THE FLUOROSIS PROBLEM IN TROPICAL SHEEP

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SUMMARY: A study of sheep subsisting on fluoride-contaminated forage (up tp 390.0 ppm) in the vicinity of an aluminium factory was undertaken to determine fluorotic lesions in their incisors. Of 83 sheep examined, 67.5% (aged 1 to 3, 3 to 5, 5 to 7 and above 7 years) showed mild to severe degrees of dental lesions and ruptured/chipped-off edges. Their serum and milk fluoride levels were increased during the study period. In addition, urinary fluoride was 10.2 to 57.6 ppm, whereas a maximum of 2.40 ppm fluoride was recorded from controls.

Key words: Aluminium factory; Fluorotic lesions; Mottling; Tropical sheep.

Introduction

Sheep foraging in the vicinity of fluoride-contaminating sources such as ceramic works, phosphate fertilizer plants and aluminium factories often develop fluorosis (1,2), an ailment due to prolonged ingestion of fluoride-contaminated vegetation. The severity of symptoms depends on the fluoride content of forage and duration of ingestion. According to Pierce (3), daily ingestion of 60 mg or more of fluoride caused changes in the teeth of sheep roughly proportional to the amount of fluoride ingested.

Industrial fluorosis in sheep has been extensively studied in Europe (4,5) and Australia (6), and in India some work has been done by Naik and Samal (7). This study assesses the percentage of fluorotic animals (sheep) and fluoride content of their milk, blood serum and urine related to fluoride distribution in forage in the Hirakud area of Orissa.

Materials and Methods

Collection of samples: Sixteen sites around the aluminium factory were selected for collection of forage (legumes and graminoids) samples commonly grazed by local sheep during 1985 through 1986. Plants were air-dried and stored in paper bags. Blood, milk and urine samples of 60 lactating ewes of various age groups from polluted and control areas were also collected monthly in polythene bottles between 5 and 7 o'clock during the same years.

Dental examination: Sheep maintained in and around the Hirakud area were examined for lesions on their incisors. Eighty-three animals of various age groups (1 to 3, 3 to 5, 5 to 7 and above 7 years) were studied and the dental lesions were scored as follows (Figure 1): A, normal appearance; B, well-established brown stain on the surface; C, mottled with black streaks and ruptured edges; D, pitted anamel and chipped-off edges.

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Determination of fluoride: The air-dried plant samples were oven-dried and ground to pass an 85-mesh sieve. Five grams of the powdered sample were made alkaline with calcium oxide suspension, ashed in a muffle furnace at 600-650°C, and fused with sodium hydroxide pellets. The fused material was distilled with perchloric acid and silver perchlorate (8).

About 30 ml milk and 5 ml blood serum were placed in nickel crucibles. The milk was dried with calcium phosphate (9) and the serum with magnesium oxide (10) in a hot water bath. The samples were then ashed in a muffle furnace and fused with sodium hydroxide pellets. The cake of materials was distilled according to Willard and Winter (8).

Fluoride concentrations in distillates of plant, blood serum, milk and urine were determined with a spectrophotometer using Zirconium-eriochrome cyanine-R reagent as described by Megregian (11).

Results

Of the 83 sheep examined, 67% had characteristic markings on their incisors. Animals aged 1 to 3 years were suffering from mild to moderate fluorotic lesions while those older had teeth with dark brown streaks, pitting of the enamel and sometimes edges that ruptured or chipped-off (Figures 1 and 2).

Fluoride in forage has a marked monthly variation and ranged from 24.0 to 360.0 ppm and 27.0 to 390.0 ppm during the peak period (July to December) of metallic aluminium production for 1985 and 1986, respectively (Figure 3). Fluoride accumulation was higher in samples collected nearer to the production sites.

Fluoride levels in milk were lower than in blood serum (Figure 4). The maximum level of 1.60 ppm was in milk from the sheep older than 7 years, whereas samples from the control area ranged from 0.01 to 0.17 ppm. Fluoride in urine varied with ranges of 10.2 to 21.7, 14.6 to 26.5, 15.4 to 42.0, and 19.5 to 57.6 ppm in sheep 1 to 3, 3 to 5, 5 to 7 and above 7 years of age, respectively (Figure 4). In the control area urinary fluoride ranged from 1.10 to 2.40 ppm.

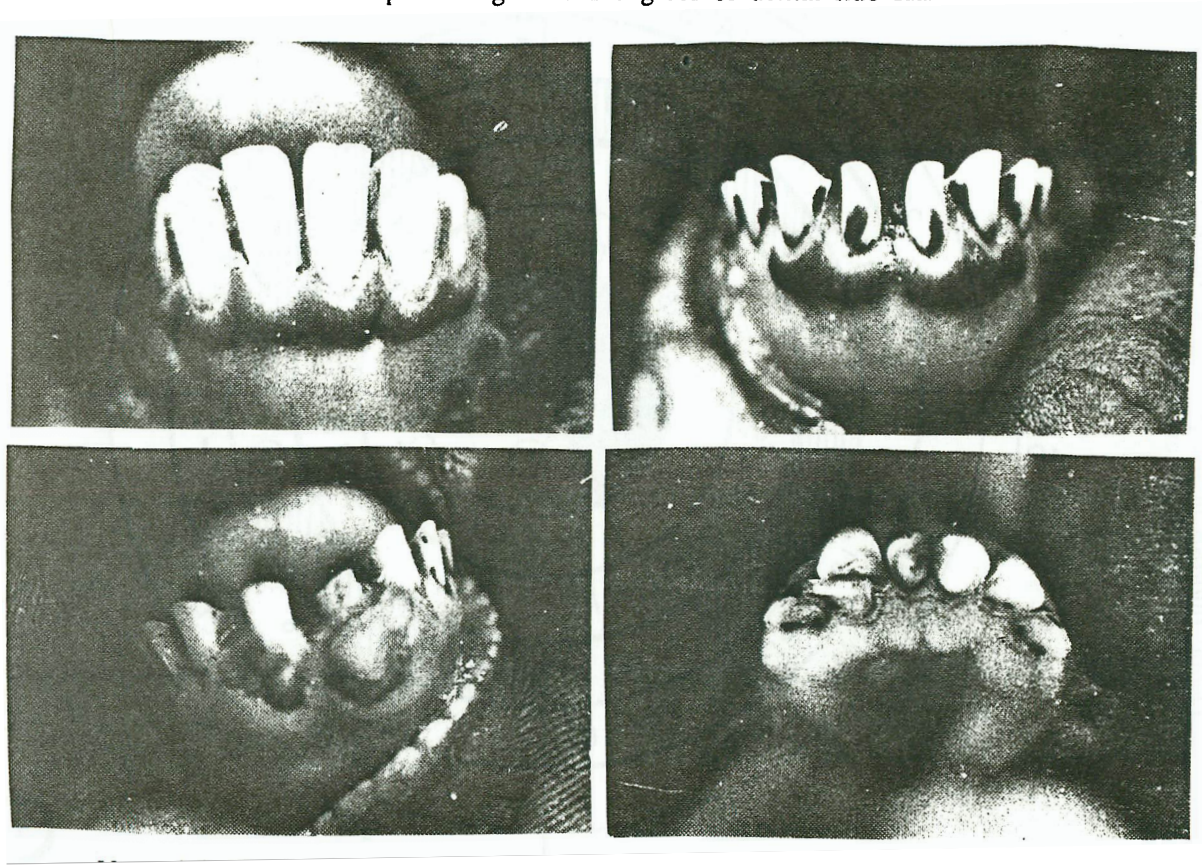
Discussion

The presence of fluoride in developing teeth interferes with calcium metabolism and oxidizes the organic material in the dental structures. When the tooth erupts it bears the characteristic markings of mottling, staining, hypoplasia and hypocalcification (12). The presence of these lesions in a large number of sheep subsisting on the fluoride-contaminated forage grown in the vicinity of an aluminium factory at Hirakud indicates the sheep had dental fluorosis. No dental lesions could be detected in the sheep that came into the endemic area after eruption of their permanent teeth.

Dietary fluoride influences the fluoride content of milk (13,14). According to Sally *et al* (15) milk from treated ewes contained more total fluoride than control ewes. In the present study milk from fluorotic ewes contained 10 times as much fluoride as that from controls.

Figure 1

Teeth of sheep showing various degrees of dental fluorosis



Upper left: Teeth with normal appearance. Upper right: Teeth with well-established brown stain on the surface. Lower left: Teeth mottled with black streaks and ruptured edges. Lower right: Teeth with pitted enamel and chipped-off edges.

Figure 2

Dental fluorosis in sheep foraging within 3 km radius of the aluminium factory at Hirakud

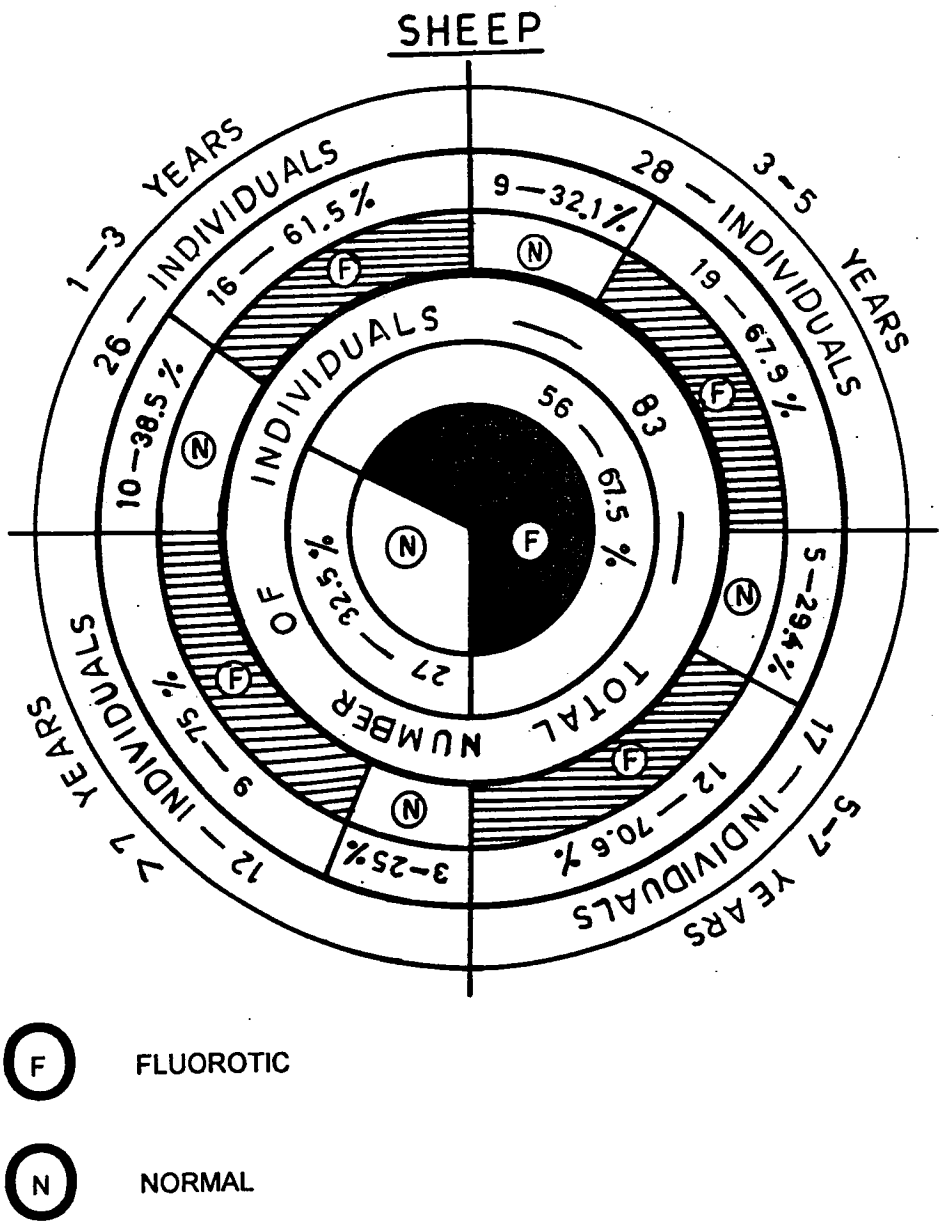


Figure 3

Monthly variation in fluoride content (ppm) of forage collected from different sites around the factory at Hirakud

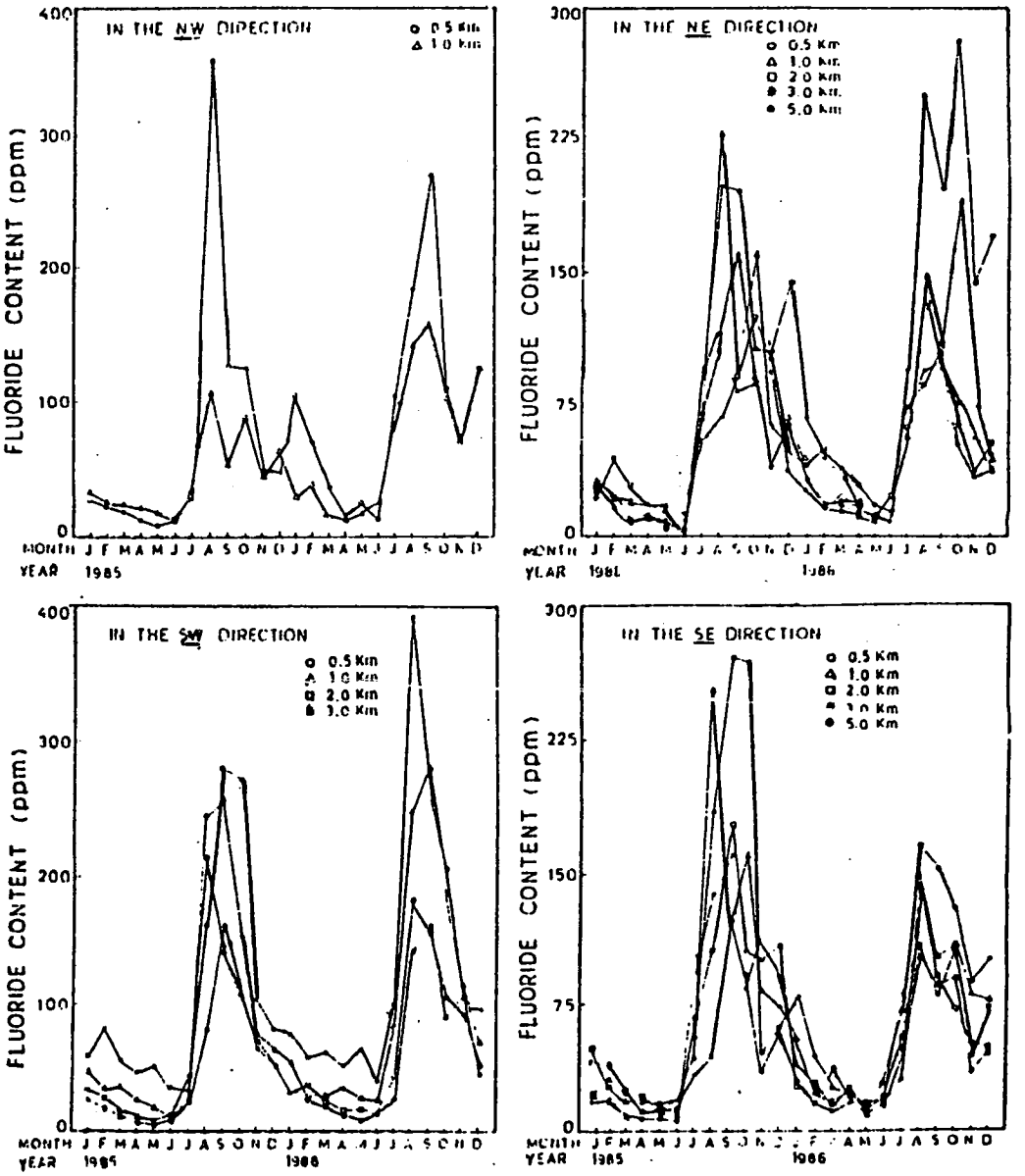
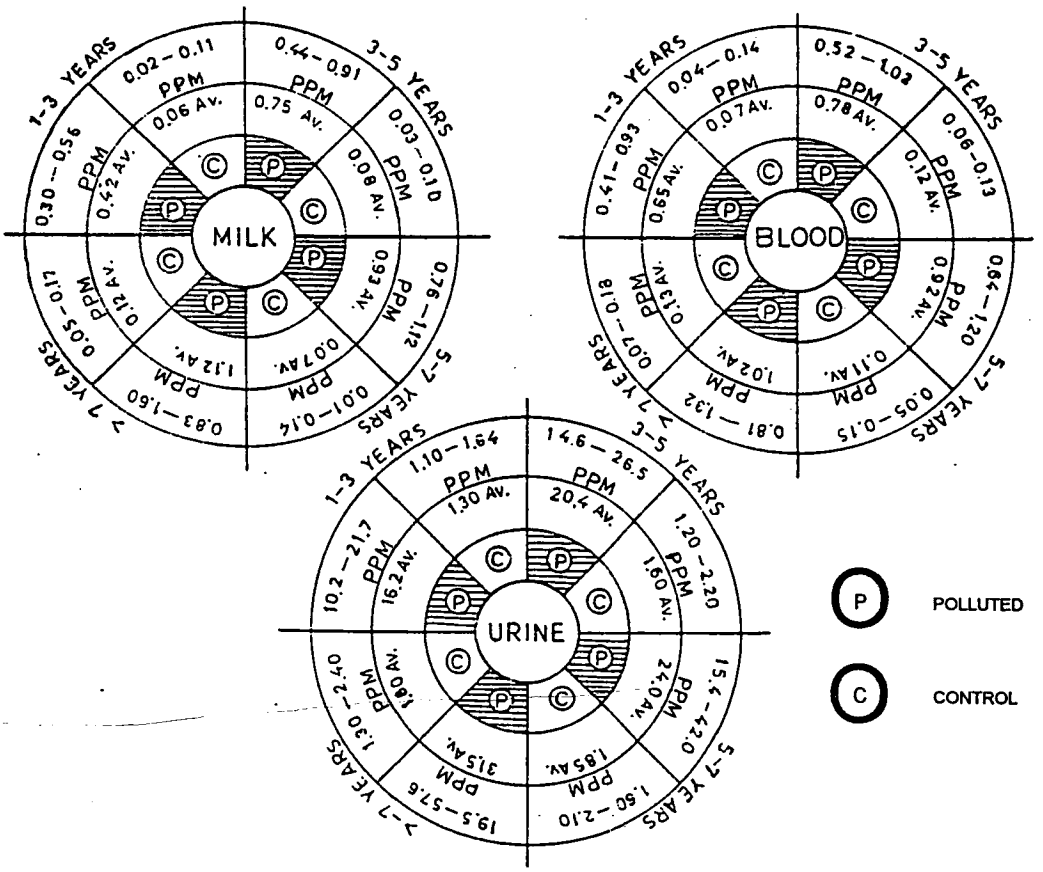


Figure 4

Fluoride concentration in certain biological materials collected from sheep within 3 km radius of the aluminium factory at Hirakud



Ingestion of fluoride-contaminated vegetation results in increased concentrations of blood fluoride (16) and relates to the development of anaemia (17). Hoogstratten *et al* (18) found a correlation between serum fluoride and dietary fluoride. The present investigation reveals that sheep maintained in and around the Hirakud area had increases in the fluoride concentration of their blood that correlated with the fluoride in their forage diet and with their age.

Urinary fluoride can be a good indicator of fluorosis in sheep. According to Boddie (2) fluoride tests of urine are useful to detect fluoride intoxication. He found 19 to 33 ppm F in the urine of cattle with continuous intake of vegetation containing 776 ppm F. Shupe *et al* (16) showed a direct linear relationship between the fluoride concentration in the total ration and that in the urine. They also recorded urinary fluoride concentrations from 8.04 to 14.78 ppm in mild fluorosis, from 10.54 to 20.96 ppm in moderate fluorosis, and from 14.71 to 30.09 ppm in severe fluorosis. In our study urinary fluoride ranged from 10.2 to 57.6 ppm (Figure 4), which indicates that most of the ewes suffered from moderate to severe degrees of fluorosis. Fluoride concentrations in urine also increased with age. Shupe *et al* (16) in their experiments and Rao and Pal (19) in their field investigations made similar observations. A major portion of the fluoride ingested by young and growing sheep is retained by the mineralizing bone structure, whereas the amount of fluoride eliminated through urine is lowered. As the animal grows older, its assimilation capacity is lowered and most of the ingested fluoride is excreted in urine.

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