Studies on Fluoride Content of Drinking Water in Cape Coast, Ghana (W. Africa)

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Summary: The physical, chemical and bacteriological examination of drinking water samples from twenty eight (28) sampling sites in and around Cape Coast have been reported. From the analytical data, described and discussed in this paper, it was evident that the quality of drinking water studied was poor only in respect of its low fluoride content. It was found in the range 0.09 - 0.15 mg/l, compared to WHO/APHA recommended limit of 1.0 mg/l. Some measures have been suggested for protection against dental caries among the inhabitants of Cape Coast, especially children below 14 years of age consuming fluoride deficient water.

Introduction

It is well known that a number of diseases are caused by consuming water of poor quality [1-4]. Poor quality of water may be either due to the presence of harmful bacteria or lack/overabundence of certain chemical entities [3]. Increasing agricultural activities, industrial development, poor sanitation and unhygenic practices by the public in general are regarded as the main factors responsible for deteriorating quality of a water body.

For a long time, the quality of drinking water did not cause any attention in Cape Coast, one of the main and a historical city in the Central Region of Ghana, West Africa. However, in early eighties, Ministry of Health, central region released the informations, based on a survey that there were suspected cases of dental caries among school going children and recorded cases of water borne diseases, which for a continuous period of four months (Sept-Dec., 1984) was recorded as high as 100 cases per month in one main hospital (TWIFU PRASU) in Cape Coast [5]. Through literature study, it was also observed that (i) there was lack of systematic physico-chemical and biological data base on the quality status of water supply in cape coast and (ii) the absence of a National criteria for determining the water quality for domestic, agricultural, industrial and other uses.

In view of the above, it was therefore, thought worthwhile to undertake the physical, chemical and biological examination of drinking water in Cape Coast. In the present study, water samples were collected from 28 sampling sites including 11 locations in Cape Coast town, 6 locations on Cape Coast university campus and 11 villages in and around the town and the university campus. The parameters studied were pH, alkalinity, hardness, dissolved oxygen, iodide chloride, fluoride, nitrate, nitrite and bacterial content. Details of these investigations carried out and the results achieved, are described and discussed in this paper.

Results and Discussion

The results of chemical analyses are described in Table-1 and 2. The recommended/ permissible limits for various parameters are also given in Table-2.

pH of the water samples studied was found to be between 7.18-7.68 which was within the permissible limits for drinking water. The pH of water samples from the university campus was slightly lower as compared to water samples from the town and villages. Alkalinity of university campus water samples was also found to be the lowest. Generally, the alkalinity (as $CaCO_3$) of water samples studied was found to be between 30.08 to 23.47 mg/l. Dissolved oxygen and hardness (as $CaCO_3$) of all water samples under examination were lower than the permissible limits of 4 mg/l and 100 mg/l, respectively. Iodide content for water samples from the town, villages and

Table-1: Fluoride concentration in mg/l in drinking water samples

S.No	Location (Town)	Fluoride (mg/l)	S.No.	Location (Villages)	Fluoride (mg/l)	S.No.	Location (University campus)	Fluoride (mg/l)
1.	Ola estate	0.15	1.	Amana	0.12	1.	Casely Hayford Hall	0.11
2.	St. Peters Seminary	0.11	2.	Akotokyir	0.11	2.	Ogua Hall	0.12
3.	Ameen Factory	0.15	3.	Kwapro	0.11	3.	Banglow No.30 (old site)	0.10
4.	Police Headquarters	0.15	4.	Apewosika	0.10	4.	Banglow No.137 (new site)	0.11
5.	Bakano	0.13	5.	Pedu	0.13	5.	Guest House	0.10
6.	Adisidel Estate	0.13	6.	Abura	0.14	6.	Science Faculty	0.09
7.	Ola Training College	0.13	7.	Eyifua	0.14		Average	0.11 ± 0.01
8.	St. Augustine College	0.13	8.	Kakomdo	0.13			
9.	Methodist School	0.13	9.	Esuekyir	0.14			
10.	Wesley School	0.12	10.	Siwidu	0.10			
11.	Pedu Estate	0.14	11.	Adisadel	0.13			
	Average	0.13 ± 0.01		Average	0.12 ± 0.02			

Table-2: Analyses of drinking water sameples* in and around Cape Coast

S.No.	Parameters	Locations (Town) SS-11	Locations (Villages) SS-11	Locations (University Campus) SS-6	Recommended/ Permissible Limits (3,6)
1.	pH	7.67	7.68	7.18	6.5 - 8.5
2.	Alkalinity as $CaCO_3$(mg/l).	30.08	25.01	23.47	-
3.	Hardness as $CaCO_3$(mg/l)	16.58	25.23	30.95	100 - 500
4.	Dissolved oxygen (mg/l).	2.54	2.70	3.46	4 - 6
5.	Iodide (mg/l)	25.86	28.00	24.01	-
6.	Chloride (mg/l)	17.24	21.71	23.24	200
7.	Fluoride (mg/l)	0.13	0.12	0.11	0.6 - 1.7
8.	Nitrate (mg/l)	0.16	0.17	-	10 - 10
9.	Nitrite (mg/l)	0.02	0.02	-	0.1
10.	Bacteria (Count/l)	28	30	50	500

SS = Sampling Sites; *Volume of sample for 1,2,4-7 = 100 ml.
(Average results reported) 3, 8, 9 = 50 ml.

university campus was found in the range 24.01-28.00 mg/l. The recommended dietary allowance for iodine is 100-150 mg per day [10] and as such, a healthy body iodine needs would have to be fulfilled through iodized salts or supplementary iodine rich foods, to avoid development of simple goiter [11-12]. The chloride content of water samples studied was found in the range 17.24-23.24 mg/l which was lower than the permissible limits of 200 mg/l. The results obtained for nitrate and nitrite concentrations of town water samples were 0.16 mg/l and 0.02 mg/l and for villages water samples 0.17 mg/l, and 0.02 mg/.l respectively. Both results were below the WHO approved limits of nitrate 10 mg/l and nitrite 0.1 mg/l (Table-2) and therefore the possibility of occurrence of cyanosis disease [13] among the children living in Cape Coast area, appeared to be minimum.

The bacterial content of water samples under examination was found to be in the range 28-50 count per litre, the university water samples giving higher values compared to water samples from the town and village. However, the values were far below the WHO approved limit for drinking water. Bi-weekly bacterial examination of drinking water samples from the University campus and Amana village were also carried out over a period of six months (details of this study would be published elsewhere). An increase only upto 77 count per litre (less than WHO'S approved limit) in bacterial content of some water samples was observed. However, the overall results of bacterial examination did not show any increasing or decreasing directional trends.

The results described in the Table-2, with exception of fluoride, generally fall within the permissible limits approved by WHO/APHA. Fluoride concentration of approximately 1.0 mg/l in drinking water, effectively reduces dental caries without harmful effects on health. As established by Mckay [3], fluorosis (Mottled teeth) may occur when the fluoride levels in drinking water exceeds 3.5 mg/l. The high fluoride content may also cause weakening of bones, weight-loss, thyroid and kidney injury [3]. The values of fluoride content of water samples from each sampling site in cape coast are given in Table-1. The values were found in the range 0.11-0.15 mg/l, 0.10-0.14 mg/l and 0.09-0.12 mg/l for water samples from the town, villages and the university, respectively (Table-1).

It was evident from the data that fluoride content of drinking water in and around Cape Coast was very low as compared to the recommended limit, 1 mg/l and therefore, the inhabitants of Cape Coast, specially children below the age of 14 years, are exposed to dental caries [3-4,14].

The addition of fluoride to fluoride deficient public water supplies is now a wide-spread and common practice in the developed countries [3-4,16]. It has been suggested to Ghana water and sewerage corporation, Regional Office, Cape Coast to fluoridate (upto 1 mg fluoride/l) treated tap water as a matter of urgency. Chemicals like sodium fluoride, fluorosilicate and hydro-fluorosilicate may be used without causing any physiological side effect [3]. Alternatively, the children may be given fluoride tables (0.25 milligram tablets thrice/day)or may be advised teeth-brushing with fluoride containing tooth-pastes, as about 100 micrograms gets allowed with each brushing. Some fibrous foods such as apples, carrots and sugarcane because of their scouring/ abrasive action on teeth are known for protection against dental caries. Other foods such as cheese and peanuts have also been reported for their protective action against dental caries which is though to be due to increased flow of saliva, pH change and calcium content [3,4,14]. In areas such as Cape Coast, whereas quality of drinking water is poor because of its low fluoride content, all these foods are highly recommended as an essential part of the children's diet for protection against dental caries.

Experimental

Sampling

In selecting the sampling points, care was taken that the sites were well far-apart and the taps were well-used by the communities living around, to full-fill their water needs for drinking, washing and other domestic purposes. The locations of the 28 sampling points are given in Table-1. The taps selected were those without defective washers so that water did not escape between the spridle and the gland. Sample bottles were carefully cleaned with detergent, washed several times with laboratory tap water, rinsed with hydrochloric acid thoroughly rinsed with tap water and finally with distilled water. All necessary precautions were observed while filling up the bottles with water samples from taps. Water samples for the determination of dissolved oxygen were collected using a rubber tube and by following the standard sampling procedure [3,6].

Chemical analyses

pH, alkalinity, dissolved oxygen, nitrate and nitrite determinations were carried out as soon as the water samples were brought to the laboratory. pH was measured at room temperature using a pH meter calibrated with standard buffer solutions. Alkalinity was determined titrimetrically using standard hydrochloric acid with methyl red as an indicator [6]. EDTA complexometric titration was used in the determination of total hardness [7]. Dissolved oxygen was estimated by Winkler's method with Azide modification [8]. Nitrate and nitrite contents were determined by colorimetric methods using brucine and naphthylamine sulphanilic acid, respectively [3,6]. Determinations of chloride and iodide contents were made by argentometric titrations with standard silver nitrate solution using potassium chromate and dichloro-tetraiodo-fluorescein as indicators, respectively [7,9]. Colorimetric method, based on the reaction of fluoride in destroying the colour of zirconinium lakes of Alizrin Red S [6], was used in the determination of fluoride content.

Bacterial examination

Glass-stoppered sample bottles were cleaned as described above and were sterilized by heating at 170°C in an oven. No water sample for bacterial examination was taken from leacking taps. To neutralize any residual chlorine, 0.3 ml. of a 3% solution of crystalline sodium thiosulphate was employed. The agar medium used to culture bacteria was prepared from dehydrated tryptone glucose agar (BDH) and was sterilized with a portable Universal Electric Autoclave. Aliquot of water samples in agar were incubated for 24 hours at 37°C in sterilized petri plates. The counting was done using a Hand Telly Counter (Veeder Root, USA). All precautions were taken to avoid the slightest risk of the water sample being contaminated [7].

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