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Thyroid hormones in native Colombian bovine breeds

Hormônios tireoidianos em raças bovinas Colombiana nativas

Rómulo Campos,* Félix H. Diaz González,** Ángela Rodas,* Carolina Cruz*

Abstract

Colombia has the greatest number of native bovine breeds from *Bos taurus* origin in America, which is an important source of genetic resources and biodiversity conservation. Those breeds have showed adaptation to the tropic conditions, which are characterized by high temperature and humidity, as well as intense solar brightness. Physiological adaptation under heat stress conditions is partially regulated by thyroid hormones. In this work there were studied blood concentrations of thyroid hormones. Twenty-eight cows of eight different Colombian native breeds were used, divided in four different production groups: heifers, early lactation cows, end lactation cows and dry cows. The breeds were: Blanco-Orejinegro (BON), Chino Santandereano (CHI), Hartón del Valle (HVA) and Lucerna (LUC), with dairy production ability; Romosinuano (ROM) and Sanmartinero (SAM) with meat production ability; and Casanareño (CAS) and Costeño Con Cuernos (CCC) with undefined production ability. Triiodothyronine (T_3) and thyroxine (T_4) were measured in serum by radioimmunoassay technique (RIA). Mean values found were 1.89 nmol/L and 49.3 nmol/L, respectively. There were detected significant differences among breeds. Heifers had the greatest concentrations of thyroid hormones among the groups of animals studied.

Keywords: thyroid hormones, native cows, Colombia.

Resumo

Colômbia possui o maior rebanho de raças nativas bovinas originadas do *Bos taurus* na América, sendo uma fonte importante de recursos genéticos e biodiversidade. Estas raças têm mostrado adaptação às condições tropicais, caracterizadas por altos valores de temperatura e umidade, bem como intenso brilho solar. A adaptação fisiológica a condições de estresse térmico está parcialmente regulada pelos hormônios tireoidianos. No presente trabalho foram estudadas as concentrações sangüíneas desses hormônios. Vinte e oito animais de oito diferentes raças nativas colombianas foram utilizadas, separadas em grupos fisiológicos de produção: novilhas, vacas em início de lactação, vacas em final de lactação e vacas secas. As raças foram as seguintes: Blanco-Orejinegro (BON), Chino Santandereano (CHI), Hartón del Valle (HVA) e Lucerna (LUC), com aptidão para produção do leite; Romosinuano (ROM) e Sanmartinero (SAM) com aptidão para produção de carne; e Casanareño (CAS) e Costeño Con Cuernos (CCC) sem tipo definido de produção. Triiodotironina (T_3) e tiroxina (T_4) foram dosadas no soro mediante técnica de radioimunoanálise (RIA). Os valores médios encontrados foram de 1,89 nmol/L e 49,3 nmol/L, respectivamente. Foram detectadas diferenças significativas entre raças. As novilhas tiveram as maiores concentrações de hormônios tireoidianos entre os animais estudados.

Palavras-chave: hormônios tireoidianos, vacas nativas, Colômbia.

Introduction

Spaniards introduced native Colombian cattle in 16° century (Pinzón, 1991). Along centuries these animals became adapted to tropical environment, characterized by intense radiation, high temperature and humidity, as well as poor quality feed and high parasitic load. Native cattle show good reproductive traits, rusticity and reasonable production characteristics.

Thyroid hormones have been recognized as important factors in basal metabolism regulation and physiological processes related to heat resistance. Magdub et al. (1982) proposed that studying thyroid function might contribute to explain heat stress adaptation in animals. Some works in Latin America (Campos & Rodas, 1999; Velásquez, et al, 1999; Valle, 2002) related thyroid hormones with different conditions of husbandry and nutrition. Campos (1995) found differences in blood concentrations of thyroid hormones among bovine breeds in the tropics. McDowell (1978) showed a high relationship between energy metabolism and environment and proposed indicators for physiological mechanisms of thermoregulation and metabolic expenditure.

The present work studied serum levels of triiodothyronine (T_3) and thyroxine (T_4) in native cattle in Colombia, in relation to the tropical environment where the animals have been adapted.

Materials and methods

Eight native Colombian breeds existing in Colombia (FAO, 1999) were studied. The description of their habitats is shown in Table 1. The table is a description help for the geographical localization and climate characteristics (Cruz, 2000; Espinal,

* Department of Animal Science, National University of Colombia, Palmira, Colombia. romo90@latinmail.com.

** Faculty of Veterinary, Federal University of Rio Grande do Sul, Porto Alegre, Brazil. felixgon@orion.ufrgs.br

Table 1: Geographic localization and climatic conditions of the regions of origin of Colombian native breeds studied

Breed	Geographic localization	Altitude (meter above sea level)	Mean temperature (°C)	Mean rainfall (mm/year)	Mean relative humidity (%)	Solar brightness (h/day)
Blanco-Orejinegro (BON)	04°53´ N 75°53´ W	900	22	1704	70	5.5
Casanareño (CAS)	05°10´ N 72°33´ W	300	27	2441	70	4.9
Chino Santandereano (CHI)	07°45´ N 73°23´ W	125	28	2313	70	5.5
Costeño con Cuernos (CCC)	08°45´ N 75°53´ W	49	28	1249	83	5.0
Hartón del Valle (HVA)	03°26´ N 76°31´ W	991	24	1473	72	5.6
Lucerna (LUC)	04°12´ N 76°09´ W	960	23	1166	74	5.6
Romosinuano (ROM)	03°59´ N 73°45´ W	523	25	5018	79	4.20
Sanmartinero (SAM)	04°09´ N 73°38´ W	336	26	2787	79	4.66

1990). The study included the following native Colombian breeds: Blanco-Orejinegro (BON), Chino Santandereano (CHI), Hartón del Valle (HVA) and Lucerna (LUC) which have dairy production ability; Romosinuano (ROM) and Sanmartinero (SAM) with meat production ability; and Casanareño (CAS) and Costeño Con Cuernos (CCC) whitout any definite production type. Twenty-eight animals were selected for each breed, from which there were formed four different groups of production, as follows: heifers, early lactation cows, end lactation cows and dry cows, performing 56 animals per production group, corresponding to seven animals per breed.

Blood samples were collected from each animal by coccigeal venipuncture with vacutainer tubes without anticoagulant. Blood sample were centrifuged (2500 rpm) and serum was extracted and stored at -20°C until analysis. Almost all animals had a body condition score of 3.0 (scale 1-5) when blood was collected. Only the CAS breed group showed a lower body condition score of 2.0.

Thyroid hormones triiodothyronine (T_3) and thyroxine (T_4) were measured by solid phase radioimmunoassay (RIA) using reagents from Diagnostic Product Corporation (Los Angeles, CA, USA). Data were processed through RIAPC software (University of Guelph, Canada).

Results were statistically analyzed using SAS program (Cary, NC, USA) using GLM method for descriptive statistics, Duncan mean tests and analysis of variance according to the following model:

$$E_{jklm} = m + E_j + E_{jk} + E_{jkl} + E_{jklm}$$

Where: m is the population mean, E_j the effect of breed, E_{jkl}, the effect of production condition, E_{jkl} the interaction breed*production condition and E_{jklm} the experimental error.

Results and discussion

Serum concentrations of triiodothyronine (T_3) and thyroxine (T_4) in the different native breeds are shown in Table 2. Campos (1993) reported that T_3 values in bovines range between 0.064 and 2.85 nmol/L. Mean value of T_3 obtained here for native Colombian cows was 1.89 nmol/L. Dairy cattle of other breeds have higher values of T_3 (Walsh et al., 1980; Fish & Swanson, 1983; Campos & Rodas, 1999), which may suggest that native Colombian cattle could have a lesser metabolic rate, as a consequence of adaptation process.

Table 2: Mean and standard deviation values of serum triiodothyronine and thyroxine in native Colombian cows

Breed	N	Triiodothyronine (nmol/L)		Thyroxine (nmol/L)	
		Mean	Standard deviation	Mean	Standard deviation
Blanco Orejinegro (BON)	28	1.47 ^{b,c}	0.39	55.22 ^{a}	14.89
Casanarenho (CAS)	28	1.16 ^{c}	0.46	53.02 ^{a,b}	18.52
Chino Santadereano (CHI)	28	1.48 ^{b,c}	1.73	41.88 ^{c}	2.19
Costeño con Cuernos (CCC)	28	1.74 ^{b}	0.44	43.43 ^{b,c}	12.28
Hartón del Valle (HVA)	28	1.55 ^{b,c}	0.47	50.87 ^{a,b,c}	15.97
Lucerna (LUC)	28	1.58 ^{b,c}	0.62	44.96 ^{b,c}	19.18
Romosinuano (ROM)	28	2.85 ^{a}	1.46	48.62 ^{a,b,c}	23.77
Sanmartinero (SAM)	28	3.17 ^{a}	1.52	57.63 ^{a}	17.02

Different letters differ significantly ($p< 0.05$)

Although climate condition is an important factor that affect the thyroid hormones levels, the separated climate components (rain precipitation, humidity, temperature, altitude and solar brightness) could not be evaluated to explain the triiodothyronine variations, as the environmental conditions were not included into the statistical model.

Serum T_3 in adapted or introduced bovines under tropical conditions (Velásquez et al., 1999; Campos & Rodas, 1999), showed lower values than bovines from tempered regions, which may be indicating that hot environment is responsible for a lesser secretion of thyroid hormones as a mechanism for decreasing body heat. Those mentioned works were done out of thermal comfort zones, that is, with relative humidity higher than 80%, environmental temperature higher than 23.8°C and solar bright higher than 4.5 hours/day (Du Preez et al., 1990). Thyroid hormones play an important role in regulating body temperature. At low temperature, animal basal metabolism increases for generating heat through increasing T_3 secretion. At high temperature it occurs the opposite (Guyton, 1989; Illera, 1984; Magdub et al., 1982).

In the present work there were differences in serum T_3 concentration among breeds ($p< 0.05$) possibly indicating an effect of the different ecosystems where native animals have been living for centuries. Highest values of T_3 were for ROM (3.17 nmol/L) and SAM (2.85 nmol/L). Those breeds are located in similar agro-ecological conditions with the highest rainfall means, that could alleviate hot stress. Additionally, both breeds have meat production ability, a process that demands less metabolic activity than milk production (Nixon et al., 1988). Native breeds with milk production ability (LUC, BON, HVA and CHI) showed similar values of serum T_3. The lowest value of T_3 was observed in CAS breed animals (1.16 nmol/L), which were in the poorest nutritional conditions, evidenced by their body condition score of about 2.0 (1-5 scale) at sampling time. Illera (1984) mentioned that stress situations and limited feed alter deiodination mechanism in cells decreasing T_3 levels.

Thyroxine levels showed low variation among breed groups, possibly because this hormone is not the active biological form, although it constitutes an important reserve. Mean serum thyroxin value was 49.3 nmol/L. Variations among breeds are shown in Table 2. Reference values of T_4 are in a range between 13.73 and 95.01 nmol/L (Nixon et al., 1988; Fish & Swansom, 1993; Campos & Rodas, 1999). Those authors mentioned that Holstein cows and native cows in tropical highlands (high altitude and cold temperatures) have higher T_4 values than animals located in hotter tropical regions. Tropical Colombian highlands are regions of thermal comfort for dairy specialized breeds (Manrique, 1997).

Similar to that observed for T_3, there were significant differences ($p< 0.05$) in T_4 concentrations among different breeds (Table 2). Higher values were observed in SAM and BON breeds (57.63 and 55.22 nmol/L, respectively). Velásquez et al. (1999) found similar values of T_4 in SAM breed. In the case of BON, high values of T_4 may be related to mineral supplementation with iodine, which lacked in the other groups. Lowest value of T_4 was observed in CHI breed (41.88 nmol/L).

Concerning production groups, there were no significant differences among groups of cows in T_3 and T_4 concentrations. The group of heifers, however, had higher concentrations ($p< 0.05$) of both hormones (2.15 nmol/L for T_3 and 59.78 nmol/L for T_4) compared with the groups of cows (Table 3). This behavior favors the concept that younger animals have greater metabolic rate than adult animals either within the same breeds (Fish & Swansom, 1983; Nixon et al., 1988). There were no significant interaction between breed and production group.

Table 3: Serum concentrations of thyroid hormones in different physiological status of Colombian native cows

Physiological group	N	Triiodothyronine (nmol/L)		Thyroxine (nmol/L)	
		Mean	Standard deviation	Mean	Standard deviation
Heifers	56	2.15 [a]	1.20	57.78 [a]	19.33
Early lactation cows	56	1.84 [a,b]	1.03	44.99 [b]	16.72
End lactation cows	56	1.81 [a,b]	0.97	49.12 [b]	16.04
Dry cows	56	1.75 [b]	1.2	42.69 [b]	18.00

Different letters differ significantly ($p<0.05$)

Conclusions

The present results show that thyroid hormone values in native Colombian cattle may differ among breeds, possibly by influence of environment and production traits. Also, the higher levels of the hormones observed in heifers in comparison to the cows revealed higher metabolic rates in that group of animals. The thyroid hormones in Colombian breeds studied fell in the physiological range for bovines, but the lower levels found compared with other works are worthy of additional studies concerning adaptation process under tropic environment conditions.

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