Chapter - V

SUMMARY AND CONCLUSIONS

In the course of the present investigations, the effects of fluoride on the structure and function of some organs of adult albino male mice (Mus musculus) were studied. An investigative survey in Mehsana and Banaskantha districts was conducted and the level of health hazards related to the consumption of fluoride in drinking water in human population were also studied.

An attempt was made to develop a simple defluoridation unit in The Department of Environmental Engineering, L.D. College of Engineering, Navarangpura, Ahmedabad.

PART - I

STUDIES ON EFFECTS OF SODIUM FLUORIDE (NaF) INGESTION ON SOME TISSUES OF ALBINO MALE MICE.

1. NaF was administered via the oral route, at the dose of 10mg/kg of body weight/day/ animal for 30 days. No alterations in the haematological parameters like the concentration of haemoglobin (Hb), Red Blood cell count and white blood cell count were observed. Hence, it was concluded that the
possibility of anaemic condition in experimental animals does not exist.

2. The treatment of NaF brought about marked decrease in the protein levels of all the three organs (Viz. Kidney, liver and gastrocnemius muscle) indicating alteration of protein metabolism which would affect the growth of the animal.

3. An increase in the levels of sodium (Na⁺) and potassium (K⁺) levels in serum revealed that the electrolyte balance was not maintained which might ultimately lead to loss of water from the body.

To conclude the present work, in support of other reports from our laboratory suggests that fluoride does not affect the haematological parameters like haemoglobin, Red blood cells count and white blood cells count in 30 days treatment. Yet, there is significant alteration in protein levels and electrolyte balance of male mice. This study is important in view of human exposure to fluoride and other fluoride containing compounds in our environment.

PART - II

STUDIES ON IMPACT OF HIGH WATER-BORNE FLUORIDE IN ENDEMIC HUMAN POPULATION OF MEHSANA AND BANASKANTHA DISTRICTS OF NORTH GUJARAT.

An extensive survey work was undertaken in 53 villages of Mehsana and Banaskantha districts of North Gujarat, India, in population consuming fluoride contaminated drinking water, in order to evaluate the extent of toxicity in some tissues.

1. The drinking water samples gathered from control areas of Ahmedabad city
revealed fluoride content within the permissible levels.

2. The high fluoride levels in drinking water is the major source for human population residing in these villages, although food stuffs also contribute to a smaller extent. The high fluoride levels in drinking water of endemic regions may be due to the presence of fluoride bearing rocks/minerals and their contact with water.

3. The haemoglobin levels were not altered significantly in fluorotic human population of North Gujarat as compared to control population which indicates no occurrence of anaemia in this endemic population. However, in some cases, it declined which might also be due to malnutrition.

4. The serum fluoride levels were elevated in fluoride afflicted human population as compared to control population which may be due to impaired excretion by the kidney.

5. The levels of blood glucose were declined in fluorotic human subjects of North Gujarat with respect to control population elucidating alteration in glycolysis. These changes are responsible for altered carbohydrate metabolism.

6. The levels of epinephrine and nor-epinephrine were increased significantly in fluorotic cases of North Gujarat as compared to control cases of Ahmedabad which might affect the carbohydrate metabolism.

7. The serum cholesterol levels remained unaltered in fluorotic human population suggesting that there was no possibility of hypo or hypercholesterolemia. In addition to this, the individuals have no risk of atherosclerosis at least in early stages of exposure.

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8. The levels of circulating testosterone were reduced in fluoride afflicted individuals as compared to control population of Ahmedabad city showing decrease in androgen levels in these individuals and probably alteration in steroidogenesis.

9. The serum protein levels were altered in fluorotic population as compared to control population, suggesting that protein synthesis was altered which would further affect the growth and body weight.

10. Body accumulation of fluoride resulted in enhancement of serum transaminases i.e. SGOT and SGPT indicating altered liver function in fluorotic individuals as compared to control population of Ahmedabad city.

11. The levels of triiodothyronine and thyroid stimulating hormone were not affected in fluorotic population of endemic regions in North Gujarat as compared to control population indicating normal basal metabolic rate and almost normal functioning of thyroid gland in these individuals.

12. The profile of serum tetraiodothyronine (T₄) was increased in afflicted individuals suggesting its higher metabolism or reduced utilization in these individuals as compared to control population in Ahmedabad city.

13. The serum follicle stimulating hormone (FSH) levels remained unaltered in afflicted individuals of North Gujarat as compared to control population.

14. The electrolyte levels in the sera of afflicted individuals of North Gujarat were elevated with respect to the control population of Ahmedabad city, which might cause water imbalance in these individuals.

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15. The serum calcium levels were decreased in many of the individuals residing in endemic regions due to soft tissue calcification in their body.

16. Urinary protein levels were increased in fluoride afflicted individuals as compared to control individuals suggesting reduction in body weight and growth of the individual.

The present investigations revealed that many of the people residing in endemic regions are not only affected by skeletal fluorosis, but also their soft tissues undergo various changes. Thus, it is absolutely essential to take preventive measures. Therefore, the responsibilities lies with the government and non-government organisations to help the endemic population who have been already affected or are on their way to get afflicted with fluorosis.

In view of all this, defluoridation units must be established which will suit the domestic needs. The individuals must be educated regarding problems of high fluoride consumption and must be provided defluoridated water having fluoride levels within the permissible limits. Therefore, the work carried out in human population in endemic regions of North Gujarat during the tenure of these investigations is a significant contribution (i) in understanding the mechanism of action of fluoride to some extent in soft tissue function and metabolism and (ii) in the existing knowledge in the field.
STUDIES ON MASS-BALANCE OF FLUORIDE OF DEFLUORIDATION
TECHNIQUE

A prototype, laboratory scale model, based on guidelines of NEERI for defluoridation of water was used to study the mass-balance relationship, chemical analysis was carried out to assess the quality of water after defluoridation.

1. The levels of fluoride were adjusted to vary between 2.60 mg/L to 5.80 mg/L by adding concentrated sodium fluoride (0.75%) solution in raw water.

2. The levels of fluoride were significantly reduced in outlet as a result of defluoridation treatment.

3. Due to addition of lime solution during the treatment, pH levels were increased in treated water due to the release of hydroxide ions.

4. Alkalinity of the treated water was decreased in outlet as compared to inlet due to addition of alum.

5. Calcium hardness and total hardness were increased due to increased concentration of calcium ions in lime added set.

6. Calcium hardness and total hardness remained unaltered in the remaining sets in the treated water as compared to raw water of defluoridation unit.

7. Magnesium hardness remained unaltered as compared to raw water of defluoridation unit.

8. During the course of this study, total dissolved solids were increased in treated water as compared to raw water of defluoridation unit indicating the presence

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of aluminium and calcium salts.

9. The levels of chloride remained unaltered in the treated water of defluoridation unit as compared to raw water.

10. Sulphate levels were increased during the course of study in treated water as compared to raw water due to addition of ferric alumina.

11. Studies on mass-balance indicated that proper mass-balance was not achieved in theoretically calculated sludge and actually collected sludge.

12. Percentage of fluoride reported indicated better accountability in batch process as compared to continuous flow system.

FUTURE LINES OF WORK:

The findings obtained and incorporated in the present study necessitate the following investigations to be undertaken in future in order to understand effects of fluoride and its mechanism of action in details as well as defluoridation of water.

Hence, some future lines of work are suggested:

1. ANIMAL STUDIES:

1. To study the effect of fluoride on haematology in order to evaluate the mechanism of action of fluoride on haemoglobin, Red Blood cell count, white Blood cell count during long term treatment.

2. To study the characterization of protein in different organs/tissues.

3. Since there is a paucity of data on cattle fluorosis, extensive studies in endemic regions in this direction are called for.

4. Impact on carbohydrate and lipid metabolism in connection with fluoride toxicity should be studied in comprehensive detailed manner in experimental

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animals.

5. As there is a lacuna of knowledge on the immunological studies in relation to fluoride toxicity, extensive work in this direction should be given top priority.

6. In view of unavailability of data on effect of fluoride toxicity on cardiovascular system, investigations in this direction are strongly recommended.

7. Ultrastructural studies on different organs like kidney, liver, gastrocnemius muscle and reproductive organs are essential in order to study the structural alterations after fluoride treatment.

8. Studies on supplementation of various therapeutic agents need to be undertaken in order to evaluate their ameliorative effects.

9. In view of controversial reports related to genotoxic effects of fluoride, further research in this direction is essential.

10. Studies using radiolabelled fluoride have to be carried out in various systems to ascertain its precise site of action.

11. Apart from Na⁺ and K⁺ other trace elements like Cu²⁺, Mg²⁺, Al³⁺ etc., are required to be studied in relation to fluoride toxicity.

II HUMAN STUDIES:

1. Detailed studies on various endocrine glands need to be carried out.

2. In view of rapid and easy detection of fluoride from nail, saliva, hair or urine, simple, reliable and cheap diagnostic tests should be developed for diagnosis of fluorosis as well as to take precautionary measures in fluoride endemic regions.

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3. Training cum awareness camps should be arranged for fluorotic human subjects of endemic ares to educate the rural public about the disease as well to take some preventive measures.

III DEFLUORIDATION STUDIES:

1. In view of the interference of aluminium with fluoride, determination of aluminium in raw water and treated water is essential.

2. In order to evaluate the extent of aluminium toxicity, tap water, raw water and treated water should be tested in laboratory rodents.

3. Studies related to mass-balance analysis should be carried out in existing defluoridation plants all over the country.

4. Suitable sludge disposal/treatment method should be developed to avoid fluoride leaching after its disposal.

5. Studies to establish the relationship between depleting water table and fluoride concentration should be carried out.

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