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Fluoride Status of Underground Water of Faisalabad City Area

RUBINA KAUSAR, SARFRAZ AHMAD, KHALIL-UR-REHMAN AND RIAZ AHMAD
Department of Chemistry, University of Agriculture, Faisalabd–38040, Pakistan

ABSTRACT

Fluorine is an essential micronutrient, which is present in trace amount in human body. Its optimum concentration is critical for human health because its deficiency leads to dental caries while excess causes dental mottling. Dental florosis of mild or higher degree has been observed in certain areas of Pakistan. Therefore, the present study was aimed to determine the fluoride contents of drinking water of Faisalabad city area. 40 samples of drinking water from nine different localities were collected and analyased for their fluoride contents, TSS and pH. The highest average fluoride contents were 1.15 ppm while lowest contents were 0.38 ppm. Total soluble salts concentration ranges from 310 ppm to 2330 ppm. Hydrogen ion concentration (pH) of underground water ranges from 7.46 to 8.13. The results revealed that in the area containing less fluoride contents in the water, the dental caries and cardiovascular abnormalities might be occurred and in order to prevent from it water must be fluorinated while in areas of high fluoride contents the incidence of dental mottling might be occurred, so the water must be deflourinated

Key Words: Fluoride ion; pH; Drinking water; Total soluble salts; Ion specific electrode; Electrical conductivity.
Abbreviations: ppm, parts per million; TSS, total soluble salts

INTRODUCTION

Fluorine is regarded as an essential constituent in the drinking water. It is one of those chemical substances which if not present at sufficient concentration, human health may be effected adversely. Its concentration greater than definite limit may be injurious to health.

Although fluorine is widely distributed in nature, present in human diet and consequently forming natural part of man's environment, yet if present in excess, it is known to be harmful (Martin, 1970). A fluoride level of 1 ppm in the drinking water seems to reduce the evidence of dental caries. Water fluoridation is under taken in the many countries of the world like United States, Brazil etc.. An average daily diet provides 0.25-0.35 mg fluorine. In addition the average adult may ingest 1.0 and 1.5 mg from drinking and cooking water containing 1 ppm fluorine (Anonymous, 1973; Anonymous, 2003). Excessive supply (1.5 ppm or more) causes the mottling of teeth enamel. Even if fluorine so present in diet less than sub optimal level, it produces detrimental effect while prolong ingestion of small fluorine causes florosis. The main signs of acute intoxication which is although very rare are diffused abdominal pains, diarrhea, vomiting and painful spasm in the limbs.

Fluorine in the body acts in two ways i.e. by increasing resistance of the enamel and by reducing the effectiveness of microbial activity (Hardwick *et al*., 1958). The resistance of the enamel surface of the teeth to acid attack can greatly be enhanced by incorporation of minute amount of fluoride ions so that hydroxyapetite becomes florapetite which is more resistant to acid attack. High fluoride in the drinking water (10ppm) or more inhibits the enzyme phosphoglyceromutase of oral bacteria (*Streptococcus mutans*). This inhibition also requires Magnesium and organic phosphate. Addition of fluoride salts in drinking water to make an optimum proportion of one part in one million parts, have played significant role in the reduction of dental caries. Fluoridation is an effective, inexpensive and safe because it does not affect the health of the people. Naturally fluoridated water obtains its fluoride by being in contact with fluoride containing rocks and soil as passes through the earth. Therefore, nearly all water contains some fluoride.

Dental florosis of mild or higher degree has been observed in certain areas of Pakistan like Sarghoda, Mianwali, Pisheen, Sahiwal, D.G.Khan, Therparker and Quetta where fluoride contents were higher than 2.5 ppm resulting in aesthetic and cosmetic problems of teeth JOPDAK (1986). Keeping in view the importance of fluoride in human health, study was undertaken with the objective to determine fluoride contents of drinking water of Faisalabad city area. So that plan may be under taken to bring fluoride contents to optimum level, which is required for human health.

MATERIALS AND METHODS

Forty samples were collected from nine different localities of Faisalabad city (Table I) area especially from those areas where under ground water is the only source of drinking water. Samples were stored in thoroughly cleaned plastic bottles at room temperature. Following parameters were determined:

1. Fluoride concentration.
2. Total soluble salts.
3. pH.

The localitities were graded according to the fluoride

contents of the drinking water as follows:

I) F= 0.0-0.5ppm(Fluoride free areas)
II) F= 0.5-0.9ppm(sub optimal level area)
III) F= 1.00-more ppm (Fluoride areas)

Fluoride concentration. Fluoride concentration determination was carried out in the Laboratories of National Institute of Fertilizer Development, Faisalabad. Fluoride contents of collected water were determined by using ion specific electrode as described by Zentener and Harry (1973). In this electrode, the sensing element is Lathanum fluoride single crystal membrane in contact with an internal reference solution. Crystal membrane is highly selective conductor in which only fluoride ions are mobile.

Table I. Localities of Faisalabad city area

Sr. No	Localities
L1	Jinnah colony
L2	Samanabad
L3	Samandri Road
L4	People's Colony
L5	Abdullah pur
L6	Medina Town
L7	Mansoorabad
L8	Dhudiwala
L9	Head waterworks

Buffer preparation

Standard solution. To make 1 and 10 ppm solution of fluorine, 1 mL and 10 mL fluorine were taken from 100 mL flask containing standard stock solution and 10 mL of citrate/ hydroxide in each flask diluted to volume with distilled water. 10 mL of water was taken in a beaker and to it 10 mL sodium citrate solution was added and checked the pH of the solution and found that the range, was 7.0 to 8.5. Concentration was measured by standardizing the specific ion analyzer with two standards already prepared (lower and upper range) 10ppm fluoride and 100ppm fluoride.

Total soluble salts. Electrical conductivity test was used as basis to measure total soluble salt concentration in drinking water. Electrical conductivity of water was measured by using conductivity meter (model MC Mark V.C. Kent electronic instrument Ltd. England). The samples were brought to 25°C and immersed electrodes in the water samples and also read the temperature just after immersing. Conductivity was measured by the equation

$$K = C/R$$

Where

R= resistance

C= constant obtained by the geometry of the cell

These results were expressed as µ S/cm that replaces µ mho/cm.

$$TSS = \frac{EC \times 10^6}{1000} \times \mu mho / cm$$

$TSS = EC \times 10^3$ mili mho/cm

Which were then converted in ppm by formula:

$$TSS = \frac{EC \times 10^3 \times 0.064}{1000} \times 10$$

Hydrogen ion concentration. Hydrogen ion concentration (pH) was determined by Glass electrode conductivity meter. pH was checked against two buffer solutions, one of each side of the expected pH range. For this buffer solution of potassium hydrogen phthalate having pH 4.0 and buffer solution of sodium tetraborate having pH 9.19 were prepared. pH was checked against these buffer solutions and 50 mL beaker was half filled with water then electrode were immersed and allowed to stand. Final pH was noted, after 15 min of immersion.

Statistical analysis. The data collected was analyzed by completely randomized design and LSD test was applied at 5% probability level.

RESULTS AND DISCUSSION

A total of 40 samples of underground drinking water were collected from nine different localities of Faisalabad city areas mentioned in (Table I) and were analyzed for their fluoride contents, total soluble salts and pH. The results show that the average fluoride contents of L5, L6, L7 and L9 fall in the first category having fluoride free water while L4, L2 and L1 lies in the second category and L8 falls in the third category. The results reveal that higher incidences of dental caries is likely to occur if fluoride concentration in the drinking water is less than 0.5 ppm. To prevent dental caries, the water should be fluorinated to bring concentration up to 1 ppm. Any one of the various methods for fluoridation of drinking water should be adopted as reported by Calavska (1987).

In the locality where drinking water contains excessive concentration of fluorides (2.20 ppm) likely to develop dental florosis, so the water supply of these localities must be deflourinated. Deflorination can be successfully achieved by activated alumina and bone char as suggested by Horowitz *et al*. (1972). Fluorine is found in the human body as trace element and distributed in many foodstuffs especially fish. The interest in the fluorine arises from the toxic effects of prolonged ingestion of small amounts of fluorine together with the detrimental results of sub optimal level in the diet.

The results show that ion-selective electrode method, for determination of fluorides in drinking water is best method because it is less susceptible than colorimetric method to interference with other ions in the solution. Moreover, it gives theoretical recoveries of fluorides added to the several supplies. These results are in agreement with those obtained by Hannah (1986) and Jin and Zhaeng (1985) but do not agree with those obtained by Ditterick (1985), Lie *et al.* (1986) and Anonymous (1983). Because the method described by them give either only trace of

Fig. 1. Average Fluoride concentration (ppm) of drinking water of various localities of Faisalabad. The bars with different alphabets are statistically different at p 0.05

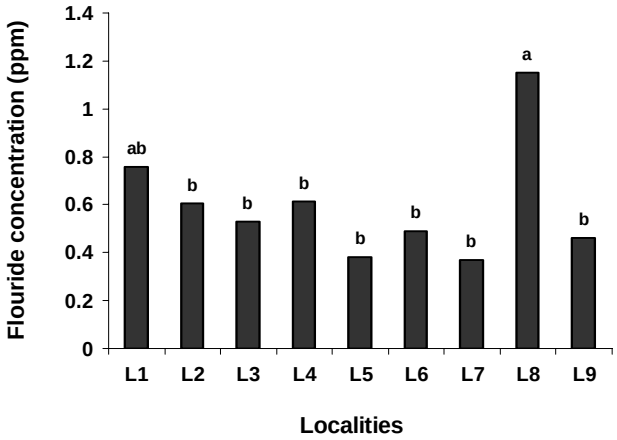


Fig. 2. Average total soluble salts concentration (ppm) of drinking water of Faisalabad. The bars with different alphabets are statistically different at p 0.05

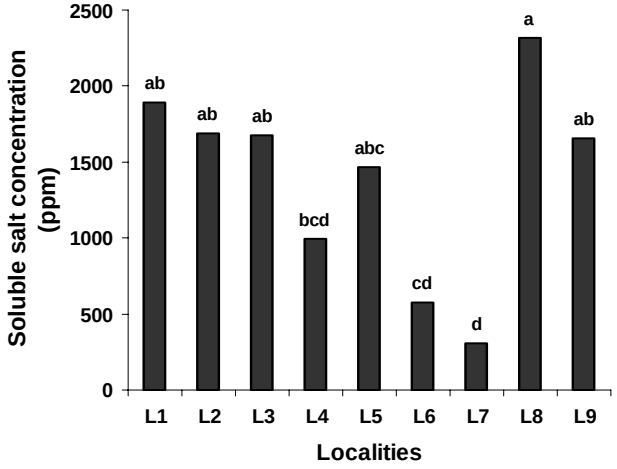
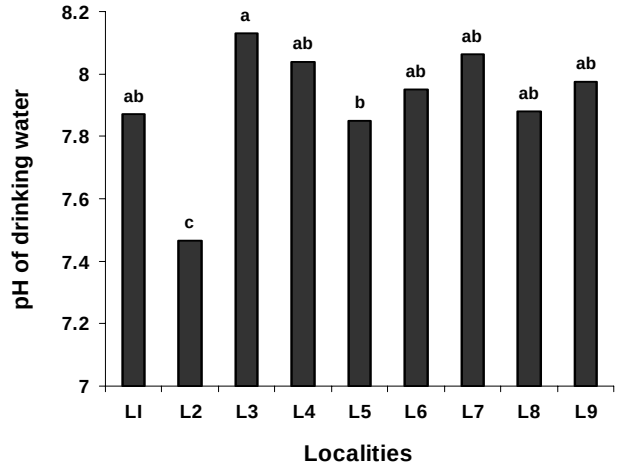


Fig. 3. Average pH of drinking water of various localities of Faisalabad. The bars with different alphabets are statistically different at p 0.05



It is obvious from (Fig. 1) that significant difference in the fluoride contents were observed in waters supply of L7 and L8 localities and the mean values of the localities varies from 0.37 to 1.15 ppm. The comparison of mean of LSD revealed significant difference in the fluoride contents of L1 and L8. L8 has higher fluoride contents (1.15ppm) in the water supply. The fluoride contents of remaining seven localities are statistically non significant.

The data regarding TSS present in the drinking water of various localities of Faisalabad showed significant differences in drinking water and the mean values varied from 310-2330 ppm (Fig. 2). TSS is measure of the total amount of salts dissolved in the water. It is calculated on the basis of electrical conductivity test, which measures conductivity of water. When mineral salts are dissolved in the water it can conduct electrical current, otherwise it is poor conductor. Higher the EC, the more mineral salts are present in the water. EC is directly related to the total soluble salts present in the water. If TSS is higher than 500 mg/L the water may give objectionable taste. However, more salts than this are not harmful, it depends which minerals are present causing in the elevation of TSS (Anonymous, 2003). From Fig.2 it is clear that, the water of L8 had highest TSS (2330 ppm) and that of L7 had the lowest TSS (310 ppm). Examination of the mean values of TSS of drinking water of different localities by LSD test indicated significant difference between L8 and L7.

Fig. 3 shows that there is significant difference of drinking water of certain areas of Faisalabad through the pH values varied from (7.46 to 8.13). pH is a measure of hydrogen ion concentration in water. Higher the pH value, the more basic it is and vice versa. pH itself is not a health concern. The drinking water should have pH in the range of 6.5 to 8.5. Water outside this range is not necessarily harmful. Extremely lower and high pH is an indication of dissolved metals (lead) and caustic soda respectively (Anonymous, 2003). In our experiment the pH values lies in the safe range (7.46 to 8.13). The comparison of mean values of pH of dinking water by LSD test revealed non significant difference except that of L2, L3 and L8 where pH is 7.46, 8.13 and 7.88 respectively.

It is concluded from the above research that in the areas having high fluoride contents, the incidence of dental florosis might be occurred while in the areas having fluoride contents less than optimum limit dental caries is likely to occur. Fluoride contents less or high than

optimum levels are more harmful for children. So, the water must be fluorinated or deflorinated as required to bring fluoride content to 1 ppm.

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