EFFECTS OF CHRONIC FLUOROSIS ON THYROXINE, TRIIODOTHYRONINE, AND PROTEIN-BOUND IODINE IN COWS

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SUMMARY: This study was conducted to evaluate the effects of chronic fluorosis in cows on their blood serum levels of thyroxine (T_4), triiodothyronine (T_3), and protein-bound iodine (PBI). Data collected from twenty cows with chronic fluorosis in the Tendurek Mountain region (altitude about 2000 m) in East Anatolia, Turkey, were compared with data from ten healthy cows from the Van region (altitude 1700 m). Statistically significant differences ($p<0.05$) between the serum values in the fluorotic cows and the controls were found: 5.7±0.48 vs 3.7±0.45 µg/dL for T_4, 1.53±0.038 vs 0.97±0.051 ng/mL for T_3, and 3.8±0.29 vs 2.6±0.23 µg/dL for PBI. Hypothyroidism was therefore evident in the cows with chronic fluorosis.

Keywords: Chronic Fluorosis; Cows in Turkey; Protein-bound iodine; Thyroxine; Triiodothyronine.

INTRODUCTION

Fluoride is known to accumulate not only in bones and teeth but also, to a lesser extent, in soft tissues, especially the cardiovascular system.[1] Fluoride can rapidly cross certain cell membranes and is distributed in skeletal and cardiac muscle, liver, skin, and erythrocytes.[2-4] High concentration of fluoride are noxious in the environment, affecting the health of humans and animals.[5] Volcanic regions are usually rich in fluoride, and chronic fluorosis is often present in such areas.[6,7]

Because many parts of East Anatolia, Turkey, are covered with volcanic ash, some trace elements are scarce, and some are abundant, such as fluoride, in the drinking water, soil, and flora.[6,8] As a result, endemic fluorosis has been known for many years in this region. The level of fluoride in the available drinking water ranges from 5.7 to 15.2 ppm.[6,8] This high level especially affects dairy cows.[7] Thyroid dysfunction, stunted growth, and low milk production have been reported in livestock with fluorosis,[6] but this finding is disputed.[7]

The effects of chronic fluorosis on different mechanisms have been examined,[1,2,9-13] but the effect of fluoride on thyroid hormones and protein bound iodine has had limited study in cows, and the findings are not in agreement.[6,7] In this study, we report results of our examination of the effects of chronic fluorosis on thyroid hormones and protein bound iodine in fluorotic cows.

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MATERIALS AND METHODS

Thirty cows above 3 years of age (20 fluorotic and 10 healthy) were included in this study. The 20 cows with chronic fluorosis were obtained from the Tendurek Mountain region (altitude about 2000 m) in East Anatolia. All animals with fluorosis were living in and around Tendurek Mountain (Van-Ağrı, Turkey). Chronic fluorosis was diagnosed after clinical examination of the cows.[9,14] The ten healthy cows used as the control group were obtained from our own Van region (altitude 1700 m). Blood serum levels of thyroxine (T_4) and triiodothyronine (T_3) were determined by radioimmunoassay (RIA)[15,16]. The level of PBI was measured spectrophotometrically.[8] Statistical analyses were performed by Student's t test.

RESULTS AND DISCUSSION

In this study, the serum levels of thyroxine (T_4), triiodothyronine (T_3), and protein-bound iodine (PBI) in the control cows were in the normal range of healthy cows, but they were significantly lower ($p<0.05$) in the fluorotic cows (Table).

Table. Serum levels of thyroxine, triiodothyronine, and protein-bound iodine in control (healthy) and fluorotic cattle (mean±SD)

	Thyroxine (T_4) μg/dL	Triiodothyronine (T_3) ng/mL	Iodine (PBI) μg/dL
Control cattle (n = 10)	5.7 ± 0.48^a	1.53 ± 0.038^a	3.8 ± 0.29^a
Fluorotic cattle (n = 20)	3.7 ± 0.45^b	0.97 ± 0.051^b	2.6 ± 0.23^b
Standard normal values and ranges[15,16]	6.22 4.2 – 8.6	1.6 1.4 – 4.0	3.53 2.7 – 4.1

[a,b]Means in the same column with different superscripts differ significantly, ($p<0.05$).

These findings are consistent with the results of research with sheep,[8] calves,[15] cattle,[16] and rats.[18] In sheep with chronic fluorosis, a significant decrease in the levels of protein-bound iodine, and an increase in fluoride in blood were reported by Bildik.[8] Shivashankara *et al*[17] found reduced serum potassium and urea in children with chronic fluorosis. In another study,[18] rats with chronic fluorosis had decreases in T_3 and T_4 hormones released from thyroid gland. On the other hand, Choubisa[7] reported that none of a group of fluorotic domestic animals exhibited any apparent evidence of hypothyroidism, stunted growth, low milk production, or correlation between gender and the prevalence of fluorosis, but the prevalence and severity of skeletal fluorosis increased with increasing fluoride exposure and age.

By contrast, chronic fluoride poisoning in Cornwall Island cattle on the St. Lawrence River was manifested clinically by stunted growth and dental fluorosis to a degree of severe interference with drinking and mastication, so that the cows died at or had to be slaughtered after the third pregnancy.[19] In fluorosed dairy cows studied by Hillman et al,[13] urinary fluoride and eosinophilia increased, as did thyroid depression and blood cholesterol. The results of the present study are therefore similar to findings in the literature.[13,15,18] A decrease in PBI, T_3, and T_4 levels in the blood is known to be associated with a decrease in the rate of metabolism by as much as 30 to 40% in cases of hypothyroidism.[20]

As Guan et al[18] have shown, chronic fluoride intoxication can cause severe morphological and functional changes in the thyroid gland of the rat. In our view, the reason for decreased levels of T_4, T_3, and PBI in our cows with chronic fluorosis might be due to: 1) inhibition of the absorption of the iodine and some amino acids (e.g., tyrosine) in the gastrointestinal tract, 2) insufficient synthesis and secretion of thyroglobulin and oxidized iodides from the thyroid glands, 3) low levels of bioavailable iodine in the Tendurek Mountain region.

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