Quality analysis of bottled drinking water in Jaffna Peninsula

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Abstract

In Jaffna peninsula ground water was used for drinking and other domestic purposes for long time. However, now this trend is changed and people feel only bottled water is suitable for drinking purposes. Water bottles of five different batch numbers of eight brands were tested for chemical, physical and microbial parameters. The pH of all the water samples studied ranged from 6.06-7.43. The alkalinity of the water samples reflects the same. Conductivity, alkalinity, calcium, magnesium, hardness, potassium, phosphate, chloride, salinity, coliforms and fecal coliforms of the above water samples were determined. The amount of conductivity, alkalinity, calcium, magnesium, hardness, potassium, chloride and salinity were found to be within the Sri Lankan Standard (SLS) recommended values. Phosphate values exceeded the SLS recommended values in tested three bottles. The microbial values revealed that four brands out of eight brands tested, not suitable for drinking purposes. When all the chemical physical and microbial parameters are concerned, only two out of eight brands tested were found to be suitable for drinking purposes.

Key words: Drinking water, pH, coliforms, SLS

Introduction

People in Jaffna Peninsula have started to depend on the bottled drinking water. They expect the bottled drinking water to be free of microbial contamination and health hazards. People in Jaffna peninsula, depend mainly on ground water for their drinking and other domestic purposes as other water sources such as waterfalls and rivers are not available and fresh water ponds and rainfall are not sufficient (Mageswaran *et al*., 2004). However, the ground water in Jaffna is in danger due to over exploitation and pollution caused by excessive usage of agrochemicals and fertilizer (Velauthamoorthy, 2001 and Balasanthiran, 2005). In addition to that people who are living in some recognized places around Chunnagam area are in fear of oil contaminated ground water. When the main entrance to Jaffna peninsula (A9 road) was opened after three decades of war, several bottled water brands are available for sale. People think that the bottled drinking water taste better than well water because the Total Dissolved Solid (TDS) values of well water lies more than 400 ppm. They perceive it would be safer and better quality. Since most of the bottled drinking water companies use surface water such as mountain spring, river, lake water stream as their water resources, there are possibilities for consumption

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of contaminated water, though companies use reverse osmosis system for the purification of water. Sri Lankan bottled water companies should follow the Sri Lankan standards for bottled water. The bottled water quality is frequently tested both by independent laboratory and by internal laboratory of the company. However, there are possibilities for the test results from internal laboratory to be biased. Therefore the questions about its quality and safety have raised. Hence this study was made to analyze the microbial contamination, physical properties and chemical contents in different brands of bottled water sold in Jaffna peninsula (Theivendirarajah, 1990).

Materials and Methods

Five different batch numbers of each brand were brought from randomly selected grocery stores in Jaffna peninsula. A total of 8 brands (labeled as A, B, C, D, E, F, G, and H) were analyzed. All the samples selected for this study were stored at room temperature (25-30°C) and the samples were analyzed within 1-6 months from the date of manufacture. Physical, chemical and microbiological requirements were tested, and compared with the recommended Sri Lankan Standard (SLS) values (SLS 614, 2013). Colour was measured by visual comparison method. Odour and taste were measured through sensory evaluation method. The amount of phosphate was measured using a Colorimeter (6051 colorimeter, Jenway, U.K.). The electrical conductivity was measured with a conductivity meter (Orion 4 star pH, Conductivity Bench top, Singapore) for analysis. The pH values of the bottled water samples were measured with a pH meter (PHS-3BW pH / mV / Temperature meter). Alkalinity and Chloride were determined by the titrimetric method. Calcium and Magnesium were measured by EDTA titration method. The values of potassium were measured with the flame photometer. Number of coliforms and fecal coliforms were determined by the standard membrane filter method and the occurrence of Escherichia coli was also tested.

Membrane filter method

Membrane filter assembly was setup with sterile membrane filter of 0.45 µm in diameter. Bottled water was shaked and 100 ml of the sample was poured into the funnel of the membrane filter and fitted on to suction flask. After filtering under vacuum, membrane filter was removed from the filter assembly by using a sterile forceps. Then it was placed on the surface of the endo agar plate. Plate was incubated at 37 ^{0}C for 24-48 hours. Typical coliform colonies (deep red in colour) were counted.

The above procedure was repeated to count the number of fecal coliforms / 100 ml of water sample when the plate was incubated at 44.5 ^{0}C for 24-48 hours. *E. coli* was confirmed by the appearance of greenish metallic sheen colonies on Eosin Methylene Blue (EMB) agar medium and the positive result for indole production at 44.5 ^{0}C (Tiwari *et al*., 2006).

The mean values and standard deviations were calculated for tested parameters of each brand.

Results and Discussion

The pH values of the 8 different brands of bottled water samples varied from 6.06 to 7.43 (Table 1) and the recommended range is 6.5 to 8.5. Electrical conductivity content of the 8 different brands of the water samples varied from 46.8 to 349 µS / cm (See Table 1) and the

SLS recommends the electrical conductivity as 750 µS / cm. Alkalinity of the water samples varied from 76.5 to 284.8 ppm (Table 1) and the SLS recommended value is 400 ppm. Calcium content of the water samples varied from 11.4 to 26.6 ppm (Table 1) and the SLS permits the calcium content up to 100 ppm. Magnesium content of the water samples varied from 14.5 to 24.5 ppm (Table 1) and the SLS permits the magnesium content up to 150 ppm. Hardness of the 8 different brands of water samples varied from 99.8 to 145.59 ppm (Table 1) and the SLS recommends the hardness 400 ppm. Potassium content of the water samples varied from 0.318 to 1.56 ppm (Table 1) and the SLS permits the potassium content up to 20 ppm. Phosphate content of the water samples varied from 1.26 to 2.29 ppm (Table 1) and the SLS permits the phosphate content up to 2.0 ppm. Chloride content of the water samples varied from 101.2 to 172.7 ppm (Table 1) and the SLS permits the chloride content up to 200 ppm. Salinity of the 8 different brands of water samples varied from 35.1 to 38.8 ppm (Table 1) and the SLS recommends the salinity up to 150 ppm. Only one batch of the brand C (2nd batch), E (2nd batch) and F (1st batch) had very high number of coliforms beyond the accepted level of the SLS. E.coli was present in only one batch of the brand A. Faecal coliforms were observed only in two batches of the brand A among the brands tested, which was not accepted according to the standard (E.coli and Faecal should be absent. Coliforms should be less than 10/ 100 ml of sample). When microbial safety was concerned, bottled water brands B, D, G and H were safe for drinking purposes. But when physico chemical parameters were concerned, A, B, C and D were safe for drinking purposes.

Table1: Physical and mineral constituents of different brands of bottled drinking water (mean±S)

	Sample	A	B	C	D	E	F	G	H
Physical constituents	Colour	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless
	Odour	No Smell	No Smell	No Smell	No Smell	No Smell	No Smell	No Smell	No Smell
	Taste	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless	Tasteless
	pH	6.46(±0.1)	7.08(±0.4)	6.72(±0.05)	6.44(±0.2)	7.41(±0.4)	6.06(±0.2)	6.59(±0.2)	7.43(±0.2)
	Conductivity (µS/cm)	79.7(±3.5)	81.0(±10.9)	48.6(±7.2)	46.8(±1.2)	122.0(±5.4)	104.0(±14.9)	63.8(±1.8)	349.0(±122.0)
Mineral constituents	Alkalinity (ppm)	159.6(±11.9)	158.6(±25.3)	109.1(±18.8)	90.1(±13.1)	110.8(±19.3)	100.3(±8.3)	76.5(±16.6)	284.8(±86.5)
	Calcium (ppm)	14.3(±1.3)	17.3(±0.8)	11.4(±0.7)	15.8(±0.9)	26.6(±0.6)	17.1(±1.1)	12.2(±0.7)	18.01(±4.4)
	Magnesium (ppm)	18.1(±0.9)	16.1(±0.9)	19.6(±1.1)	14.7(±0.7)	14.5(±1.1)	21.5(±1.4)	17.8(±0.3)	24.5(±2.1)
	Hardness (ppm)	109.7(±1.9)	109.1(±5.7)	108.8(±2.9)	99.8(±3.8)	126.1(±3.5)	130.7(±3.4)	103.4(±2.05)	145.59(±14.2)
	Potassium (ppm)	1.303(±0.2)	1.56(±0.15)	0.318(±0.16)	1.149(±0.14)	1.528(±0.25)	1.384(±0.15)	0.882(±0.15)	0.903(±0.16)
	Phosphate (ppm)	1.49(±0.3)	1.26(±0.23)	1.49(±0.31)	1.72(±0)	2.29(±1.07)	2.06(±0.5)	2.41(±0.6)	1.95(±0.65)
	Chloride (ppm)	151.8(±3.6)	133.5(±6.3)	115.9(±5.7)	115.9(±4.8)	131.7(±6.3)	156.4(±11.14)	101.2(±7.66)	172.7(±14.5)
	Salinity (ppm)	37.7(±0.18)	36.8(±0.32)	35.9(±0.29)	35.9(±0.25)	36.7(±0.32)	37.9(±0.57)	35.1(±0.39)	38.8(±0.74)

Table 2. Results for Coliforms and Faecal coliforms

Water Sample	No of colonies (in 100 ml)	Coliforms		Faecal coliforms	
		Confirmatory test for *E. coli*	No of colonies (in 100 ml)	Confirmatory test for *E.coli*	
A	1	3	(+) ve	7	(-) ve
	2	0	-	0	-
	3	0	-	0	-
	4	5	(-) ve	3	-
	5	0	-	0	-
B	1	0	-	0	-
	2	0	-	0	-
	3	0	-	0	-
	4	1	(-) ve	0	-
	5	0	-	0	-
C	1	0	-	0	-
	2	96	(-) ve	0	-
	3	1	(-) ve	0	-
	4	0	-	0	-
	5	3	(-) ve	0	-
D	1	0	-	0	-
	2	0	-	0	-
	3	0	-	0	-
	4	0	-	0	-
	5	0	-	0	-
E	1	0	-	0	-
	2	168	(-) ve	0	
	3	0	-	0	-
	4	0	-	0	-
	5	4	(-) ve	0	-
F	1	126	(-) ve	0	-
	2	0	-	0	-
	3	0	-	0	-
	4	0	-	0	-
	5	6	(-) ve	0	-

G	1	3	(-) ve	0	-
	2	5	(-) ve	0	-
	3	0	-	0	-
	4	0	-	0	-
	5	2	(-) ve	0	-
H	1	5	(-) ve	0	-
	2	0	-	0	-
	3	0	-	0	-
	4	1	(-) ve	0	-
	5	3	(-) ve	0	-

Conclusion

The results of this study revealed that the values of electrical conductivity, chloride, salinity, alkalinity, calcium, magnesium, total hardness, and potassium in all of the water samples were within the acceptable limits of Sri Lankan Standards for drinking water. The mean value of phosphate ion of E, F, G and H brands exceeds the Sri Lankan standard limit. High phosphate levels cause eutrophication. The mean value of pH of A, D, F and G exceeds the Sri Lankan standard limit. The changes of this pH indicate the presence of contaminants in the water samples. First and fourth batches of brand A had high fecal contamination and not suitable for consumption whereas one batch of C, E and F had a risk of contamination and not suitable for drinking as the presence of fecal coliforms in water samples indicates that the water had received contamination of fecal and E. coli is generally used as an indicator for fecal contamination. Occurrence of fecal coliforms and coliforms in high number is also associated with the presence of pathogenic organisms as a health hazard in water samples.

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