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Review article

Is Industrial Fluoride Pollution Harmful to Agricultural Crops? Farmers Need to Know

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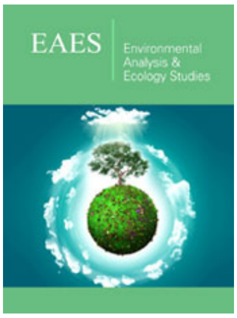

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Abstract

Industrialization is more important for running and strengthening the economic system of any country. But there are many industries that also emit fluoride along with other toxic gases, causing fluoride pollution. Due to this, not only air, soil, and water but also herbage, vegetation and agricultural crops get contaminated with fluoride. Among these industries, coal-burning power stations and brick kilns and the manufacture or production plants of steel, iron, aluminum, zinc, phosphorus, chemical fertilizers, glass, plastics, cement, oil refineries, etc. are the most common sources of fluoride pollution. Fluoride is released from these sources into the surrounding environment in both gaseous and particulate or dust forms. Studies have revealed that chronic exposure to this industrial fluoride is unsafe or harmful to agricultural crops and produces a variety of toxic effects. In fact, industrial fluoride enters crop plants mainly through the stomata of the leaves. However, it can also enter through the root in fluoride-contaminated soil. The bioaccumulation of fluoride in plants disturbs their morphological, physiological, and biochemical parameters. The persistence of fluoride bioaccumulation in crop plants adversely affects their photosynthesis, respiration, mineral nutrition, fertilization, germination, growth and development, biochemical processes, and agricultural productivity. The most common visible pathognomonic symptoms of industrial fluoride poisoning in crop plants have been found to be stunted growth (dwarfism), chlorosis, necrosis, abscission of leaves, flowers, and fruits, and decreased seed production. Once plants develop necrotic spots on their leaves, the damage cannot be reversed by any treatment. But most of the farmers are not aware of these side effects on crops or the economic loss caused by industrial fluoride emissions. The current communication focuses on whether industrial fluoride pollution is harmful for the health of agricultural crops. Simultaneously, research gaps are also highlighted for further research work on industrial fluoride toxicity in diverse agricultural crops.

Keywords: Abscission; Chlorosis; Crops; Dwarfism; Industrial fluoride pollution; Necrosis; Photosynthesis; Phytotoxicosis; Productivity; Respiration; Toxic effects

Introduction

Fluoride is found naturally in almost every ecosystem or environment with varying concentrations [1,2]. However, its presence in water and air is more important for the health of humans and domestic animals. It is clear from several research studies that repeated exposure to fluoride from any medium or source over a long period of time is unsafe and extremely harmful not only to humans [3-7] and domestic animals [8-13] but also to various agricultural crops [14-22]. However, chronic fluoride poisoning (fluorosis) in humans [23-32] and various species of domestic animals [33-55] through drinking fluoridated water has been more widely studied worldwide. In various agricultural crops, chronic fluoride poisoning or toxicity due to chronic exposure of fluoride through industrial fluoride pollution and fluoridated water has also been studied by many workers [14-22]. The current communication focuses on whether industrial fluoride pollution is unsafe or harmful for the health of agricultural crops. Along with this, research gaps have also been highlighted for further research work on the industrial fluoride-induced toxic effects on diverse species of agricultural crops.

Industrial Fluoride Pollution

It is a well-known fact that industrialization is more important than ever run and strengthen the economic system of any country. That is why every country pays special attention to industrialization. But it is also true that, due to industrialization in one way or another, our ecosystem or environment is also suffering a lot of damage. Due to this, not only the health of humans and animals but also agricultural production is deeply affected. The main reason for this is the air and water pollution caused by them. But most people do not know that there are many factories or industries running around us that emit fluoride along with other toxic gases in the environment, causing fluoride pollution. Due to this, not only air, soil, and water but also herbage, vegetation, and agricultural feed and crops get contaminated with fluoride. Among these industries, coal-burning power stations and brick kilns and the manufacture or production of steel, iron, aluminum, zinc, phosphorus, chemical fertilizers, glass, plastics, cement, oil refineries, and hydrofluoric acid plants or unites are common sources of industrial fluoride pollution [1] (Figure 1). However, coal-fired brick kilns are the commonest and main source of industrial fluoride pollution in rural areas [11,12] and these are mostly established on or near agricultural land or fields (Figure 2). These industrial sources or activities release fluoride into the surrounding environment in both gaseous and particulate or dust forms. However, the spread of fluoride pollution is more dependent on wind direction and its velocity.

Figure 1: Potential sources of industrial fluoride pollution. Atomic power stations (Fig a) and cement plants operating in or near various agriculture crops (Figs b-d).

Figure 2: Fluoride pollution from coal-burning brick-kilns operating in or near various agricultural crops.

Is Industrial Fluoride Pollution Harmful to Agricultural Crops?

Yes, industrial fluoride has the potential to harm a variety of agricultural crops. This has been proven by several studies conducted on a variety of agricultural crops [14-22]. In fact, industrial fluoride contaminates not only crop plants but also agriculture soil and freshwater ecosystems. Therefore, fluoride can enter plants through two main routes. First, air-borne deposition of gaseous fluoride due to industrial fluoride pollution occurs through stomatal diffusion. Through leaf stomata, fluoride penetrates the cell wall and migrates to the margins and tips of leaves, which are the sites of greatest volatilization [56]. The second route is through a passive diffusion process in the roots of plants in fluoride contaminated soil and fresh water. Fluoride is subsequently transported through the xylem via-apoplastic and simplastic pathways in a directional distal movement to the shoot [57]. In fact, fluoride moves into the transpiration stream from the roots and/or through the stomata, where it eventually accumulates in the leaf margins. Generally, fluoride accumulation follows the order of soil > root > shoot > grain. The bio-availability of fluoride to plants is mainly influenced by the presence of metal ions such as calcium (Ca), aluminum (L), and phosphorus (P), the pH of the solution, and the type of soil [58].

Repeated or chronic industrial fluoride exposure for long period of time and its persistence bioaccumulation produces diverse adverse toxic effects in both seasonal and off-season agricultural crops, vegetables, and trees [14,17,20]. In fact, bioaccumulation of fluoride in different parts of plants disturbs or causes adverse changes in various physico-biochemical or metabolic processes and ultimately triggers the development of various side effects or ill effects. Ultimately, these effects reduce the annual productivity or yield and harvest index of the agricultural crop.

The most common and earliest visible morphological changes induced by fluoride in crop plants are stunted growth (dwarfism syndrome), necrotic lesions or necrosis, chlorosis, abscission of leaves, flowers, and fruits, leaf damage, tip burning, and curling of leaves that spread inward (Figures 3 & 4) [14,20]. Once plants develop necrotic spots on their leaves, the damage cannot be reversed by any treatment. In fact, fluoride has the ability to inhibit or alter the physiology of photosynthesis and other biological processes such as seed germination, respiration, CO_2 assimilation, protein and nucleotide synthesis, carbohydrate metabolism, hormonal imbalance, various enzyme activities, gene expression patterns, inhibition of developmental and reproductive capabilities, etc. These parameters have been well studied scientifically by several researchers on a variety of agricultural crops [59-65]. Ultimately, these fluoride-induced morpho-physiological changes affect the rate of agricultural productivity or yield due to which the farmers suffer huge economic losses. Scientific evaluation has not yet been done on such economic losses, which is also very important. This type of evaluation is very important and helps in the determination of economic policy. However, which agricultural crop is more susceptible, sensitive, or less tolerant to industrial fluoride is not yet clear. Therefore, there is still a need for more comparative studies on the sensitivity of different species of agricultural crops to fluoride.

Figure 3: Rice plants (*Oryza sativa*) showing leaf necrosis with burnt margin due to chronic fluoride exposure through industrial fluoride pollution [14].

Figure 4: Stunted growth in rice plants (*Oryza sativa*) due to chronic fluoride exposure through industrial fluoride pollution [14].

The magnitudes of these pathological changes in crop plants are generally dependent on the industrial fluoride concentration, the frequency and duration of exposure, and the density of its bioaccumulation. However, more studies are needed on the diverse factors that influence the severity of the toxic effects of industrial fluoride in plants as studied in humans and animals [66-73]. The findings of such studies are more useful in amelioration of fluoride toxicity in agricultural crops. Moreover, there is also a great need of guidelines for the correct diagnosis of fluoride induced toxicity in crop plants as in humans and domestic animals [74-77]. However, accurate detection of fluoride toxicity in crops can be easily done by fluoride estimation in their feed [78].

"A major danger from industrial fluoride poisoning in crops is the possibility of fluorosis in animals and humans by eating fodder and grain from these crops, respectively. In fact, there are more chances for the presence of fluoride in their fodder and grains [79-81]. Interestingly, most people are unaware of this. So it is very important and necessary to prevent or control industrial fluoride pollution in rural or agricultural areas. This can be made possible by adopting effective scientific techniques, thereby reducing fluoride emissions. In addition, there is a need for regulators of fluoride emissions, as well as stricter laws and their effective implementation. Otherwise, the owners and management of these fluoride-emitting industries will not pay attention to the fluoride pollution and will also be careless towards it".

Conclusion

In or around the agricultural lands, several industries, such as coal-burning power stations and brick kilns and the manufacture or production plants of steel, iron, aluminum, zinc, phosphorus, chemical fertilizers, glass, plastics, cement, oil refineries, and hydrofluoric acid are sources of fluoride pollution. Fluoride from these sources is released into the surrounding environment, contaminating various ecosystems and agriculture soil and crops. The continuous bio-accumulation of industrial fluoride in agricultural crop plants is not safe and harmful and causes many mild to severe pathological changes (stunted growth, necrosis, chlorosis, abscission of leaves, flowers, and fruits, leaf damage, tip burning, curling of leaves, and various physiological processes) in them and ultimately reduces their productivity. Fluoride-induced necrosis is irreversible damage in crop plants. Furthermore, there is also a great need for correct guidelines for the correct diagnosis of fluoride-induced toxicity in plants. Prolonged consumption of fodder and grains of fluoride affected crop plants, which are also harmful for domestic animals and humans, respectively. Therefore, it is very important to stop or reduce industrial fluoride pollution, which is possible by making strict laws and implementing them effectively.

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References

1. Choubisa SL (2018) Fluoride distribution in drinking groundwater in Rajasthan, India. Current Science 114(9): 1851-1857.
2. Choubisa SL (2018) A brief and critical review on hydrofluorosis in diverse species of domestic animals in India. Environmental Geochemistry and Health 40(1): 99-114.
3. Adler P, Armstrong WD, Bell ME, Bhussry BR, Büttner W, et al. (1970) Fluorides and human health. World Health Organization Monograph Series No. 59, World Health Organization, Switzerland, Geneva.
4. Choubisa SL (2018) A brief and critical review of endemic hydrofluorosis in Rajasthan, India. Fluoride 51(1): 13-33.
5. Choubisa SL (2022) Status of chronic fluoride exposure and its adverse health consequences in the tribal people of the scheduled area of Rajasthan, India. Fluoride 55(1): 8-30.
6. Choubisa SL, Choubisa D, Choubisa A (2023) Fluoride contamination of groundwater and its threat to health of villagers and their domestic animals and agriculture crops in rural Rajasthan, India. Environmental Geochemistry and Health 45(3): 607-628.
7. Choubisa SL (2023) Is drinking groundwater in India safe for human health in terms of fluoride? Journal of Biomed Research 4(1): 64-71.
8. Choubisa SL (2015) Industrial fluorosis in domestic goats *(Capra hircus)*, Rajasthan, India. Fluoride 48(2): 105-115.
9. Choubisa SL, Choubisa D (2015) Neighbourhood fluorosis in people residing in the vicinity of superphosphate fertilizer plants near Udaipur city of Rajasthan (India). Environmental Monitoring and Assessment 187(8): 497.
10. Choubisa SL, Choubisa D (2016) Status of industrial fluoride pollution and its diverse adverse health effects in man and domestic animals in India. Environmental Science and Pollution Research 23(8): 7244-7254.
11. Choubisa SL (2023) Industrial fluoride emissions are dangerous to animal health, but most ranchers are unaware of it. Austin Environmental Sciences 8(1): 1-4.
12. Choubisa SL (2023) A brief review of industrial fluorosis in domesticated bovines in India: focus on its socio-economic impacts on livestock farmers. Journal of Biomed Research 4(1): 8-15.
13. Choubisa SL (2023) Is drinking groundwater in India safe for domestic animals with respect to fluoride? Archives of Animal Husbandry & Dairy Science 2(4): 1-7.
14. Gupta S, Banerjee S, Mondal S (2009) Phytotoxicity of fluoride in the germination of paddy *(Oryza sativa)* and its effect on the physiology and biochemistry of germinated seedlings. Fluoride 42(2):142-146.
15. Datta JK, Maitra A, Mondal NK, Banerjee A (2012) Studies on the impact of fluoride toxicity on germination and seedling growth of gram seed (*Cicer arietinum* L. cv. Anuradha). Journal of Stress Physiology & Biochemistry 8:194-202.
16. Singh M, Verma KK (2013) Influence of fluoride-contaminated irrigation water on physiological responses of poplar seedlings (*Populus deltoides* L. clone-S_7C_{15}). Fluoride 46(2): 83-89.
17. Mondal NK (2017) Effect of fluoride on photosynthesis, growth and accumulation of four widely cultivated rice *(Oryza sativa L.)* varieties in India. Ecotoxicology and Environmental Safety 114: 36-44.
18. Singh B, Jajoo A (2020) Comparative analysis of fluoride inhibition of photosynthesis in C_3 (wheat) and C_4 (maize) plants. Fluoride 53(3 Pt 2): 554-563.
19. Pelc J, Snioszek M, Wróbel J, Telesiński A (2020) Effect of fluoride on germination, early growth and antioxidant enzymes activity of three winter wheat *(Triticum aestivum L.)* cultivars. Appl Sci 10(19): 6971.
20. Mohapatra S, Tripathy SK, Mohanty AK, Tripathy S (2021) Fluoride toxicity in rice fields in the periphery of an aluminium smelter in Odisha, India. Fluoride 54(4): 298-308.
21. Singh G, Kumari B, Singh J, Kumar P, Kriti K, et al. (2023) A comparative assessment of fluoride uptake and toxicity in four major crop seedlings: reduction of α-amylase activity and gibberellic acid. Acta Physiologiae Plantarum 45: 87.
22. Choubisa SL (1996) An epidemiological study on endemic fluorosis in tribal areas of southern Rajasthan. A Technical Report. The Ministry of Environment and Forests, Government of India, New Delhi, pp. 1-84.
23. Choubisa SL, Sompura K, Bhatt SK, Choubisa DK, Pandya H, et al. (1996) Prevalence of fluorosis in some villages of Dungarpur district of Rajasthan. Indian Journal of Environmental Health 38(2): 119-126.
24. Choubisa SL, Sompura K (1996) Dental fluorosis in tribal villages of Dungarpur district (Rajasthan). Pollution Research 15(1): 45-47.
25. Choubisa SL (1996) Radiological skeletal changes due to chronic fluoride intoxication in Udaipur district (Rajasthan). Pollution Research 15(3): 227-229.

26. Choubisa SL, Choubisa DK, Joshi SC, Choubisa L (1997) Fluorosis in some tribal villages of Dungarpur district of Rajasthan, India. Fluoride 30(4): 223-228.

27. Choubisa SL (1998) Fluorosis in some tribal villages of Udaipur district (Rajasthan). Journal of Environmental Biology 19(4): 341-352.

28. Choubisa SL (1999) Chronic fluoride intoxication (fluorosis) in tribes and their domestic animals. International Journal of Environmental Studies 56(5): 703-716.

29. Choubisa SL (2001) Endemic fluorosis in southern Rajasthan (India). Fluoride 34(1): 61-70.

30. Choubisa SL, Choubisa L, Choubisa DK (2001) Endemic fluorosis in Rajasthan. Indian Journal of Environmental Health 43(4): 177-189.

31. Choubisa SL (2012) Fluoride in drinking water and its toxicosis in tribals, Rajasthan, India. Proceedings of National Academy of Sciences, India Section B: Biological Sciences 82(2): 325-330.

32. Choubisa SL, Choubisa D (2019) Genu-valgum (knock-knee) syndrome in fluorosis- endemic Rajasthan and its current status in India. Fluoride 52(2): 161-168.

33. Choubisa SL, Pandya H, Choubisa DK, Sharma OP, Bhatt SK, et al. (1996) Osteo-dental fluorosis in bovines of tribal region in Dungarpur (Rajasthan). Journal of Environmental Biology 17(2): 85-92.

34. Choubisa SL (1999) Some observations on endemic fluorosis in domestic animals of southern Rajasthan (India). Veterinary Research Communications 23(7): 457-465.

35. Choubisa SL (2000) Fluoride toxicity in domestic animals in Southern Rajasthan. Pashudhan 15(4): 5.

36. Choubisa SL (2007) Fluoridated ground water and its toxic effects on domesticated animals residing in rural tribal areas of Rajasthan (India). International Journal of Environmental Studies 64(2): 151-159.

37. Choubisa SL (2008) Dental fluorosis in domestic animals. Current Science 95(12): 1674-1675.

38. Choubisa SL, Mali P (2009) Fluoride toxicity in domestic animals. In: Dadhich L, Sultana F (Eds.), Proceedings of the National Conference on Environmental Health Hazards, Kota, Rajasthan, India, p.103.

39. Choubisa SL (2010) Osteo-dental fluorosis in horses and donkeys of Rajasthan, India. Fluoride 43(1): 5-10.

40. Choubisa SL (2010) Fluorosis in dromedary camels of Rajasthan, India. Fluoride 43(3): 194-199.

41. Choubisa SL, Mishra GV, Sheikh Z, Bhardwaj B, Mali P, et al. (2011) Toxic effects of fluoride in domestic animals. Advances in Pharmacology and Toxicology 12(2): 29-37.

42. Choubisa SL (2012) Status of fluorosis in animals. Proceedings of National Academy of Sciences, India Section B: Biological Sciences 82(3): 331-339.

43. Choubisa SL, Modasiya V, Bahura CK, Sheikh Z (2012) Toxicity of fluoride in cattle of the Indian Thar desert, Rajasthan, India. Fluoride 45(4): 371-376.

44. Choubisa SL (2012) Study of natural fluoride toxicity in domestic animals inhabiting arid and sub-humid ecosystems of Rajasthan. A Technical Report. University Grants Commission, New Delhi, India, pp. 1-29.

45. Choubisa SL (2013) Fluorotoxicosis in diverse species of domestic animals inhabiting areas with high fluoride in drinking waters of Rajasthan, India. Proceedings of National Academy of Sciences, India Section B: Biological Sciences 83(3): 317-321.

46. Choubisa SL (2013) Fluoride toxicosis in immature herbivorous domestic animals living in low fluoride water endemic areas of Rajasthan, India: An observational survey. Fluoride 46(1): 19-24.

47. Choubisa SL, Mishra GV (2013) Fluoride toxicosis in bovines and flocks of desert environment. International Journal of Pharmacology and Biological Sciences 7(3): 35-40.

48. Choubisa SL (2014) Bovine calves as ideal bio-indicators for fluoridated drinking water and endemic osteo-dental fluorosis. Environ Monitoring and Assessment 186 (7): 4493-4498.

49. Choubisa SL (2021) Chronic fluoride exposure and its diverse adverse health effects in bovine calves in India: An epitomised review. Global Journal of Biology, Agriculture and Health Sciences 10(3): 1-6.

50. Choubisa SL (2022) A brief and critical review of chronic fluoride poisoning (fluorosis) in domesticated water buffaloes *(Bubalus bubalis)* in India: Focus on its impact on rural economy. Journal of Biomedical Research and Environmental Sciences 3(1): 96-104.

51. Choubisa SL (2022) A brief review of chronic fluoride toxicosis in the small ruminants, sheep and goats in India: focus on its adverse economic consequences. Fluoride 55(4): 296-310.

52. Choubisa SL (2023) Endemic hydrofluorosis in cattle *(Bos taurus)* in India: An epitomised review. International Journal of Veterinary Science and Technology 8(1): 001-007.

53. Choubisa SL (2023) Chronic fluoride poisoning in domestic equines, horses *(Equus caballus)* and donkeys *(Equus asinus)*. Journal of Biomed Research 4(1): 29-32.

54. Choubisa SL (2023) A brief review of fluorosis in dromedary camels *(Camelus dromedarius)* and focus on their fluoride susceptibility. Austin Journal of Veterinary Science and Animal Husbandry 10(1):1-6.

55. Choubisa SL (2023) A brief and critical review of endemic fluorosis in domestic animals of scheduled area of Rajasthan, India: focus on its impact on tribal economy. Clinical Research in Animal Science 3(1): 1-11.

56. Kamaluddin M, Zwiazek JJ (2003) Fluoride inhibits root water transport and affects leaf expansion and gas exchange in aspen *(Populus tremuloides)* seedlings. Physiolo Plant 117(3): 368-375.

57. Pant S, Pant P, Bhiravamurthy PV (2008) Effects of fluoride on early root and shoot growth of typical crop plants of India. Fluoride 41(1): 57-60.

58. Khandare AL, Rao GS. (2006) Uptake of fluoride, aluminum and molybdenum by some vegetables from irrigation water. Journal of Human Ecology 9(4): 283-288.

59. Hill AC, Pack MR, Transtrum LG, Winters WS (1959) Effects of atmospheric fluorides and various types of injury on the respiration of leaf tissue. Plant Physiology 34(1): 11-16.

60. Brewer RF, Creveling RK, Guillemet FB, Sutherland FH (1960) The effects of hydrogen fluoride on seven citrus varieties. Proceedings of the American Society for Horticultural Science 75: 236-243.

61. MacLean DC, Schneider RE (1981) Effects of gaseous hydrogen fluoride on the yield of field-grown wheat. Environmental Pollution 24(: 39-44.)

62. Doley D (1988) Fluoride-induced enhancement and inhibition of photosynthesis in four taxa of pines. New Phytologist 110: 21-32.

63. Baunthiyal M, Ranghara S (2014) Physiological and biochemical responses of plants under fluoride stress: An overview. Fluoride 47(4): 287-293.

64. Panda D (2015) Fluoride toxicity stress: physiological and biochemical consequences on plants. International Journal of Bio-resource. Environment and Agricultural Sciences 1(1): 70-84.

65. Gadi BR, Kumar R, Goswamil B, Rao SR, Kumar R (2020) Recent developments in understanding fluoride accumulation, toxicity, and tolerance mechanisms in plants: An overview. Journal of Soil Science and Plant Nutrition 21(12): 209-228.

66. Choubisa SL, Choubisa L, Sompura K, Choubisa D (2007) Fluorosis in subjects belonging to different ethnic groups of Rajasthan. Journal of Communicable Diseases 39(3): 171-177.

67. Choubisa SL, Choubisa L, Choubisa D (2009) Osteo-dental fluorosis in relation to nutritional status, living habits and occupation in rural areas of Rajasthan, India. Fluoride 42(3): 210-215.

68. Choubisa SL, Choubisa L, Choubisa D (2010) Osteo-dental fluorosis in relation to age and sex in tribal districts of Rajasthan, India. Journal of Environmental Science and Engineering 52(3): 199-204.

69. Choubisa SL (2010) Natural amelioration of fluoride toxicity (fluorosis) in goats and sheep. Current Science 99(10): 1331-1332.

70. Choubisa SL, Choubisa L, Choubisa D (2011) Reversibility of natural dental fluorosis. International Journal of Pharmacology and Biological Sciences 5(20): 89-93.

71. Choubisa SL, Mishra GV, Sheikh Z, Bhardwaj B, Mali P, et al. (2011) Food, fluoride, and fluorosis in domestic ruminants in the Dungarpur district of Rajasthan, India. Fluoride 44(2): 70-76.

72. Choubisa SL (2012) Osteo-dental fluorosis in relation to chemical constituents of drinking waters. Journal of Environmental Science and Engineering 54(1): 153-158.

73. Choubisa SL (2013) Why desert camels are least afflicted with osteo-dental fluorosis? Current Science 105(12): 1671-1672.

74. Choubisa SL (2022) The diagnosis and prevention of fluorosis in humans. Journal of Biomedical Research and Environmental Sciences 3(3): 264-267.

75. Choubisa SL (2022) How can fluorosis in animals be diagnosed and prevented? Austin Journal of Veterinary Science and Animal Husbandry 9(3): 1-5.

76. Choubisa SL (2022) Radiological findings more important and reliable in the diagnosis of skeletal fluorosis. Austin Medical Sciences 7(2): 1-4.

77. Choubisa SL, Choubisa A (2021) A brief review of ideal bio-indicators, bio-markers and determinants of endemic of fluoride and fluorosis. Journal of Biomedical Research and Environmental Sciences 2(10): 920-925.

78. Gautam R, Bhardwaj N, Saini Y (2010) Fluoride accumulation by vegetables and crops grown in Nawa tehsil of Nagaur district (Rajasthan, India). The Journal of Phytology 2(2): 80-85.

79. Gupta S, Banerjee S (2011) Fluoride accumulation in crops and vegetables and dietary intake in a fluoride-endemic area of west Bengal. Fluoride 44(3): 153-157.

80. Arora G, Bhateja S (2014) Estimating the fluoride concentration in soil and crops grown over it in and around Mathura, Uttar Pradesh, India. American Journal of Ethnomedicine 1: 36-41.

81. Dhanu G, Shiny R, Havale R, Shrutha SP (2017) Assessment of fluoride retention in jowar consuming population: A cross-sectional study. Journal of Indian Society of Pedodontics and Preventive Dentistry 35: 198-202.