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The Effect of Ambient Temperature on Thyroid Hormones Concentration and Histopathological Changes of Thyroid Gland in Cattle in Tabriz, Iran

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Abstract: To identify the thyroid histological and hormonal changes in response to ambient temperature variations, thyroid glands and blood samples were randomly collected from 800 indigenous corss-breed cattle of both sex and different age groups from municipal Tabriz slaughter house. The extent of fluctuations in triiodothyronine (T_3), thyroxin (T_4), T_3 uptake and thyroid histopathological lesions were scrutinized in 2 months in year 2007, viz., February (the coldest month) and August (the hottest month). A marked decline was discernable in T_3, T_4 and T_3 uptake in August compared to February. Out of 800 pairs of thyroid glands, 120 (15%) had lesions in which histopathological changes were categorized as follicular atrophy (2.5%), Paranchymal cyst (1.38%), colloid goiter (3.39%), follicular cell hyperplasia (0.27%), thyroid fibrosis(0.635%), focal hyperplastic goiter (0.88%), diffuse hyperplastic goiter additional paranchymal cyst (0.63%). Mean of thyroidal parameters for T_4, T_3 and T_3 uptake was lower in lesioned group ($p<0.01$). The frequency of lesioned thyroid was higher in snmmer than winter ($p<0.001$). The result of this study showed that high ambient temperature has profound effect on thyroid function, secretion and pathological changes in cattle.

Key words: Environment temperature, thyroxin, thyroid, pathology, cow

INTRODUCTION

Thyroid function of domestic animals is known to be altered by many environmental factors including environmental factors. Special attention has been given to the effect of ambient temperature (Hoersch *et al*., 1961; Thompson *et al*., 1963; Valtorta *et al*., 1982; Prawl *et al*., 1998; Webster *et al*., 1991; Starling *et al*., 2005) and feed intake (Yousef and Johnson, 1960; Singh *et al*., 1971; Pereira *et al*., 2008) on thyroid activity. The effects of exposure to high environmental temperature on blood thyroid hormone concentration in rnminants have been the subjects of nnmerous review articles. It has been shown that exposure to high environmental temperatures depresses thyroid activity whereas exposure to cool environments increase thyroid activity (Yousef and Johnson, 1960; Thompson, 1973; Johnson and Vanjonak, 1976; Young, 1981; Pratt and Wettemann, 1986; Hocquette, 1992; Doubek *et al*., 2003). In another study in cattle, a decreased feed intake caused by exposure to a high environmental temperature correlated with decrease in T_4 (Yousef and Jhonson, 1960). In experiments carried out on sheep, it was shown that blood thyroid hormone (T_4) concentration decreased gradually between the 40th and 80th day of exposure to 32°C (Sanchez and Evans, 1972).

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In researchers study in cattle, it has been found that a decreased feed intake caused by exposure to a high environmental temperature is correlated with a decrease in T_4 (Yousef and Johnson, 1960). It has been reported that increase in ambient temperature depresses feed intake in sheep and results in decrease in plasma T_4 concentration, but temperature *per se* appears to provide an additional depression in the reduction of plasma T_4 levels (Valtorta *et al*., 1982). Recent study in a very hot place in the south of Iran revealed the existence of high percentage of histopathological changes in the thyroid glands of sheep in that area (Nouri *et al*., 2006). We have also recently noticed that ovine fetuses in summer have significantly histologic changes in their thyroids in comparison with the fetuses in winter months (unpublished data). The present study was undertaken to determine the relationship between ambient temperature and histological and hormonal changes in the thyroid glands of cows in an area in the north east of Iran with a low ambient temperature in winter and mild temperature in summer.

MATERIALS AND METHODS

The research was carried out in Tabriz, capital of East Azarbaijan province, a city in East of Iran, 600 km to Tehran, the capital, with very low temperature in winter and a mild climate in summer and its temperature in winter reaches -10°C and some days even low than -15°C.

In this study blood samples and thyroid glands were collected randomly from 800 cows slaughtered at Tabriz Municipal Abattoir. The cows in the area were kept indoors throughout year. The age of the animals ranged from below 8 months to above 60 months. The entire period of study was classified into two months in year 2007 with very different temperatures; February with minimum and maximum temperatures below 15 and above 1°C, respectively and relative humidity 76% and August with minimum and maximum temperatures 22 and 34°C, respectively and relative humidity 60% were the months we collected our samples. In each month 400 blood and thyroid samples were collected. After collection, the blood samples were allowed to stand for 20-30 minutes and then they were centrifuged at 2000 to 3000 rpm. The serum was separated and stored at -22°C till assayed. Serum T_3, T_4 and T_3 uptake were determined by the standard ELISA method according to the protocol described in the commercial kits of Pishtazteb Inc, Tehran, Iran.

After macroscopical examination, all thyroid glands were fixed 10% formaldehyde for 24-48 h, dehydrated in an ethyl alcohol series (70, 80, 90, 100, 100-I, 100-II%) and embedded in paraffin wax. Sections were cut and stained with Hematoxylin and Eosin, periodic Acid Schiff-Hematoxylin by Gallego's method (McManus and Mowry, 1968).

Quantitative data were analysed by one way ANOVA followed by Post Hoc Tukey methods and levels below 5% were considered statistically significant.

RESULTS

Analysis on blood samples showed significant differences of total T_3, T_4 and T_3 uptake between February and August (Table 1). Total T_3, T_4 and T_3 uptake decreased in August compared to February ($p<0.01$).

Among 800 thyroid glands divided equally in two groups of 400, 120 revealed some pathological changes under light microscopy which equals 15% of all samples (Table 2). Among all pathological changes, 34.16 and 65.84% were in February and August, respectively; In other words, 5.065% of thyroid samples in February and 9.935% of samples in August had some pathological changes, which was significantly different ($p<0.01$). Furthermore in Table 3, the incidences of specific types of pathological changes are demonstrated.

Table 1: Thyroidal indices in cow slaughtered in Tabriz abattoir

Date	Total T_4 (µg/100 mL)	T_3 uptake (%)	Total T_3 (ng/100 mL)
February	3.67±0.11	5.64±0.05	239.71±1.07
August	2.05±0.07	4.03±0.20	178.74±2.01
p-value	<0.001	<0.001	<0.001

On the other hand, evaluation of the effect of these pathological lesions on thyroid function showed significant decrease in thyroid function in the presence of pathology (Table 4). For more information, each pathologic lesion is shown in brief in Fig. 1.

Table 2: Number and incidence of pathological lesions in cow in February and August

Frequency of lesions	Total	February	August
Number of lesioned samples	120	41	79
Sample size	800	400	400
Incidence of pathologic lesions (%)	15	5	9.9
Distribution of pathologic lesions (%)	-	34.16	65.8

Table 3: Incidence of pathological lesions in thyroid glands in February and August

Frequency of lesions in winter and summer	Follicular atrophy	Paranchymal cyst	Colloid goiter	Para follicular cell hyperplasia	Thyroid fibrosis	Thyroid necrosis
February	9	11	5	-	-	-
August	11	-	26	2	5	2
Distribution in all lesions (%)	2.5	1.375	3.385	0.27	0.625	0.27

Frequency of lesions in winter and summer	Multinodular goiter	Focal hyperplastic goiter	Diffuse hyperplastic goiter	Follicular atrophy additional thyroid fibrosis	Diffuse hyperplastic goiter additional paranchymal cyst
Feb	2	7	-	2	5
Aug	2	-	31	-	-
Distribution in all lesions (%)	0.54	0.875	3.385	0.27	0.625

Table 4: Thyroidal indices based on the presence of pathological lesions

Status of the thyroid	Total T_4 (μg/100 mL)	T_3 uptake(%)	Total T_3 (ng/100 mL)
Lesioned	2.81±0.02	4.75±0.03	188.31±1.08
Normal	2.91±0.18	4.92± 0.3	230.14±3.01
p-value	p<0.01	p<0.01	p<0.01

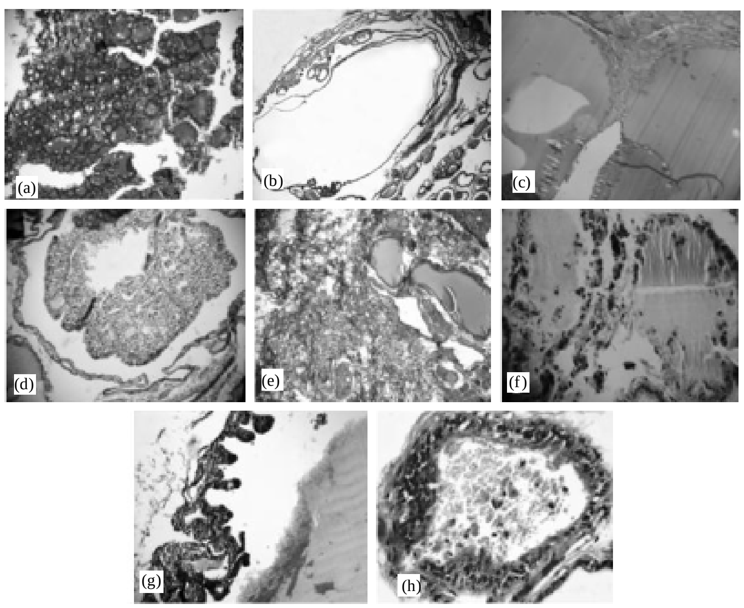

Fig. 1: Light microscopy sections demonstrate wide variety of pathological changes in thyroid glands: Follicular atrophy showing small follicles contained small quantity of colloid (a), Paranchymal cysts where some are too distended and ruptured (b), colloid goiter with large follicles contained eosinophilic colloid (c), Para follicular cell hyperplasia seen in some follicles (d), Thyroid fibrosis with fibrous counective tissue (e), thyroid necrosis (f), multi nodular goiter (g), hyperplastic goiter (h). (H and E, Ax66; Bx66; Cx660; Dx66; Ex66; Fx660; Gx66; Hx1650)

DISCUSSION

It is well known that among environmental factors, two factors more importantly affect the blood level of thyroid hormones: Ambient temperature and feed intake (Grossie and Turner, 1962; Sutherland and Irvine, 1974; Evans and Ingram, 1977; Webster *et al*., 1991; Todini, 2007). High temperature and decreased feed intake have been shown to decline thyroid hormone via various mechanisms (Portnay *et al*., 1974; Panda and Turner, 1975; Szabo and Frohman, 1977; Hefco *et al*., 1975; Vagenakis *et al*., 1977; Suda *et al*., 1978). Notably, it has been proposed that temperature plays a dual role in between: Its direct effect on TRH and subsequently plasma T_4 (Valtorta *et al*., 1982) and indirect effect on decreasing appetite which on its own can decrease thyroid hormone blood level. T3 directly stimulates feed intake at the hypothalamic level (Kong *et al*., 2004) while on the other hand, the quantity and quality of food eaten is a major factor determining plasma concentrations of TH (Dauncey, 1990). So, whether high temperature independently suppresses thyroid hormone may raise controversy. To shed some light on it, Yousef and Johnson (1960) proclaimed that even the force-fed cattle showed a significant decrease in thyroid activity when subjected to the heat treatment. For reconfirmation, Valtorta *et al*. (1982) ran a study contained a heat- stressed group compared with control and feed-restricted groups which showed temperature effect was additional to the feed effect and the heat-stressed group displayed a significantly greater decline in plasma T_4. Based on these studies, we come to the point that although feed restriction has a great impact on plasma levels of thyroid hormone, we can not ignore the dramatic independent effect of ambient temperature. One aim in this study was to compare the effect of temperature, a hot month versus a cold month, on the thyroid hormones and as it could be prognosticated, our experience revealed significant decreased blood levels of T_4, T_3 and T_3 uptake in August compared to February (Table 1). Since the animals were fed *ad libitum*, it is not claimed that the intake effect as a confounding factor has been eliminated, but according to the evidence given above, it could be concluded that differences observed in our study, were mostly due to the high temperature effect not decreased food intake.

More interestingly, not mentioned previously in literatures, samples collected in Augnst were affected more frequently than those obtained in February (Table 2), which is in line with the findings of Nouri *et al*. (2006), who showed a high range of thyroids pathological changes in sheep in Augnst in comparison with February. A wide spectrum of pathological changes were observed in these lesions depicted in Table 3 among which colloid goiter and diffuse hyperplastic goiter, which compose 7.75% of all lesions, worth being more addressed. These pathologic changes can be attributed to the increased TSH level in Augnst, which may lead to pathologic lesions, due to decreased T_4 and T_3 level (Thomson, 1988).

Last thing which attracted our attention was the high incidence of pathologic changes in thyroid glands in both seasons and the low levels of T_3, T_4 secretion and T_3 uptake in lesioned thyroid in comparison to other reports around the world (Sutherland and Irvine, 1974; Valtorta *et al*., 1982; Guerrini and Bertchinger, 1983; Mixner *et al*., 1962).

The results of this research revealed that thyroid lesions are very high among cattle in the area and deeply affect the function of the gland. The consequences of this malfunction have not been evaluated yet and a case control study to estimate the related economical losses is recommended.

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