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PACKAGED DRINKING WATER QUALITY CHARACTERISTICS AT CHENNAI CITY, TAMILNADU.

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ABSTRACT

The inadequacy of protected water supplies in urban centre is a growing problem. In recent years, as communities resort to buy water from vendors, bubble top cans and bottled water became major sources of drinking water in the households and at work. This study is conducted in Chennai city to assess the physiochemical and bacteriological quality of packaged water sold in several key locations of study area. The three main source of packaged water includes bottled water, sachet and Bubble top cans. At the time of study 40 key locations were identified in study area. From each location samples were collected from various vendors and subjected to physical, chemical and bacteriological analysis. World Health Organization (WHO) standards were adopted for calculation of Water Quality Index (WQI). WQI provides an easy and rapid method of monitoring of water quality. Water quality indices revealed that drinking water of Bubble top cans and Sachet were found to be contaminated, comparing to bottled drinking water, so they needs some degree of more treatment before consumption.

Key words: Water quality Index, Packaged water, Physiochemical parameters, biological parameters and Water quality standards.

1 Introduction

Adequate supply of fresh and safe drinking water is a basic need for all human beings on the earth. Communities in urban areas suffer from acute drinking water shortage. To augment this situation many entrepreneurs took to packaged water business- production and vending[2]. "Packaged waters", other than natural mineral waters, are waters for human consumption and may contain minerals, naturally occurring or intentionally added; may contain carbon dioxide, naturally occurring or intentionally added; but shall not contain sugars, sweeteners, flavorings or other food stuffs. The major supply which has become popular among the medium and low income groups are, the cheap nylon sachets either registered with the regulatory body or with no registration There is rush to get into business and as a result quality control has been under played. Therefore, waters other than those in company sealed bottles are a source of waterborne infections. Water borne diseases such as diarrhoea, typhoid fever, cholera and bacillary dysentery has been traced to the consumption of unsafe water and unhygienic drinking water production practices. Water Quality Index (WQI) is regarded as one of the most effective way to communicate water quality[3] .Water quality is assessed on the basis of calculated water quality indices .The data obtained through quantitative analysis and WHO water quality standards were used for calculating water quality indices[10]. The purpose of calculating WQI and comparing it with standards is to assess drinking water contamination and variation of drinking water quality in different type of packaged water on basis of calculated value of water quality indices. The Corporation area of Chennai, Tamil Nadu has been identified as study area. Chennai city lies on longitude 80^0 18" East of Greenwich meridian and latitude 13^0 06" North of the Equator lies on the coast of Bay of Bengal. Besides being the largest indigenous city in Tamil Nadu, this is an important trade and educational centre and Asia's largest manufacturing companies are located here. Study area has population more than 65 lakhs Chennai supplies four lakhs liters of water, consisting of around 250 to 300 suppliers and 4,000 dealers. About 270 brands of packaged water available in the city at the time of this study and the number are increasing every day. They are broadly classified as bottled water, sachet[4] and bubble top cans. Sachets are water packets in 200ml nylon / plastic film sachets and sealed by heat at production site where as bubble top water cans are made of plastic/polyethylene cans, available in 20 liter cans[9].

2 Materials and Methods

Fourty key locations in study area were located inorder to collect samples. At the time of study 12 samples were collected from each location in all three categories of packaged water from various vendors. A total of 480 samples were collected from 40 locations of study area. The samples collected on a day were immediately processed for physiochemical and bacteriological analysis as as per standard methods (APHA, 1998)[1]. The samples were analyzed for 12 different parameters. Parameters includes pH, Manganese, Total Dissolved Solids(TDS),Total Hardness, alkalinity,coliform, Chlorides, Sulphates,Turbidity, calcium,Flourides,and Magnesium. pH was measured using a pH analyzer. Turbidity was measured by Nephelometer using 0.02 NTU standards. Total hardness was estimated by the Complexmetric titration with standard EDTA solution using Eriochrome Black as indicator. Whatman 541 filter papers were used for the determination of TDS.All other chemical parameters manganese; alkalinity, chlorides sulphides calcium.flourides and magnesium are measured using basic laboratory test[5]. Total coli form was found out using H_2S-Strip method (As per IS 1622:1981)**[8].**

Brown et al. (1970) developed a water quality index similar in structure to Horton's index but with much greater rigour in selecting parameters, developing a common scale, and assigning weights for which elaborate Delphic exercises were performed. This effort was supported by the National Sanitation Foundation (NSF). For this reason Brown's index is also referred as NSFWQI.For computing WQI three steps are followed. In the first step, each parameter has been assigned a weight (wi) according to its relative importance in the overall quality of water for drinking purposes as shown Table 1.The maximum weight of 5 has been assigned to the parameter coliform due to its relative importance in water quality. The principal risk to human health derives from fecal contamination. In some countries there may also be hazards associated with specific chemical contaminants such as manganese and fluoride, but the levels of these substances are unlikely to change significantly with time. In contrast, the potential for fecal contamination is much more if it leads untreated[6,7].

Magnesium, calcium, hardness and alkalinity have given the minimum weight of as these parameters may not much harmful. In the second step, the relative weight (Wi) is computed from the following equation

$$Wi = wi / \sum_{i=1}^{i=n} wi$$

Where, Wi is the relative weight, wi is the weight of each parameter and n is the number of parameters. Calculated relative weight (Wi) values of each parameter are presented in Table 1.In the third step, a quality rating scale (qi) for each parameter is assigned by dividing its concentration in each water sample (Ci) by its respective standard limit value according to the guidelines laid down by WHO (Si) and the result is multiplied by 100. The equation for qi is shown below:

$$qi = (Ci / Si) \times 100$$

For computing the WQI, the Sub-Index (SI) is first determined for each chemical parameter, which is then used to determine the WQI as per the following equations:

$$SIi = Wi. qi$$
$$WQI = \sum SIi$$

Table1 –Relative weight age of physiochemical and biological parameters.

Location	parameter	WHO Standards	Weight(w_i)	Relative weightage (W_i)
1	pH	8.5	4	0.10256
2	Manganese (mg/l)	0.4	4	0.10256
3	Total Dissolved Solids(TDS) (mg/l)	600	4	0.10256

4	Total Hardness (as CaCO3) (mg/l)	200	2	0.05128
5	Alkalinity (mg/l)	120	2	0.05128
6	Coliform (cfu/100ml)	NIL	5	0.12824
7	Chloride (mg/l)	250	3	0.07692
8	Sulphate (mg/l)	250	4	0.10256
9	Turbidity (NTU)	5	3	0.07692
10	calcium (mg/l)	75	2	0.05128
11	Fluorides (mg/l)	1.5	4	0.10256
12	Magnesium (mg/l)	30	2	0.05128
		Total	39	1.00

3 Results and Discussion

From the weightage (w_i), Relative weightage (W_i) and sub index (SI) assigned to physiochemical and biological parameters, WQI can be calculated .Location wise WQI for all three categories is shown in table 2

Table 2-Location wise WQI for three categories of packaged water

LOCATIONS	WATER QUALITY INDEX		
	Bottled water	Sachet water	Bubble top cans
L1 -Vadapalani	25	23	41
L2- Koyembedu	22	20	53
L3- Kodambakkam	25	39	52
L4- Ashok nagar.	19	78	60
L5- West Mambalam.	24	33	32
L6- Saidapet.	22	43	43
L7 -Arumbakkam	26	51	29
L8 -Annanagar	27	38	58
L9 -Kotturpuram.	25	64	36
L10 -Ayanavaram	24	48	64
L11 -Teynampet	51	37	28
L12 -Alwarpet	28	33	34
L13 -Kilpauk	18	48	53
L14 -Egmore	16	24	27
L15 -Nugambakkam	17	56	38
L16 -Adayar	25	39	34
L17 -Besant Nagar	27	54	29
L18- Shastri nagar	32	48	76
L19 -Gandhi Nagar.	17	45	57
L20 -Tidal park	24	28	28
L21 -Thiruvanmiyur	22	32	48
L22 -Mylapore	26	75	36
L23 -Mandaveli	17	37	38

L24 -Alwarpet.	19	41	34
L25 -Royapettah	31	70	57
L26 -Triplicane.	27	43	27
L27 -Santhome.	26	35	39
L28 -Tiruveilikeni	22	46	79
L29 -Chindaripet	16	34	32
L30 -Parambur	24	41	48
L31 -Vyasarpadi	21	44	43
L32 -Washermanpet	17	34	38
L33 -Vepry	23	48	48
L34 -Royapuram	26	29	56
L35-Trisulam	24	89	45
L36 -Chrompet	28	34	46
L37-Pallavaram	25	45	71
L38 -Tambaram	19	39	36
L39- Alandur	25	34	38
L40- Purusawalkam	27	32	29

In this study the computed WQI values ranges from 16 to 89 and therefore it an be categorized in to four types, excellent water to poor water. Percentage of water samples that falls under different quality is shown in table 3.The high value of WQI has been found in packaged water mainly due to higher values of Total coliform, pH, Total dissolved solids, manganese, sulphate and fluorides. Bottled water is almost 97% excellent to drink. In case of Sachet water only 80 % falls in excellent range rest 12.5 % in good and 7.5% in fair range. Bubble top cans are highly contaminated comparing to others because only 70% falls in excellent category.

Table3: Water quality classification based on WQI

WQI value	Drinking purpose	Percentage of water samples		
		Bottled water	Sachet	Bubble top cans
< 50	Excellent	97.5	80	70
50-75	good	2.5	12.5	25
75-100	fair	0	7.5	5
>100	poor	0	0	0

From the percentage value of drinking water quality obtained based on WQI, pie graph is generated for all three categories and shown in figure 1, 2 and 3.

Figure 1 : Bottled water

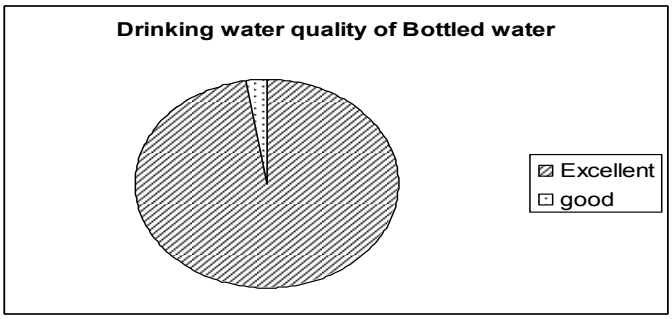


Figure 2: Sachet water

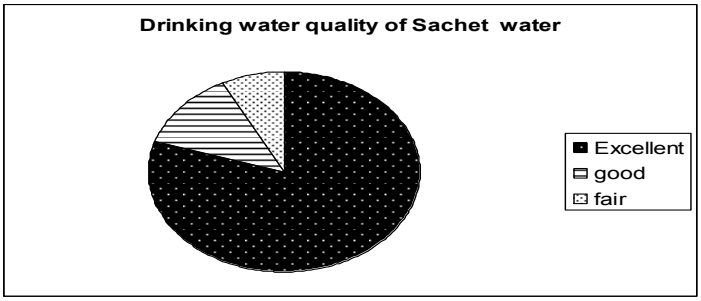
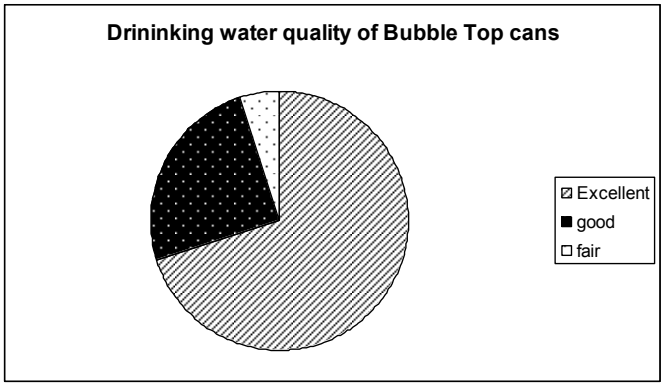


Figure 3: Bubble top cans



4 Conclusions

The samples were tested in physical, chemical and biological analysis and the results were interpretted in terms of Water Qulity Index (WQI). The analysis reveals that the packaged water quality of bottled water is with in the limit and almost 97% are excellent to drink.In case of bubble top cans and sachets water quality is not up the WHO standards.Only 80 % of sachet water and 70% of bubble top cans are with in excellent limit of WHO. The Presences of coliform bacteria is identified by Total coliform test of bubble top cans and sachet..So before re- filling the bubble top cans, the sterilisation to be done properly.During the manufacturing process, the membrane used in the RO process should be back washed properly. bubble top cans and sachets water needs some degree of more treatment before consumption .

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