Technical Note

Concentration of serum total iodine and thyroid hormones in Holstein cows in central Iran

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Abstract The aim of this study was to evaluate total iodine, triiodothyronine (T3) and thyroxine (T4) status in the blood serum of Holstein cows on six farms in central Iran. Total iodine, T3 and T4 concentrations were measured in 90 blood serum samples (15 per farm). Mean concentrations of total iodine (38.80 ± 1.52 µg/l) and T3 (1.57 ± 0.10 nmol/l) were lower but the mean concentration of T4 (45.60 ± 1.53 nmol/l) was greater than the critical levels ($P < 0.01$). Deficiency of total iodine, T3 and T4 was diagnosed in 82%, 85% and 35% of the cows, respectively. It was concluded that cows in central Iran were deficient in total serum iodine concentration. Increasing dietary iodine and further studies on the interaction between iodine and other minerals is recommended.

Keywords: iodine, triiodothyronine, thyroxine, blood, Holstein cows, central Iran

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Introduction

Iodine is an essential trace element present in human and animal body in minute amounts. The only confirmed role of iodine is its use in the synthesis of thyroid hormones, triiodothyronine (T3) and thyroxine (T4) that are essential for neuronal and sexual development, growth, and regulation of metabolism, body heat, and energy status. Consequently, severe iodine deficiency impairs thyroid hormone secretion (Delange and Dunn, 2005; Klimiene et al., 2008; Samanc et al., 2010). Iodine deficiency during pregnancy causes retardation of fetal development, abortion, stillbirth or birth of weak neonates with hyperplastic thyroid in cattle. The importance of subclinical iodine deficiency as a cause of impaired reproductive performance and neonatal mortality could be much greater than clinical disease (Radostits et al., 2007).

Deficiency of iodine in the diet or drinking water is related to geographical conditions and can impair thyroidal function (Honarpisheh et al., 2009).

Many parts of Iran have been identified as areas of endemic goiter, specially the Alborz and Zagros mountain ranges (Delshad et al., 2010). Since iodine cannot be synthetized in the body, soil and consequently plants are the primary sources of iodine (Paulikova et al., 2002). Because the iodine concentrations of soils in the Zagros mountain range (central Iran) are relatively low (Delshad et al., 2010), the foodstuffs cannot supply an adequate iodine intake for animals. In these areas the occurrence of functional thyroid disorders has been increasing in animals and because of subclinical symptoms, very little attention has been paid to the problem of iodine deficiency in cattle (Paulikova et al., 2002).

Little information is available on serum concentration of trace elements in Holstein dairy cattle in central Iran and to our knowledge; there is no information on iodine and thyroidal hormone status in Holstein dairy cattle in central Iran. Knowledge of microelement status of cattle and correct interpretation are of major importance in preventive measures. Therefore, the aim of this research was to study the status of total iodine, and T3 and T4 in the blood serum of Holstein dairy cows in Isfahan, central Iran.

Materials and methods

The study was carried out on six Holstein dairy cattle farms in Isfahan province (latitude 30°43'–34°27' N, longitude 49°36'–55°31' E), central Iran. Blood samples were collected in the morning via the jugular vein from 15 healthy dairy cows (at least 3 years old, 70 ± 35 days after calving and 25 ± 4 kg daily milk yield) and transported to the laboratory in an icebox.

Serum samples, prepared after centrifugation at 2795 g force for 10 min, were stored at -20°C until analysis. Cows on all farms were fed with a total mixed ration *ad libitum*. The most commonly used feedstuffs were alfalfa hay, clover, corn silage, wheat and barley straw. The concentrate portion consisted mainly of barely, corn grain, wheat bran, sugar beet pulp, cottonseed meal, soybean meal, molasses and mineral supplements. No clinical signs of iodine deficiency had been recorded on the farms by the veterinarians. The total iodine content was determined using the spectrophotometric method, based on the Sandel-Kolthoff reaction (Aumont and Tressol, 1987). Concentrations of T3 and T4 were measured by radioimmunoassay kits (Kavoshyar, Tehran, Iran), according to the manufacturer's instructions. Intra-assay and inter-assay coefficients of variation (CV) for T3 was 3.6% and 4.4%, respectively. Intra-assay and inter-assay CV for T4 were 4.7% and 4.9%, respectively. Mean values and standard errors were calculated and the results compared with the critical levels of the reference values. using one-sample *t* test (SAS, 2001).

Results and discussion

The mean (± SE) concentrations of total iodine, T3 and T4 in blood serum of Holstein cows are shown in Table 1. The mean concentrations of total iodine and T3 were lower but the mean concentration of T4 was higher than the critical levels ($P < 0.01$). Total iodine, T3 and T4 deficiency was diagnosed in 82%, 85% and 35% of the examined dairy cows, respectively.

Feeding less than the optimum amount of any mineral can increase the incidence of disease and reproductive problems, lower milk production and decrease growth rate (McDowell, 2002). The critical level of serum total iodine for dairy cattle is 50 µg/L (Kincaid, 2000). In the present study, the overall mean concentration of serum total iodine was 38.80 ± 1.52 µg/L which was lower than the critical level. It seems that dietary intake of iodine in Holstein cows of central Iran is low. Although farmers on all farms stated that diets were formulated by a nutritionist, serum total iodine deficiency was observed in a large proportion of cows (82%). It is postulated that low iodine intake in the diet and drinking water, high intake of calcium or continuous intake of low level of cyanogenic glycosides may result in low level of iodine in cattle. Sharma et al. (2005) reported that the deficiency of iodine in diet and drinking water was related to geographical characteristics. Several years ago, iodine deficiency symptoms were recorded in the central parts of Iran (Honarpisheh et al., 2009), therefore, iodine deficiency in Holstein dairy cows in this region was suspected. There are also reports of low serum iodine concentration in dairy cattle from other iodine-deficient areas (Singh and Singh, 2011).

Table 1. Concentrations of total Iodine, T3 and T4 in blood serum of Holstein cows in central Iran

	Critical Level[1]	Concentration (Mean ± S.E.)
Total Iodine (µg/L)	< 50	38.80 ± 1.52*
T3 (nmol/L)	< 2	1.57 ± 0.10*
T4 (nmol/L)	< 38	45.60 ± 1.53*

1. Values taken from Radostits et al. (2007)
* Significantly different (P < 0.01) from the critical level.

Although iodized salt is used in human diet in Iran but its use is not common in dairy cattle as yet. High levels of iodine in the cow's milk may substantially increase the iodine intake in humans (Carleton et al., 2008). Because iodine concentration in the milk of cows is a reflection of dietary iodine content (Radostits et al., 2007), an increase in dietary iodine level, above that (0.5 mg/kg diet DM) recommended by NRC (2001), not only is useful in correcting the iodine deficiency in cattle but may also increase milk iodine levels for human consumption (Norouzian, 2011).

The critical levels of serum T4 and T3 for cattle are 38 nmol/L and 2 nmol/L, respectively (Underwood and Suttle, 1999). About 85% of serum samples recordedT3 values below the critical level. About 80% of T3 is synthesized extrathyroidally through deiodination of T4 (Underwood and Suttle, 1999). When there is a deficiency in T4 conversion to T3, blood T4 levels may be high or normal but the animals may show signs of hypothyroidism (Underwood and Suttle, 1999). This may be the reason for low concentration of T3 and normal level of T4 recorded in the present experiment.

In addition, deficiency of several trace elements may affect serum thyroidal hormone concentration (Keles et al., 2006). Copper deficiency may cause atrophy of the intestinal villus (Radostits et al., 2007), and zinc deficiency may induce anorexia (Underwood and Suttle, 1999). Such deficiencies could impair absorption in the digestive system, and reduce feed efficiency and thyroid hormone secretion (Keles et al., 2006). Noaman et al. (2011) found significantly lower serum Cu and Zn levels in Isfahan Holstein farms. Therefore, the low levels of iodine and T3 could be the result of inadequate dietary levels of these elements.

Conclusion

Despite feeding iodine-containing mineral supplements, low serum iodine and T3 concentrations were common in Isfahan Holstein cows. It is important that nutritionists consider both the dietary iodine concentration and its interaction with other minerals. The most common cause of iodine deficiency in farm animals is the failure to provide sufficient iodine in the diet. Iodine deficiency can be corrected by adding iodine to the diet in the form of iodized salt licks. Future studies should be focused on environmental conditions (iodine levels in soil and pasture), management practices, and physiological state that make every production system unique with respect to mineral needs.

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