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Review Article

Fluoride Containing Food –Effects on Human Health

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Abstract

This article mainly based on reviewed studies of fluoride contamination of foods and its adverse effects on human health. Fluoride mainly causes dental and orthopedics problems. This paper mainly discuss those foods and its effects as well as remedial measures.

Keywords: Fluoride; Water; Mineral

Introduction

Fluoride is a natural minerals in every ware like soil, water, and air. Industrial waste water contain a huge amount of fluoride. other than that, some food and dental product also contain quantity of fluoride. soil pollution from fluoride occurs in areas where industries emit fluoride into the air and from the use of phosphate fertilizers. However, Fluoride contamination is a public health problem in many areas around the world. Fluoride is the main reason behind diseases like dental fluorosis, Alzheimer's disease, dementia, skeletal fluorosis, abnormal thyroid function and other hormonal disturbances. In addition to fluoride-affected Indian states like Andhra Pradesh and Punjab, the specified regions of Birbhum and Purulia districts of West Bengal have already been declared to be fluoride-polluted by the Public Health Engineering Department. Fluoride has both beneficial and harmful effects on the environment and the human. Fluoride-containing compounds are used in topical and systemic fluoride therapy for preventing tooth decay.

Now the questions arises what is fluoride?

Fluorine is the lightest halogen and most reactive of all chemical elements. In the environment it is not freely found. It is negatively charged ions. Fluoride forms mineral complexes with cations and mineral of low solubility. About 0.06–0.09 per cent of the earth's crust contain fluoride contain complex which is approximately 30mg/kg. Fluoride are found in fluorspar, rock phosphate, cryolite, aptite, mica etc.

Different sources of fluoride

Ground water

The natural concentration of fluoride in groundwater, depends on the geological, chemical and physical characteristics of the aquifer, the temperature, chemical action the porosity and acidity of the soil and rocks, and the depth of the aquifer. In groundwater, fluoride concentrations depends on rock types and permeably. The fluoride concentrations in groundwater in Kenya, South Africa and India can range from below 1 mg/litre to more than 36 mg/litre. Till today maximum fluoride confrontations founds about 2500mg/lit.

Fluoride distribution in water

Some quantity of Fluoride is found in all water body. Seawater typically contains about 1 mg l-1 while rivers and lakes generally exhibit concentrations of less than 0.5 mg l-1 depending on the nature of the rocks and the occurrence of fluoride-bearing minerals. As per Edmunds and Smedley (1996) low concentrations of calcium proves water for fluoride pollution.

Fluorosis is definitely an endemic disease but not in every case. High fluoride concentrations found

- Sediments of marine origin in mountainous areas.
- Volcanic rocks.
- Granitic and gneissic rocks.

Air

Fluoride is also present in the air. Fluorides are widely distributed in the atmosphere Due to dust, industrial production etc. Due

to coal burning and phosphate fertilizer proves high Fluoride contamination. Air of Netherlands USA contain about 70 μg/m^3 and 0.02–2.0 μg/m^3 respectively.

Dental products

So many products for the children to reduce dental decay contain fluoride. This includes

- **Toothpaste:** 1.0–1.5 g kg-1 fluoride,
- **Fluoride Solutions and Gels:** 0.25–24.0 mg kg-1 fluoride
- **Fluoride Tablets:** 0.25, 0.50 or 1.00 mg.

These products contribute fluoride in our nature. Dental products contribute about 0.50 or 0.75 mg fluoride per child per day (Murray, 1986).

Food and beverages

Many foods like Barley, Rice, Taro, Yams and Cassava contain about 2 mg/kg (Murray, 1986). In general, the levels of fluoride in meat (0.2–1.0 mg kg^{-1}) and fish (2–5 mg kg^{-1}) are relatively low. However, Even with a relatively high fish consumption in a mixed diet, the fluoride intake from fish alone would seldom exceed 0.2 mg F- per day. Milk typically contains low levels of fluoride, e.g. 0.02 mg l^{-1} in human breast milk and 0.02–0.05 mg l^{-1} in cow's milk (Murray, 1986). Tea leaves contain high levels of fluoride (up to 400 mg kg^{-1} dry weight).

Total fluoride exposure

Based on the previous discussion, it follows that total daily fluoride contamination can vary from one place to another. In summer season drinking water consumption is higher so the probability of fluoride consumption also increases many times than normal.

List of some foods containing Fluoride

Sources	Fluoride per 100g
Black Tea (Brewed with Tap Water)	372.9μg
Fruit Juice (Grape)	138μg
Sodas	80.6μg
Blue Crab	209.9μg
Shrimp	201μg
Water with Natural Fruit Flavors and Low Calorie Sweeteners	104.5μg
Table Wine	153.3μg
Coffee	90.7μg
Average Municipal (City) Tap Water	71.2μg
Raisins	233.9μg

Table 1

Effects of fluoride

Fluoride has a adverse effect against dental caries if the concentration is approximately 1 mg/l. Regular consumption of higher concentrations can cause dental fluorosis and even skeletal fluorosis. Permissible limit of Fluoride in drinking water is 1.5 mg/l as per WHO. Fluoride concentrations are critical in mainly in developing countries due lack of infrastructure. If the fluoride content in water is beyond the permissible limit, then it has to be defluoridised by suitable means. Dental caries remain a major public health concern in most industrialized countries, affecting 60–90% of schoolchildren and the vast majority of adults. When present in concentration of 0.8-1.0 mg/L, fluoride is beneficial for calcification of dental enamel especially for the children below 8 years of age. At higher concentrations (1.5-2.0 mg/L), fluoride effects adversely and leads to dental fluorosis. At still higher concentration, (3-6 mg/L) skeletal fluorosis occurs. The disease affects the bone and ligaments. Intakes of 20-40 mg F/L/day over long period have resulted in crippling skeletal fluorosis.

Effects on humans

The effects of long-term consumption of fluoride mainly from drinking-water as well as food. Many developing country are new very much concern of this new alert and doing many study on it.

Effects on teeth

The first "black teeth" or Dental Fluorsis was found in maxico in 1888. Dental Fluorsis is caused by destroying enamel of teeth (Whitford, 1997). High levels of fluoride present in concentrations up to 10 mg/ l were mainly reason for dental fluorosis (yellowish or brownish striations or mottling of the enamel) while low levels of fluoride, less than 0.1 mg l^{-1}, were associated with high levels of dental decay (Edmunds and Smedley, 1996), poor nutritional status is also an important contributory factor. Fluoride Concentrations in drinking-water of about 1 mg l^{-1} are reason for dental caries, particularly in children. This can result in erosion of enamel. But main surprising fact is that dental fluorsis is mainly observed in children but not in adults.

Figure 1: Dental Fluorosis.

Skeletal effects

Skeletal fluorosis can result of extreme fluorosis and it also causes osteosclerosis, ligamentous and tendinous calcification and

extreme bone deformity. Here are some example of crippling Skeletal Fluorosis are shown below.

Figure 2: Skeletal Fluorosis.

Cancer

There have been a huge number of studies on various cancers and exposure to fluoride in drinking-water. But till date we could not able to reached to a fruitful conclusion.

Other possible health effects

- Not effect on respiratory, hematopoietic, hepatic or renal systems has emerged from studies.
- Kidneys have a major role on fluoride excretion from human body.
- No increasing risk for pregnant women.

According to Central Pollution Control Board (PCB) the effects of fluoride levels in drinking water on human health are tabulated below.

Fluoride(mg/L)	Effects on human body
Less than 0.5	Dental cavities
0.5-1.0	Protection against dental cavities. Care of bone and teeth.
1.5-3.0	Dental fluorosis
3.0-10	Skeletal fluorosis (adverse changes in bone structure).
10 or more	Crippling skeletal fluorosis and severe ostreosclerosis.

Table 2: Different Fluoride Level Effecting on Human body.

Remediation materials

Here we discuss about some materials which gives much remedy of fluoride contamination of ground water problem;

Alumina and Aluminum

Among the adsorbents, activated alumina is one of the most important materials for defluoridation of water. For the fluoride removal from water Acidic alumina, amorphous $Al(OH)_3$, gibbsite or alumina (Al_2O_3) are used at pH range 3–8 for fluoride concentration 1.9 -19 mg/L.At pH 5–7, maximum fluoride removal was found about 16 mg/g. Fluoride adsorption on alum occurred due to electrostatic repulsion higher pH value. At neutral condition, adsorption capacity was obtained 1400 mg/kg. The proposed method is selective for aluminum fluoride complexes and Al(III) in the pH conditions of their occurrence.

Activated Alumina

Activated alumina is a highly porous rounded granular material. Main component of AA is aluminum tri hydrate used as a commercial desiccant in many gas drying processes.

Activated Alumina can be regenerated using hydrochloric acid, Sulfuric acid, Alum or sodium hydroxide which needs to be followed by a neutralization process. AA is strongly depends on pH. Batch adsorption data14 showed very little removal at pH 11.0 and optimum removal at pH 5.0. Hence raw water pH and regenerated bed pH need to be adjusted accordingly.

Fluoride removal by AA is depends on hardness also which reduce the efficiency of the system.

The use of activated alumina is an economical and efficient method. The process has been found to bring down fluoride levels to 0.1 mg/L. The operational, control and maintenance problems, mainly clogging of bed, may also be minimizing by different methods.

The various advantages of using activated alumina are listed below:

- Requires minimum contact time for maximum Defluoridation.
- It is readily available in market.
- Probability of regeneration is higher than other materials.
- Its Defluoridation capacity is not temperature related.

Iron-based adsorbents

Many Studies shown that Iron-based materials have been used for fluoride removal from water. Chloride and nitrate ions had negligible affects on fluoride adsorption rather than sulphate and phosphate ions. Fluoride uptake increased with increasing Ph values.

Calcium-based adsorbents

Calcium has a good affinity for fluoride anion and it has been used for fluoride removal. Aluminium hydroxide used as a adsorbent used for fluoride removal from water. At less pH the adsorption of lime stone was decreased.

Bio adsorbents

Many leafs are used as remedial material for fluoride like neem and papal leafs.

Carbon based sorbents

Carbon used as an adsorbent for fluoride removal. Bone charcoal and activated carbon are main materials for absorbent which are produced from burning of coconut shells, fish bone, bones of animals etc.

Bone charcoal

Charring animal bones is the basic material to produce Bone charcoal. It mainly consists of 6-10% Calcium Carbonate, 57-80% Hydroxylapatite, and 7-10% Activated Carbon.

Most of the organic materials in the bones are abolished by the heat, rest portions are being pyrolysed to activated carbon. A low concentration of oxygen will increase the quality of the product, mainly the adsorption capacity. Finally the ash are cleaned by the water approximately at 500°C.

(Source: http://en.wikipedia.org/wiki/Bone_char).

Followings are the main advantages and disadvantages of the Bone Charcoal:

Advantages

- Animal bones are easily available.
- No complex chemicals are required for this process.
- Short time needed approx 30min for 1st reaction.
- Taste and the colour of the water after purification is normal.
- High sorption capacity.

Disadvantages

- Animal bones specially in Indian context is not widely acceptable.
- Maintenance and regular monitoring necessary – if filter is saturated it needs to be regenerated or replaced.
- Apart from high alkalinity, it may impart taste and odor and result in organic leaching if not prepared properly.

Processed bone:

Calcium Phosphate which has a great affinity towards fluoride, are found in Bone. The bone is heated, degreased, dried and became powdered. The bone powder then can be used to remove fluoride from water. The bone is used as a contact bed in the process.

Activated carbons

Activated carbon is usually derived from charcoal. Water is pushed through the block of charred coconut shells. The carbon essentially polishes the water molecules, bacteria and cysts, pesticides, viruses as well as bad odors, bad tastes etc. This process is successfully used in many municipality to provide with treated municipal water and is often used in steam distillation, ozone and ultraviolet water systems, reverse osmosis. Activated carbon can also be produced by the paddy husk. The efficiency of the activated carbons produced by this way has greater efficiency.

Building materials

Many building materials are common remedial materials for fluoride removal. Concrete is also a very good adsorbent for the removal of fluoride from water. The maximum adsorption of fluoride took place at acidic medium. Hydrated cement and hardened alumina cement granules, cement sand granules are also very good for fluoride removal.

Miscellaneous adsorbents for Defluoridation of water

Bleaching powder was used for fluoride removal from water. Magnesia-loaded fly ash was prepared with magnesium chloride solution used as fluoride removing agent at pH 3. Besides the above mentioned adsorbents, various other authors also examined the potential of different types of sorbents.

Conclusion

From all the topic discuss before, we can conclude that It is necessary to remove fluoride contamination from foods otherwise it will create a big problem in future days. And at that time it will be very difficult to control all such problem. All the above materials are very useful for urban and rural area and easily available in market.

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