipalities) are fit for drinking with zero MPN values. Even most of the water samples supplied by private organizations including Non-governmental organizations are also not very safe and only 28% are found to be free from pathogenic bacteria. The mineral water supplied by various organizations after processing through Reverse Osmosis, UV light treatment, Ozonization etc., is also found to be unable to meet the national or international standards in terms of pathogenic bacteria. So resource management, proper treatment and good maintenance of piping system, above all a strong commitment to supply potable water to public are need of the hour. One of the major challenges of the twenty first century is to provide safe drinking water for all.

Keywords: Drinking Water Quality, Micro-Organisms, Cyano-Bacteria, Pathogenic Bacteria, Most Probable Number.

Introduction

Of all the natural resources water is the most important resource. Water is essential for all living beings (all plants and animals), health of public and improvement of economic prosperity. Potable water supply is a main problem throughout the world. The water potability is achieved by proper chlorination. Coliform estimation clearly conveys the drinking water suitability and its safety. But there is no guarantee that coliform free water is free from pathogenic bacteria. At present approximately 20% of world population lacks access to safe drinking water, and nearly half of the world population lacks adequate sanitation^{1,2}. If everyone had safe drinking water and proper sanitation facilities at least 200 million people may be saved from death.

It is the bacteria and pathogenic organisms in drinking water that causes health problems. The main health problems are dysentery, cholera, fevers, hepatitis, intestinal disorders etc. Excretory wastes from human and other animals are the main

source of bacteria in water. This source of contamination is from grazing lands, cattle sheds and farm deposits of animal wastes. Other sources are from septic tanks, domestic and industrial sewage effluent waters. The worst problem with contamination of drinking water is diarrhea³.

Waterborne outbreaks of infection are due to pathogens. Out of which *Cryptosporidium parvum* is a gastrointestinal parasite which causes severe diarrhea and there is no cure at present. Oocysts of *Cryptosporidium* are excreted from infected animals including humans. These oocysts are survived in the environment until ingested by a new host.

If water is not properly treated, pathological bacteria present in the drinking water causes many diseases. The main diseases through contaminated water are diarrhea, jaundice, Cramps, nausea, headaches associated with other health problems and fatigue. Drinking water treatment such as sedimentation, flocculation, filtration through sand filters and disinfection mostly by chlorination purify the water and kills the pathogenic

bacteria. Presence of coliform bacteria in the water is common and however all the bacteria are not harmful. But presence of coliform bacteria acts as an indicator that harmful bacteria may be present in the water and proper care must be taken for disinfection process^{4,5}. The major contaminant in drinking water is human fecal matter which contains pathogenic bacteria. Detection and exact determination of pathogenic bacteria in water is a difficult process. So, indicator bacteria like *Escherichia coli* and *Streptococci* are measured to know the fecal contamination. If indicators are present then there is a probability that pathogenic bacteria may be also present in the water. Even the water is treated properly at treatment plant, again it may be contaminated in the distribution pipes due to breakage and leakage of pipes and again some harmful bacteria may be entered. The pathogenic bacteria are *Pseudomonas aeruginosa* and *Aeromonas* species which may enter the water and multiply and causes health problems to consumers. Unhygienic conditions at collection point of the water at the tap may also leads to water contamination problems.

In canal water bad taste and foul smell are due to presence of some algae and algal blooms. Sewage water from domestic and industrial wastes and agricultural run-off water particularly with nitrogenous and phosphorus wastes cause these algal blooms. Algae are microscopic in size and vary from single cell to filaments or chains or group of cells. There are various types of algal species that causes variations in taste and smell, but most popular among them are diatoms, chlorophyceae etc. which causes grass or fishy taste and odor. Dead organisms also produce fishy odor. There are other organisms which produce aromatic, musk-melon like and cucumber like taste and odor. The rotten egg smell in the water is due to *Schizomycetes* which produce iron and sulfur bacteria that lead to the formation of hydrogen sulphide^{6,7}.

Treatment of water varies with the source of water and purpose for which we are going to use that water. For drinking purpose the treatment involves screening, sedimentation, filtration and disinfection. Residual chlorine (0.20ppm) must be present after completion of the treatment process so as to act as a safe guard to kill pathogenic bacteria during pumping of water through pipes.

National and International guidelines are there to measure the safety of drinking water. The most important of these are the (Bureau of Indian Standard) BIS-10500 and (World Health Organization) WHO Guidelines for Drinking-Water Quality.

Study area: The study area lies between 16°19'05.02" and 16°56'08.37" N latitudes and 80°58'16.10" and 81°51'26.10" E longitudes and situated in the Southern part of West Godavari District. The boundaries of the study area are Godavari River in the East, Eluru Canal in the North and West by Upputeru River and Kolleru Lake. The major canals in the area are Venkayya-Vayyeru canal, Attili canal, Eluru canal, Kakraparru canal, Gostani canal and Narsapur canal. The study area is the

Godavari deltaic area with intensive agriculture and aquaculture practices and industries based on agriculture (Rice mills, sugar mills, paper mills etc.) and aquaculture (Aqua processing units, Aqua feed mills etc). In addition to that, this area is densely populated and thereby a huge quantity of domestic sewage water is discharged into canals every day. So major contaminants in this area are from domestic sewage water, fertilizers and pesticides through agriculture run-off water; acids, alkalis and other chemical pollutants from industrial effluents. These are all entering into irrigation canals continuously in the study area and raising the water contamination to alarming levels. This type of contaminated irrigation canal water is the primary source of drinking water in the study area. In some villages ground water is also used as a source of drinking water, but in this area aquifers are at shallow levels and so water is highly polluted and being deltaic area salt water intrusion is also a major problem.

Methodology

Drinking water samples of both surface and groundwater are collected from all the six canal areas-Venkayya-Vayyeru canal, Attili canal, Kakraparru and Bank canal, Eluru canal, Gostani canal and Narsapur canal of study area and analyzed for various physico- chemical and biological parameters like pH, TDS, Calcium hardness, Magnesium hardness, Total hardness, Carbonate alkalinity, Bicarbonate alkalinity, Total alkalinity, Ammonia, Nitrite, Nitrate, Sodium, Potassium, Chloride, Dissolved Oxygen, BOD, COD, MPN, TFC, E.Coli etc. However in this paper only the biological parameters of Panchyat treated/Municipal treated drinking water samples of Public Water supply systems and other Private organizations and Non Governmental Organizations supplied mineral drinking water samples (with or without R.O., whatsoever that is available in that particular village or town) are analyzed and presented. These water samples were analyzed according to Standard protocol¹⁰. These samples were collected during November, December months of 2014 and January and February months of 2015 (Winter Season).

Results and Discussion

High microbial counts in water are undesirable because of the increased likelihood that pathogens may be present, the possibility that these organisms will find access to foods and drinking water thereby causing ill health and other effects on organisms. Determination of pathogenic bacteria in drinking water is a difficult process. So, to know the fecal contamination in drinking water the indicator bacteria like *Escherichia coli* and *Streptococci* are measured. Most Probable Number (MPN) value gives the idea of presence or absence of coliform bacteria both vegetative and fecal coliform. Total Fecal Coliform (TFC) comprises both vegetative and fecal coliform of different genera and species of human and animal origin. TFC is used to test the pollution of various water sources like polluted well water, contaminated watershed water, sanitary waste water etc., and thereby proper disinfection and safe discharge of that water into

the environment. E.coli which is present in intestinal tracts of warm blooded animals is an indication of fresh pollution of water by fecal matter.

Some of the E.coli strains are very dangerous and even deadly. If these species are detected by measurement of MPN, TFC and E.coli proper treatment is adopted to rectify the problem.

A total of 101 water samples of Panchayat or Municipal treated are collected from all the six canal areas of the study area and analyzed. Similarly 59 privately supplied water samples are collected and analyzed. About 24 samples of Panchayat /Municipal treated water are collected from Venkayya-Vayyeru canal area and analyzed for biological parameters like Most Probable Number, Total Fecal Coliform and *Escherichia coli*. All the 24 samples are surface water samples. The treated water samples are purified by sedimentation, filtration and disinfection. Chlorine is used in disinfection for killing the pathogenic bacteria. The results of analysis shows that only one sample out of 24 samples has the MPN value zero (BIS-Standard for MPN) and safe for drinking. Similarly 20 water samples of Private Water suppliers like Non-Governmental Organizations, various Branded and Unbranded companies and water supplied under NTR Sujala Scheme that are available in those villages and towns of Venkayya-Vayyeru canal area are also collected and analyzed. In most of the cases the water supplied by private organizations are mineral water which is purified by Reverse Osmosis, UV light and /or Ozonization process or sometimes with simple chlorination. Out of these 20

samples, only two samples have zero MPN values and fit for drinking. Similarly Total Fecal Coliform values are also determined and the results are presented in tables. In Attili canal area, 8 samples of Panchayat/Municipal treated water are collected and analyzed. Only two are found to be suitable for drinking in terms of Pathogenic bacteria (MPN). Seven samples of private supplied water are also analyzed and found that only two samples are fit for drinking. TFC and E.Coli values are also determined and presented in tables. In Kakaraparru and Bank Canal area, 10 samples of Panchyat treated and 6 samples of privately treated samples are collected and analyzed for MPN and found that only three samples in each case are suitable for drinking. Similarly TFC and E.Coli are determined and presented in the tables. In Eluru Canal area, 19 samples of Panchayat treated and 5 samples of privately treated drinking water samples are collected and analyzed for MPN and its suitability is only six and four respectively. TFC and E.Coli are also determined and presented in the tables. In Gostani canal area, 12 samples of Panchyat treated and 8 samples of privately treated water samples are collected and analyzed for MPN and found that only two and four samples are suitable in respective cases. TFC and E.Coli values are also determined and presented in tables. In Narsapur canal area, 28 samples of Panchayat treated and 13 samples of private supplied water samples are analyzed for MPN and found that only nine samples in the first case and six in the second case are fit for drinking. TFC and E.Coli values are also determined and presented in the following tables. The summary of the results in terms of percentage values of all the six canal areas are presented in the Table- 1, 2 and 3.

Table-1
Percentage of Potability of drinking water in various canal areas based on MPN (Zero MPN Values)

Treatment Method	V.V. Canal	Attili Canal	K.P. Canal	Eluru Canal	Gostani Canal	Narsapur Canal	Total
P.T.W.	4%	25%	30%	31%	18%	32%	23%
N.G.O.	10%	28%	50%	0%	50%	46%	28%

Table-2
Percentage of Potable water in terms of TFC in various canal areas

Treatment Method	V.V. Canal	Attili Canal	K.P. Canal	Eluru Canal	Gostani Canal	Narsapur Canal	Total
P.T.W.	33.3%	25%	40%	47.4%	45.5%	53.6%	40.8%
N.G.O.	35%	28.5%	50%	80%	42.5%	61.5%	49.5%

Table-3
Percentage of Potable water in terms of E.Coli/1ml in various canal areas

Treatment Method	Attili Canal	K.P. Canal	Eluru Canal	Gostani Canal	Narsapur Canal	Total
P.T.W.	50%	50%	73.7%	63.6%	60.7%	59.6%
N.G.O.	71.4%	66%	80%	67.5%	53.8%	67.7%

Table-4
Quality of drinking water Based on MPN/100ml, TFC/100ml and E. Coli CFU /1ml

Category	MPN/100ml, TFC/100ml and E.Coli/1ml	Water quality
A	0	Good- safe for drinking
B	<50	Not good- applicable to disinfection treatment
C	>50	Polluted- requires stringent methods of treatment

Table-5
Summary of MPN loads present in drinking water in Western delta of West Godavari

Method of Treatment	0	<50	>50
PTW	23%	17%	60%
NGO	28%	17%	55%

Table-6
Summary of TFC loads present in drinking water in Western delta of West Godavari

Method of Treatment	0	<50	>50
PTW	41%	26%	33%
NGO	46%	39%	15%

Table-7
Summary of E.Coli loads present in drinking water in Western delta of West Godavari

Method of Treatment	0	<50	>50
PTW	61%	0	29%
NGO	67%	0	33%

Conclusion

With the above results it may be concluded that majority of the villages and towns in West Godavari, Western Delta are not getting potable water. Out of 101 Panchayat /Municipal treated water samples only ~23% samples are suitable for drinking. Of these 59 samples are Surface water (Canal) and 43 samples are ground water (Hand pumps and Bore-wells) samples. Out of 59 samples only 12 samples are suitable in case of surface water and 13 out of 43 samples are good for drinking in case of ground water. About 59 samples of Privately treated water samples only 17 samples are fit for drinking (~ 28 %) purpose. So, in total in Western Delta of West Godavari District drinking

water quality is very poor irrespective of the public or private systems or conventional or advanced technological methods.

Even the disinfection process is good and all pathogenic bacteria are killed, that water may not be taken as safe because excess use of disinfectants causes the formation of disinfection-bi-products (DBPs) which ultimately leads to cancer and abortions, still born deaths etc. But these drawbacks of disinfectants may not be considered when the benefits of disinfection process are considered. However new technologies must be developed which provides safe drinking water without any side effects. Resource protection, proper management of storage ponds, treatment with safe chemicals and distribution without any contamination are the important steps to supply potable drinking water for the public.

Table-8
Summary of the Percentage Potability of water based on MPN, TFC and E.Coli

Treatment Method	MPN/100ml	TFC/100ml	E.Coli /1ml
P.T.W	23%	40.8%	59.6%
N .G.O	28%	49.5%	67.7%

Acknowledgement

This is a part of the work done under project No: DST/TM/WTI/2K14/183(G) sponsored by Technology Mission Cell: Solar Energy and Water Department of Science and Technology, New Delhi. We are also acknowledging the Principal and Management of S.R.K.R. Engineering College for their support in our Research Work.

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