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RESEARCH ARTICLE

"CORRELATION BETWEEN FLUORINE CONTAMINATED ANIMAL FODDER AND CATTLE MILK IN HIGH RISK FLUOROSIS DISTRICTS OF RAJASTHAN"

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Abstract

The toxic effects of fluorine depend on the intake into the body, the solubility and bio-availability of it. When daily intake of fluorine is 0.5 to 1.7 mg/kg body wt. in the form of sodium fluoride produces dental lesions in growing animals without affecting general health, whereas the adult animals can tolerate double the dose of the above intake i.e. 1 to 3.5 mg/kg. body weight per day, Minor teeth lesion occurs at 5 ppm. In cattle lateral incisors show most pronoused changes. Mottling of tooth enamel, erosion of teeth are the earlier signs of dental fluorosis. Lucerne, Barley, Common Duckweed, Rapeseed, Red Clover, False oat grass, Rye grass, Corn, Millet, Sorghum, Wheat were analyzed in all seven districts, fluoride ranges from 2.197±0.107 to 5.624±0.219mg/kg in Lucerene and False oat grass respectively. Buffalo's milk (6.034±1.837ppm) of Nagore district was highly contaminated.As concentration of fluoride increase in drinking water, there was increased concentration of fluoride in milk, blood and urine.

Introduction:-

Fluorine occurs throughout the world in soil, vegetation, water, and animal tissues. In India, fluorosis is essentially hydrofluorosis and is endemic in parts of Punjab, Haryana, Rajasthan, Bihar, Madhya Pradesh, Orissa and Andhra Pradesh having high F levels in underground water, soils and forages (Randhawa and Singh, 2010). Under normal conditions, livestock consume variable low-level amounts of fluorine. No adverse effects are known to accompany this normal fluoride ingestion. The most commonly encountered sources of potentially excessive fluorides are: (1) forages subjected to air-borne contamination in areas near industrial plants that heat fluorine-containing materials to high temperatures and expel fluorides, (2) drinking water high in fluoride content, (3) feed supplements and mineral mixtures high in fluoride content, and (4) vegetation growing on soils of high fluoride content. When fluorides above permissible limit are ingested over long periods of time, chronic fluorine toxicosis may result. Animals are also subject to acute fluorine toxicosis, but this condition is seldom encountered. Fluorosis in livestock has been reviewed by Agate et al. (1949), Mitchell and Edman (1951), and Schmidt and Rand (1952) among others. In addition, the National Research Council (1960) has evaluated the research on fluorine and suggested tolerances.

Early European literature has been reviewed by Roholm (1937), In 1929, Hupka and LuY frequently observed osteomalacia in cattle. Cow's milk has long been associated with good health, making it one of the most consumed beverages around the world. It contains valuable nutrients and offers a rich source of calcium and vitamin D. Many studies in Iran have reported on the F content of drinking water, air, fish, herbal distillates, sea water and ballast waters, and powdered and breast milk, as well as on its removal from water containing higher levels of F.

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Man and animals which consume chiefly grains will not be affected, as the majority of thefluoride will be lost in harvesting, processing, and refining any cereal grains that might be contaminated. The level of forage contamination varies over a wide range, and values from inexcess of 1000 ppm to the few ppm normally expected have been reported. Descriptions of the chronic toxicity are based on many carefully controlled experiments as well as some rather dubious field observations. With regard to domestic animals, the most complete descriptions are contained in a National Research Council publication, an excellent review of cattle damage by Schmidt and Rand, and a recent review by Cass. As the majority of the recorded cases of livestock damage by industrial fluoride pollution have involved cattle, the following description of the nature and development of the disease will centre on this species.

Dental Lesions:
The developing tooth is extremely sensitive to fluoride, and the subsequent abnormalities in the mature dentition are one of the most obvious signs of the chronic toxicity. A familiarity of the normal chronology of tooth development in the bovine, which is well covered by Brown et al, is essential for accurate interpretation of dental effects.

Osseous Lesions:
The ingestion of toxic amounts of fluorides for an extended period of time will result in the development of exostotic lesions and in some cases a general thickening andchanging in shape of certain bones. These changes which involve primarily a disturbance of normal osteon turnover have been studied and described by Schupe et al Chemical effects Fluoride accumulates as Fluorapatite in the skeleton and when equal periods of exposure are compared, the level in the bones will be correlated with the amount which has been in the diet. As the data in Table I indicate, the fluoride concentration varies in different bones, with the more porous, cancellus bones having a higher *level* than the dense, compact bones of the skeleton.

Systemic Effects:
There is no evidence to indicate that fluoride ingestion can directly influence the physiologic process of milk secretion, and any effect noted on productive ability is secondary to other responses. Intermittent lameness and stiffness of gait have often been reported, and are also symptomatic of fluorosis, but not unique to it.

Accumulative Nature of the Toxicity:
Characteristic of the disease is a latent period during which no adverse effects on the animal are apparent. It has been postulated that systemic effects are noted when soft tissue fluoride concentrations rise due to the limit of skeletal absorption and kidney excretion having been reached. This hypothesis is very attractive, and although difficult to demonstrate in laboratory animals, it is possible in cattle to show a gradual increase in serum fluoride levels with time, as the skeleton becomes more nearly saturated.

The aim of this study is to determine: (i) The F level of catte's milk available to the local residents of study area and (ii) Estimation daily intakes of F by cattle from fodder consumption.

This paper is an attempt to evaluate the general nature of F toxicity, the symptoms of the resulting disease in dairy cattle, the tolerance levels for cattle, and some guidelines which might be used as indicators of potential problem areas, or as standards for control.

Materials And Methods:-

A pilot study was designed and was conducted in highly contaminated districts of Rajasthan. The drinking water provided to the cattle, milk samples and animal fodder samples were collected and examined for fluoride level.

Approximately 200 ml of drinking water meant for livestock was collected in the acid washed plastic bottles and stored at room temperature till further analysis. Similarly, fresh Milk samples were also collected from dairy animals in clean, dry, tightly closed plastic bottles. Samples were put in cooled icebox during transportation and stored at 10°C temperature in deep freeze for further analysis.

Estimation of Fluoride concentration in drinking water, milk and urine was done by using digital ion analyser (Orion 4 star bench top pH ISE meter, Thermo Scientific, Singapore) along with F selective electrode (Thermo Scientific, USA).

Estimation of Fluoride Concentration in Milk:
Fluoride estimation in milk was determined by electrochemical means using a fluoride ion selective electrode (Orion-9609BNWP) coupled to an ion analyzer (Orion-4 Star). Before estimating the fluoride content in milk, milk was brought to a constant temperature of 25ºC in a water bath and the instrument was calibrated using fluoride standards containing TISAB III which encompassed the range of the measurement to be made (fluoride standards were 1ppm F and 10ppm F). After the calibration was done, 50 ml of milk was measured using a measuring beaker and to this 5 ml of TISAB III was added using a pipette which standardized the ionic strength and pH of the medium. The solution was stirred at a uniform rate until equilibrium was reached. Once the equilibrium was reached, the reading was recorded from the ion meter in ppm

Estimation of Fluoride Concentration in Drinking Water:
Same method was employed for the estimation of fluoride concentration in drinking water

Statistical Analysis:
The data was analysed by using SPSS USA computer software program. The mean values of various parameters were calculated and presented along with respective standard deviation and ranges.

Results:-

Fluoride (F) level in drinking water and fodder of livestock:
Beg *et al.,* 2011, Sharma *et al.,* 2004 evaluated that high F levels in groundwater were due to the presence of Ca, Mg, Na, SiO2, PO4, pH and alkalinity of the earth's crust. In the present study, it can be over and done with that hydrofluorosis was a major problem in the ground water and is responsible for dental and skeletal fluorosis in the dairy animals. The mean concentration of F in the drinking water for dairy animals was found 2.482±1.039, 4.221±3.147, 14.168±7.929, 5.409±6.327, 3.904±2.172, 3.947±3.264, 3.854±3.188(Table-1) in respectively districts Kota, Bikaner, Nagore, Jodhpur, Udaipur, Barmer, Jaisalmer. The second major factor of presence of F in cattle milk is fluoride contaminated animal fodder. Variety of Lucerne, Barley, Common Duckweed, Rapeseed, Red Clover, False oat grass, Rye grass, Corn, Millet, Sorghum, Wheat were analyzed in all seven districts. Highest Fluoride contamination in Nagore districts, its range from 2.197±0.107 to 5.624±0.219mg/kg in Lucerene and False oat grass respectively (Table-1).

Fluoride (F) level in cattle milk:
Highest Fluoride content in cattle milk was founded in Nagore district, highest fluoride contamination was in buffalo's milk of Nagore district, it was 6.034±1.837ppm(Table-2). Similarly, Dahariya *et al.* (2015) exposed the exposure of high F levels in contaminated groundwater by domestic animals of Dongargarh city, Chhattisgarh results in excess F excretion through urine, blood and milk of animals. It was observed that there was a significant increase in fluoride concentration in cattle's milk with increase in fluoride concentration in drinking water. A positive correlation found between Fluoride content in drinking water and animal fodder and cattle milk [Table-1,2]

Discussion:-

The level of fluoride in milk has been a subject of disparity for a long time. With advances in analytical technology, the reported fluoride concentration has steadily declined. In the present study, a weak to strong correlation was found between fluoride concentration in cow's milk and buffalo's milk at different levels of fluoride concentration in drinking water. The study showed that with increase in fluoride concentration in drinking water there was increase in concentration of fluoride in cow's and buffalo's milk. To best of our knowledge there is lack of pertinent studies in literature which attempted to establish relation between fluoride concentration in drinking water and concentration of fluoride in cow's and buffalo's milk. However, we assume that it might be attributed to several factors such as drinking water, fodder consumed and consumption of plantations which are grown in the same area.

Fluoride combines with the calcium component of the milk so amount of fluoride available for absorption is very less. So, consumption of milk alone is not likely to cause dental fluorosis, intake of milk with high fluoride content together with other food products the safety level of daily fluoride consumption could easily be exceeded by such combination of diet. So, there is need to do more far-reaching studies taking answerability of these factors which might be contributing to incidence of dental fluorosis. Present study have certain limitations that there is small sample size, cow's and buffalo's were of different age, size, consume different amount of water, fodder and the amount of milk produced by them vary and in present study blood fluoride level is also not evaluated of people living there. Since, present study is a pilot study considered being a pioneer study in this region.

Conclusion:-

Fluorosis disease is caused by regular intake of fluoride in feed or drinking water over a long period of time which is categorized by mottling of teeth and osteosclerosis of skeleton fluorosis and neuron development retardation as non skeleton fluorosis. As concentration of fluoride increase in drinking water, there was increased concentration of fluoride in milk, blood and urine. Here I conclude that association of fluoride in fodder and drinking water is relate to not only a single factor but rather due to culmination of several other factors. So, there is a need to explicate the other factors that might be contributing to skeletal, non skeletal and dental fluorosis.

Control and Prevention:

1. Remove sources of fluorine contamiation.
2. Gastro intestinal sedatives and demulcents should be given to acute fluorosis patients.
3. Calcium salt is another option to neutralize residual fluorine in the alimentary tract.
4. An intake of 1-1.5 mg/kg body weight fluorine is the maximum safe limit for animals which cause not specific health effect.
5. Water from deep wells and artesian bores should be analysed and defluoridated before use.
6. Al_2SO_4 @ 30 gms can be used for cure of chronic fluorosis.
7. Mineral supplements to be taken to reduce the effect of fluoride toxicity.

Table 1:- Fluoride contamination (mg/kg) in animal fodder .

Sr. N	FODDER	STUDY AREA						
		Bikaner	**Kota**	**Nagore**	**Udaipur**	**Jaisalmeir**	**Barmer**	**Jodhpur**
1	**Lucerne**	2.143±0.014	1.205±0.148	2.197±0.107	-	2.184±0.283	2.134±0.182	-
2	**Barley**	-	2.144±1.013	3.015±0.182	1.263±0.134	1.098±0.147	1.376±0.294	2.098±0.674
3	**Common Duckweed**	2.296±0.172	-	3.343±0.123	1.147±0.237	1.121±0.029	-	1.214±0.237
4	**Rapeseed**	3.347±0.103	1.873±0.184	-	1.311±0.147	-	-	1.197±0.109
5	**Red Clover**	-	0.984±0.237	4.129±0.147	1.209±0.161	0.794±0.134	0.904±0.128	-
6	**False oat grass**	2.541±0.129	-	5.624±0.219	-	1.634±0.121	1.386±0.174	2.237±0.185
7	**Rye grass**	1.029±0.102	-	4.327±0.134	0.947±0.173	0.986±0.162	2.074±0.139	1.169±0.172
8	**Corn**	1.731±0.147	1.349±0.239	-	1.534±0.132	-	0.931±0.014	1.247±0.144
9	**Millet**	2.621±0.132	1.015±0.164	3.196±0.126	1.621±0.029	1.072±0.137	1.294±0.214	3.262±0.107
10	**Sorghum**	1.554±0.154	2.216±0.139		1.419±0.102	-	1.476±0.018	-
11	**Wheat**	1.063±0.123	1.379±0.124	5.140±0.137	1.327±0.126	1.173±0.182	1.292±0.110	0.984±0.028

Table 2:- Fluoride concentration in drinking water and cattle milk.

Sr. N	LOCATION	FLUORIDE CONTAMINATION (ppm)				
		Drinking Water	**Goat**	**Buffalo**	**Cow**	**Camel**
1	**Kota**	2.482±1.039	0.134±0.041	0.378±0.124	0.274±0.035	0.412±0.137
2	**Bikaner**	4.221±3.147	2.109±0.136	1.914±0.984	1.239±0.716	2.136±0.756
3	**Nagore**	14.168±7.929	5.216±1.271	6.034±1.837	4.128±2.804	5.379±1.732
4	**Jodhpur**	5.409±6.327	1.276±0.637	1.095±0.239	1.349±0.217	1.187±0.572

5	**Udaipur**	3.904±2.172	1.115±0.934	1.521±0.539	0.984±0.237	1.217±0.416
6	**Barmer**	3.947±3.264	2.004±0.768	1.794±0.532	2.017±0.374	2.034±0.458
7	**Jaisalmer**	3.854±3.188	1.582±0.529	2.012±0.671	1.732±0.639	1.921±0.721

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