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Effects, Incidence and Investigation for Remedy of Fluoride in Drinking Water

B.H. Briz-Kishore
Director of Water Resources
Jawaharlal Nehru Technological University
Mahaveer Marg, Hyderabad-500 028 (INDIA)

ABSTRACT : *Excessive concentration of fluoride in drinking water gives rise to dental decay and physiological deformations. From this point of view it is necessary to know the fluoride content of well water, which constitute the main source of drinking water in most parts of the country. It is observed that high incidence of fluoride in ground water occur practically in all types of rock formations. While small amounts of fluoride intake are essential for preventing dental carries, excessive amounts are unsafe as they eause the disease "Fluorosis". To determine the factor contributing to excessive fluoride concentrations, systematic experimental studies have to be made with different types of water and different types of rocks and soils containing fluoride bearing minerals. It is also imperative that preventive measures should be taken immediately to protect people from the intake of large amounts of fluoride through drinking water.*

1.0 Introduction

Human as well as livestock health is in general governed by the presence of fluoride even as a trace element in food, drinks and tissues of the body. Fluoride like chloride also belongs to the halogen group. However, the fluorides are much less soluble in water than the chlorides. Consequently their concentrations in natural water are commonly limited. On account of this fact the significance of the presence of fluoride in water was not properly understood until about a few decades ago. The decay of the teeth and bones is started being recognised particularly as adverse effects of the fluoride.

Incidence of fluorosis has been reported from U.S.A., China, India, West Indies, Spain, Holland, Italy, Mexico and several other North African and South American Countries. The occurence of fluorosis is endemic in India at many places of Andhra Pradesh, Tamilnadu, Karnataka, Kerala, Gujarat, Rajasthan, Punjab, Haryana, and Bihar. In all these places where fluorosis is endemic, high concentrations of fluoride have been found in the drinking water used by the population.

The safe range of fluoride concentration in drinking water is 0.8 to 1.4 ppm. Concentration between 1.5 and 4 ppm are likely to cause moulting and staining of the teeth, those between 4 and 8 ppm. cause dental carries and minor skeletal deformations, while those above 8 ppm give rise to acute osteoselerosis, stiffness in joints and skeletal deformation. In general, fluoride concentrations of natural water may range from 0-50 ppm. The highest fluoride concentration as per available literature is 67 ppm in a water sample from South Africa (Bond, 1964). In India, the highest

concentration so far recorded is 19 ppm from Rajasthan.

2. Review of 'Fluoride'

Since the investigations of Black and MC Roy in 1916 on mottled enamel and identification of the definite association of this enamel with Fluoride content in drinking water by Churchill (1931), incidence of water borne dental as well as skeletal fluorosis has been reported from various parts of the world (WHO 1970). In India, incidence of this disease was first discovered by Dr. Lakshminarayana (1937), a Health Officer who was working in Podili area of present Prakasam District of Andhra Pradesh. Detailed epidemological studies by workers of King Institute, Guindy (Short et. al. 1937), Raghavachary & Venkatarathnam (1940), (Pandit et. al. 1940) confirmed the incidence of fluorosis associated with excessive Fluoride concentration in drinking waters.

Dever (1945) reported the prevalence of fluorosis in some parts of erstwhile Hyderabad State. Clinical and Epidemological studies were reported by Siddiqui (1955) on the occurrence of Fluorosis in Nalgonda. The occurrence of genuvalgum in endemic fluorosis areas of Nalgonda District was identified by Krishnamachary and his colleagues (1974). Fluorosis in livestock was systematically discussed by several earlier workers (Arora, Sampath and Somsundara Rao et. al. 1977).

Rao, and Venkatarangachary (1979) discussed various effects of fluorosis on vegetables and plants. They further indicated that a systematic survey of the plants growing in endemic areas of fluorosis should be conducted and the fluoride content of the plants part wise should be carried out. Further, they opined that a critical survey of the vegetables, other crops and plants grown on fluoride containing water should be undertaken and the net amount of fluoride actually accumulated in the economical and useful parts of the plants should be assessed.

2.1 Origin of Fluoride

From the surveys conducted in recent years in the country, it is observed that high incidence of fluoride in ground water occurs practically in all types of rock formations, namely the crystalline rocks of Peninsular Shield, Igneous and Metamorphic rocks of Rajasthan, Volcanic rocks of West Central India and even unconsoli dated quarternary alluvium overlying the older formations in many places. High fluoride concentrations have also been observed in water from hot springs systems in Bihar and Madhya Pradesh States.

It is usually considered that the fluoride contents of the original igneous rocks were transferred to the subsequently formed sedimentary and metamorphic rocks and also to the resultant soils. The concentration of fluoride in groundwater is attributed to the rocks through which it flows.

The parameters that contributed to the varying contents in the natural ground water are many and the following physiochemical factors appear to be most important (i) The size and distribution of the fluorate and other fluoride bearing minerals in rocks and soils, (ii) the ability of ground water to come into contact with those minerals, and (iii) the duration of contact of ground water with those minerals.

A study of the chemical composition of the fluoride bearing water tends to indicate that high fluoride concentrations are frequently found in water with high alkalinity to calcium and low calcium to fluoride ratios. It is found that the onset of fluorosis and the severity of the symptoms are governed by various factors such as nutritional deficiencies, high ambient temperature, high alkalinity and low calcium and magnesium contents in the drinking water.

3.0 Investigations Needed

(1) Well planned integrated investigations are essential for identifying the origin and

distribution in high fluoride bearing zones (Briz-Kishore, 1985). It is also essential to know whether fluoride mineralisation occurs in particular type of rocks or in all types and whether its concentration is having any favourable zones. It fs also observed that shear zones, fractures and other lineaments play significant role in fluoride mineralisation. Based on this, geological, geophysical, photogeological studies have to be employed which greatly help in locating basement topography, structure and lineaments. Combined usage of magnetic and electrical surveys will greatly help in mapping of zones effectively.

(2) Chemical variations in rain waters, rivers, sediments and ground water will give significant information on fluoride and its relation with other chemical constituents and as such hydrological, hydrogeological, and hydrometeorological data atleast over three consecutive seasons is to be recommended by establishing a network of observation wells at properly distributed places.

(3) A detailed data on the variety of irrigated crops, vegetables and their water requirements in both the fluoride affected and fluoride free zones is to be collected (Briz-Kishore, 1985) to arrive at safe limits.

(4) It is also necessary to have a complete picture regarding the chemical composition of contents in the surface and ground water through hydrogeological and hydrochemical analysis. These studies will help to fix the safe limits on the intake of fluoride content in various food products.

(5) It is necessary to evolve different remedial measures for reducing alkalinity of flouride water to normal through acid substitutes. This process involves the determination of the efficacy of calcium salts and administering extra nutrients to the undernourished people in combating the fluoride effects. This also includes working out the strategy like spreading the lime stone in selected segments of fluoride rich regions during pre-monsoon period so that they will reach down in reducing the alkalinity of water.

4.0 Computer Base

For the purpose of evolving a systematised approach for controlling the fluoride effects, a computer Data Base (Briz Kishore, 1986) is created for integrated analysis, monitoring and initiating remedial measures (Fig. 1). This data base shall have the facilities to handle mainly three files dealing with the soil characteristics, ground water features and cropwise constituents data. As can be seen from the figure, the data records of the files will be analysed by processing software programmes, to identify the presence of any abnormalities of Fluorde. For example, during the processing of the first file, the system verifies the fluoride percentage values with respect to acceptable range and communicates a message appropriately, if necessary, on the requirement of the soil treatment at the concerned location.

Similarly the second and third files will be analysed for the acceptable level of the chemical composition of the ground water samples and crop constituents, respectively, and hazardous conditions, detected if any, will be highlighted for necessary action. This method will also act as an advisory and prognostic tool in safeguarding the affected areas and also in planning the potable supply of water.

5. Conclusion

Water containing excessive amounts of Fluoride is unsafe for drinking and cause the disease called "Fluorosis". Fluoride affecting Human, livestock, crops and vegetable health required coordinated and integrated investigations for arriving at comprehensive remedial measures. Several regions which are free from fluoride have to be identified so that population

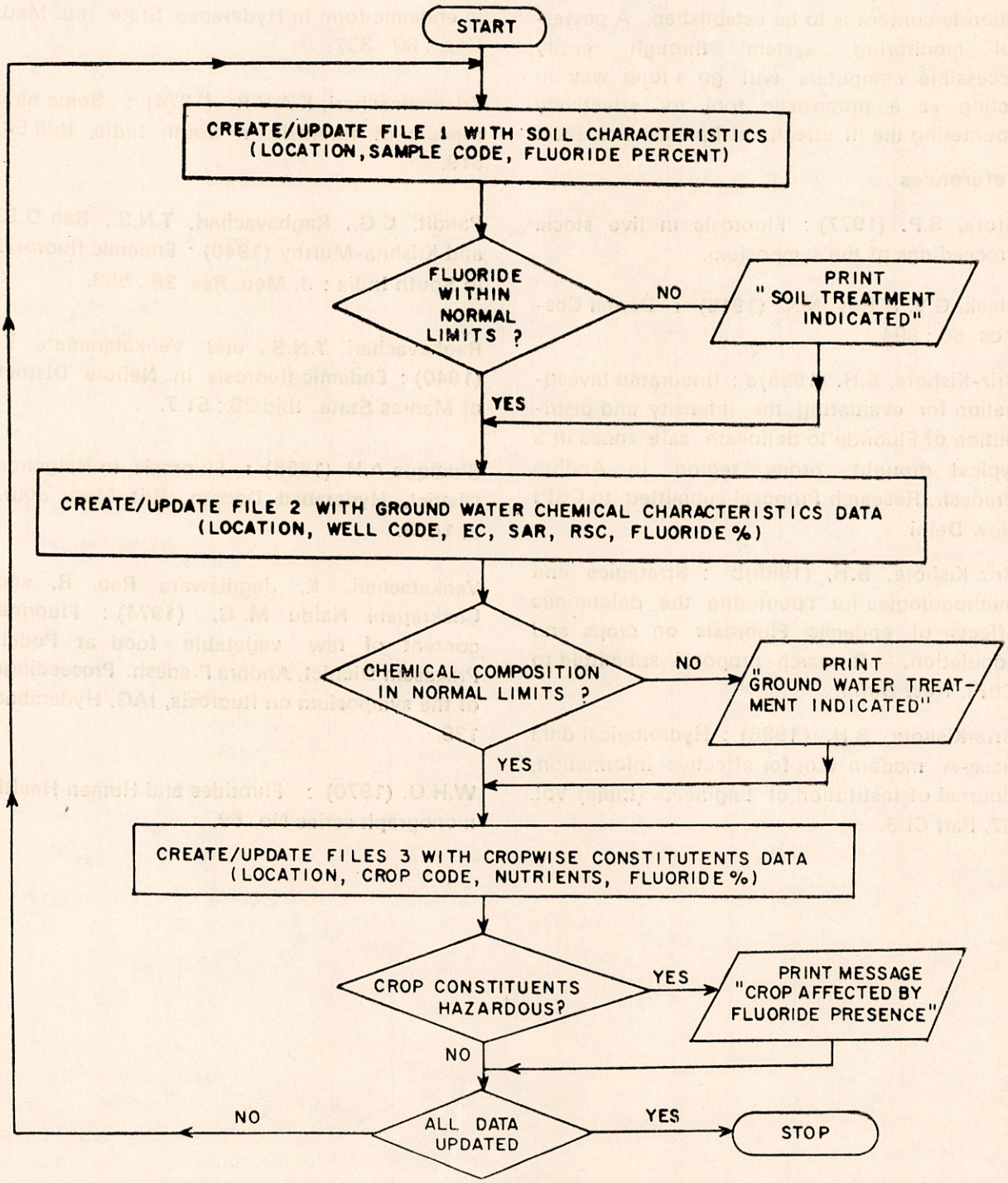

Fig. 1 : A Flow Chart for Integrated Analysis Monitoring and Remedial Measures for Fluoride

in the areas affected by fluorosis can be rehabilitated. Necessary correlation along with development of deflouridation method of chemical composition with natural water and fluoride content is to be established. A powerful monitoring system through easily accessible computers will go a long way in acting as a prognostic tool for effectively countering the ill effects of fluoride incidence.

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