CHAPTER 4

CONCLUSIONS

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- Based on the data available from Gujarat water supply and sewerage board, two districts from North Gujarat namely Mehsana and Patan and three districts from Saurashtra; Jamnagar, Amreli and Rajkot were selected for the study to map Fluoride concentration in the villages of these districts in the year 2009-12. In Mehsana, Fluoride content in 10 villages (33.33%), of Patan, 07 villages (23.33%), of Jamnagar 01 village (3.33%), in Amreli 20 villages (66.66%) and in Rajkot 11 villages (36.66%) was found to be beyond permissible limit of 1.5 ppm. Among these, Amreli, Rajkot and Mehsana recorded Fluoride level much beyond the permissible limit. The geological set up of North Gujarat region mainly comprises of country rock as charnokites, calc-granites and calc-gneiss formation. On weathering, the fluorine tends to be released preferentially from these minerals and enrich Fluoride in the groundwaters. In Saurashtra, presence of Basaltic rock, sandstone, Deccan trap lava, supra trappeans, Gaj beds, and Miliolite limestone serve as natural source of Fluoride.
- The results on mapping Fluoride concentration in 30 villages of Mehsana, Amreli and Rajkot districts revealed that in Mehsana, Satlasana taluka (village Nana Kothasana 4.6 ppm), in Amreli, Lilia taluka(village Gundaran 3.0ppm), and in Rajkot, Wankaner taluka (village Samadhiyala 3.37 ppm) showed high concentration of Fluoride in groundwater**.**
- The efficiency of Fluoride removal capacity in-vitro was checked using *Moringa oleifera* L., *Cocos nucifera* L. and *Oryza sativa* L. For *Moringa oleifera* - Bark, *Moringa oleifera* – Seed, *Cocos nucifera* - Shell, *Cocos nucifera* - Mature Fruit Fiber and *Oryza sativa* – Husk were used. The order of removal capacity of Fluoride was *M. oleifera* – Bark (16%) > *M. oleifera* – Seed (13.33 %) > *C. nucifera* - Shell (3.33 %) > *O. sativa* – Husk (2.67%) > *C. nucifera* fruit fiber (2.0%). Bark and seeds of *M. oleifera* exhibited maximum Fluoride removal capacity.
- In-vitro Fluoride removal efficiency of MBP (*M. oleifera* bark powder) was 92.75% within 8 hours of contact time at 5 g/l dose with initial concentration

of 1 ppm as measured in optimized study whereas for MSP (*M. oleifera* seed powder), the reduction was 32.5% within 4 hours of contact time at 5 g/l dose and 1 ppm initial concentration of Fluoride. The adsorption data fits Freundlich better than Langmuir isotherm for both, MBP and MSP.

- Among various physicochemical parameters estimated for groundwaters of Satlasana taluka, values of pH and Fluoride were reported beyond permissible limit whereas Total alkalinity, TDS, Calcium, Magnesium, Sulphate and Sodium were found within the limit of BIS. In Lilia, pH, Fluoride, Sodium, Sulphate and TDS were beyond the limit whereas Total Alkalinity, Calcium and Magnesium were within the limit. pH, Fluoride, TDS, Sodium and Calcium were beyond limit but Total Alkalinity, Magnesium and Sulphate were found within the limit in Wankaner taluka.
- In Satlasana taluka of Mehsana district, pre and post monsoon correlation analysis showed that Fluoride concentration in groundwater was positively correlated with pH, Total alkalinity, TDS, Carbonate, Bicarbonate and Sodium and negatively correlated with Calcium and Magnesium. The Correlation analysis in pre monsoon of Lilia taluka of Amreli district, Fluoride showed positive correlation with TDS, Carbonate, Sodium, Calcium and Magnesium while negative correlation with pH, Total alkalinity and Bicarbonate. In post monsoon, Fluoride was positively correlated with all the parameters except pH. In Wankaner taluka of Rajkot district, Fluoride showed positive correlation with pH, Total alkalinity, TDS, Carbonate, Bicarbonate and Sodium in pre monsoon season while negatively correlated with Calcium and Magnesium. For post monsoon season, Fluoride showed positive correlation with all parameters except Calcium, Magnesium and Sodium.
- Piper diagram for Satlasana reflected that the alkaline earth metal (Ca^{+2} + Mg^{+2}) exceed alkali (Na^{+}+ K^{+}) and weak acids (HCO_3^{-} + CO_3^{-2}) over strong acids (Cl^{-} + SO_4^{-2}) in both the seasons indicating Magnesium Bicarbonate type in both the seasons.

  The alkali (Na^{+}+ K^{+}) were found dominating over alkaline earth metal (Ca^{+2} + Mg^{+2}) and weak acids (HCO_3^{-} + CO_3^{-2}) exceed strong acids (Cl^{-} + SO_4^{-2}) in both the seasons in Lilia. In pre-monsoon season groundwater is of Sodium

Chloride type and Sodium Bicarbonate type and in post monsoon season it is only of Bicarbonate type.

- Groundwater type of Wankaner taluka, alkaline earth metal (Ca^{+2} + Mg^{+2}) exceeds alkali (Na^{+}+ K^{+}) and weak acids (HCO_3^{-} + CO_3^{-2}) exceed strong acids (Cl^{-} + SO_4^{-2}) in pre-monsoon season In post-monsoon, alkali (Na^{+} + K^{+}) were dominant over alkaline earth metal (Ca^{+2} + Mg^{+2}) and strong acids (Cl^{-} + SO_4^{-2}) exceed weak acids (HCO_3^{-}, CO_3^{-2}). Groundwater is of Sodium Bicarbonate and mixed type in both the seasons while is of Sodium Chloride type in post monsoon. Vajapur village of Satlasana taluka, Timbri village of Lilia taluka and Amarsar village of Wankaner taluka showed high Bicarbonate content in groundwater and was directly positively correlated with the Fluoride concentration.
- The defluoridation capacity of MBP and MSP in in-vivo was much lower than in in-vitro condition.
- The Chlorophyll content in the leaves of 1 to 5 ppm Fluoride treated plants of *Triticum aestivum* L. and *Pennisetum glaucum* R.Br. showed no definite pattern of increase or decrease in the pigment contents as compared to control plants. Thus, the contents remained unaffected when treated with Fluoride ion.
- Carbohydrate content showed rise in the level in both the treated test plants. On the contradictory, treated test plants had more carbohydrate in the vegetative parts as compared to control.
- Results obtained from our study on effect of Fluoride ion on Protein content clearly stated that with increase in Fluoride concentration in-vitro, Protein content also showed rise in the level of both the test plants. Moreover, treated plants showed more Protein content than control plants.
- The fluctuating level of Proline in both the test plants as well as in control plants was recorded in the present study. This lead us to conclude that exposure to Fluoride ion did not cause any stress. There might be no stress in treated test plants.

- The estimation of Fluoride accumulation in the grains (seeds) of both the test plants estimated Fluoride content in grains of *Triticum aestivum* L. was 0.076, 0.092, 0.128, 0.161 and 0.19 mg/g when treated with Fluoride concentration of

1,2,3,4 and 5mg/l respectively whereas in *Pennisetum glaucum* R.Br it was 0.069, 0.089, 0.114, 0.156 and 0.194 mg/g. Results showed that gradual rise in the Fluoride concentration increased Fluoride accumulation in the grains of both the test plants. There was negligible difference in the accumulation. However as compared to reports on Fluoride accumulation by various researchers, we got very less accumulation in the grains of both the test plants.

- Observations on surface morphological features of treated (5 mg/l Fluoride concentration) grains of *Triticum aestivum* L. and *Pennisetum glaucum* R.Br. grain did not exhibit any alterations or abnormal features as compared to control plants.
- The quantitative analysis using EDX on grains of Fluoride treated *Triticum aestivum* L. plant showed 0.16 % Fluoride ion and in *Pennisetum glaucum* R.Br. treated seeds Fluoride ion concentration was 0.03%, the presence of which was confirmed by a very small peak. The control grains of both the plants showed absence of Fluoride ion concentration as well as peak.