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Breed and diurnal effects on leptin and glucose concentrations in tropical cattle

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Abstract

The effects of breed and time of day was evaluated on plasma leptin and glucose concentrations in four breeds of cattle. The breeds were Muturu, White Fulani, Ndama and Muturu x White Fulani cross. Animals had ad-libitum access to feed and water. Each animal was weighed daily and bled by jugular venipuncture using Vacutainer kits for three consecutive days. Plasma leptin was determined using the Millipore Multi-species radioimmunoassay and plasma glucose was determined using the Wako Autokit Glucose technique. Plasma leptin was significantly (P<0.0001) dependent on breed. The Muturu breed had the lowest amount of leptin (3.9 ± 1.8 ng/ml) while the White Fulani breed had the highest level (8.5 ± 3.2 ng/ml). There was a significant correlation between bodyweight and leptin. Leptin level was not affected by time of day. Mean plasma glucose ranged from 42.7 to 54.7 mg/dL and was significantly (P = 0.019) dependent on cattle breed. Also, time of day had no effect on plasma glucose concentration. These data indicated that significant breed differences exist in leptin concentrations in tropical cattle. These differences may reflect the disparity in muscularity and adiposity in the breeds.

Keywords: adiposity, muscularity, Nigerian taurine bovine, radioimmunoassay

Introduction

The *Bos indicus*_cattle breed such as the White Fulani is the predominant cattle breed in sub-humid Africa but they are susceptible to trypanosomiasis. However, taurine breeds such as the N'dama and Muturu, although smaller, are trypanotolerant. The incidence of trypanosomiasis has limited cattle production in sub-humid Africa to less than half of the potential that the sub-continent can support according to Jahnke *et al.* (1988). The *Bos taurus* breeds are going into extinction irrespective of their hardiness to the cattle plaque (trypanosomiasis). In the phase of stress from parasitism, the *Bos indicus* farmers face losses ranging from emaciation (reduction in muscularity and adiposity) through cost of disease management to deaths of cattle. There is disparity in muscularity and adiposity in these tropical cattle breeds. Also the mechanisms leading to differences in carcass characteristics, particularly fat accumulation or adiposity between cattle breeds are not well understood (Higashiyama *et al*., 2003). Leptin is a peptide hormone secreted by white adipose tissue. In cattle, plasma leptin levels are closely correlated with adipose tissue cellularity, body condition score and nutritional status (Chilliard *et al*., 2001; Delavaud *et al*., 2002). Moreover, circulating leptin levels in beef cattle increase during fattening (Kawakita *et al*., 2001). This hormone affects energy expenditure, feed intake and reproduction. Significant effects of gender and physiological states have been reported in leptin levels by Ahima *et al.* (1996).

However, glucose has been implicated in the regulation of leptin concentrations.

Glucose is an essential metabolite in ruminants. It is required for synthesis and turnover of fats. While volatile fatty acids provide about 70 percent of the energy requirements of ruminants, glucose homeostasis is still critical in ruminants. Whereas propionate and amino acids are the major precursors of glucose in fed animals, the situation is different in animals maintained mainly on pastures. In many parts of Sub-Saharan Africa, cattle production is based on low quality roughages and the productivity of these animals is markedly low. Part of the breeding improvement program relates to the cross- breeding of indigenous cattle to high-producing *Bos taurus*_or local *B. taurus* breeds with some degree of trypanotolerance. Circulating leptin and adipose tissue leptin levels are correlated with body weight, food intake, nutritional status, and adipose tissue mass in animals (Larsson *et al*., 1998; Delavaud *et al*., 2002). The leptin factor has gained much attention recently as a key regulator of biological processes that are related to very important productive traits in beef cattle, such as feed intake, fat content and meat quality (Geary *et al*., 2003). A discrete temporal analysis of the dynamics (diurnal effects) of leptin secretion in tropical cattle has not been reported, although, in humans, concentrations of leptin in the circulation vary in an episodic manner with a diurnal rhythm (Licinio et al., 1997). There is paucity of information on the levels of leptin and glucose in these tropical breeds of cattle. The objective of this experiment was to determine the effects of breed and day length on plasma leptin and glucose concentrations in different cattle breeds under a tropical environment.

Materials and methods

The experiment was conducted in the Federal University of Agriculture, Abeokuta, South west Nigeria and involved the use of 19 animals. Animals were divided into groups based on breed type. The groups were as follows: Muturu (mean body weight 86 ± 6.4 Kg), N'dama (186 ± 3.1Kg), White Fulani (254 ± 4.7Kg), and Muturu x White Fulani (247 ± 2.8 Kg). Animals were maintained on roughage consisting of *Panicum maximum*, *Pennisetum typhoides* and had access to water. Each animal was weighed daily and bled by jugular venipuncture for three consecutive days. Plasma leptin was determined using the Millipore Multi-species radioimmunoassay and plasma glucose was determined using the Wako Autokit Glucose technique. Data were analyzed using the GLM procedure of SAS to determine the effect of breed, time of day, gender and their corellation on plasma leptin and glucose concentrations.

Results and discussion

Plasma leptin was significantly (P<.0001) dependent on breed. The Muturu breed had the lowest amount of leptin (3.9 ± 1.8 ng/ml) while the White Fulani breed had the highest level (8.5 ± 3.2 ng/ml) as shown in Figure 1. There was a significant correlation between bodyweight and leptin (Table 1) while leptin level was not affected by time of day as shown in figure 2.

Mean plasma glucose ranged from 42.7 to 54.7 mg/dL and was significantly (P = 0.019) dependent on cattle breed according to figure 3.

Again, time of day had no effect on plasma glucose concentration as shown in figure 4.

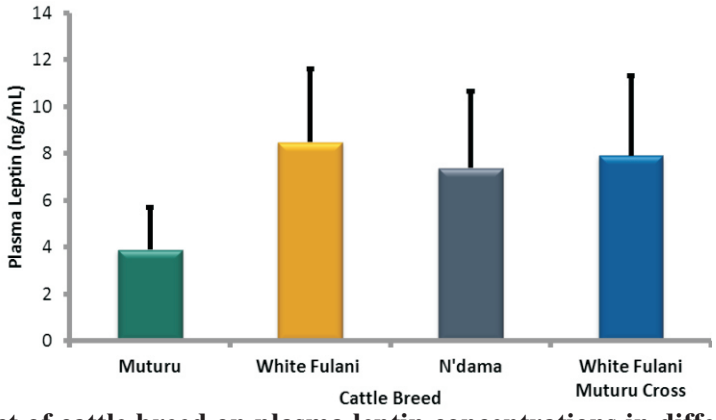

Figure 1: Effect of cattle breed on plasma leptin concentrations in different breeds of cattle raised in a tropical environment

Table 1: Correlation coefficients among bodyweight, breed and plasma variables of tropical cattle

	Body Weight	Leptin	Glucose	Breed
Breed	0.652 (<0.0001)	0.372 (<0.0001)	0.252 (-0.0086)	-
Body Weight	-	0.491 (<0.0001)	0.286 (-0.0027)	0.652 (<0.0001)
Leptin	0.491 (<0.0001)	-	0.256 (-0.0074)	0.372 (<0.0001)
Glucose	0.286 (-0,0027)	0.256 (-0.0074)	-	0.252 (-0.0086)

Numbers in parenthesis represents p values.

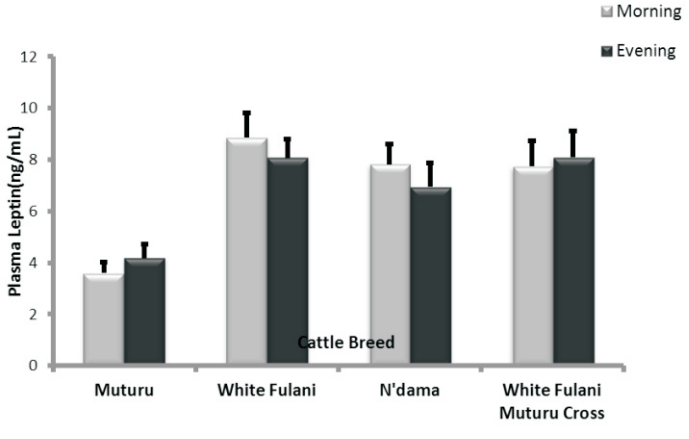

Figure 2: Effect of time of day on plasma leptin concentrations in cattle raised in a tropical environment

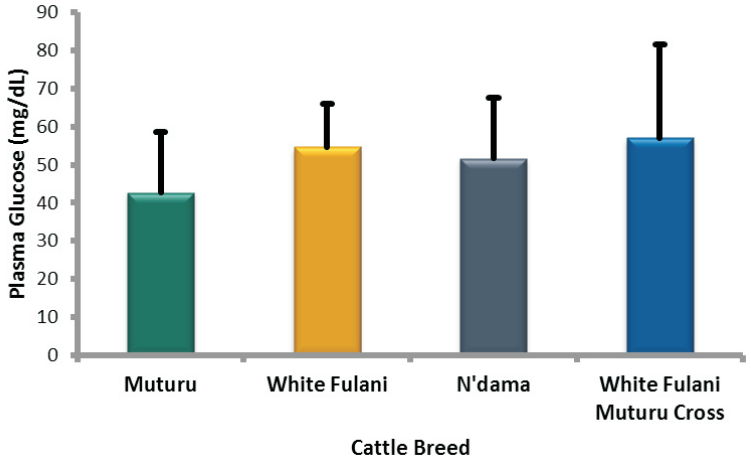

Figure 3: Mean plasma glucose concentrations in different breeds of cattle raised in a tropical environment

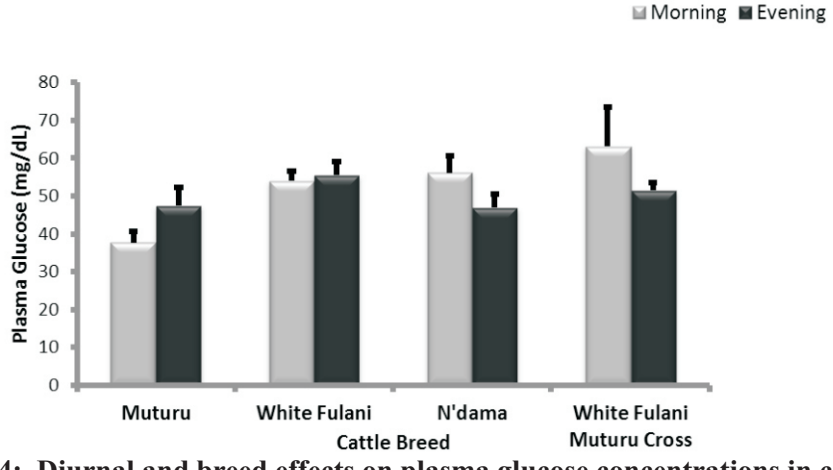

Figure 4: Diurnal and breed effects on plasma glucose concentrations in cattle raised in a tropical environment

These data indicated that significant breed differences exist in leptin and glucose concentrations in tropical cattle. Since leptin is a product of white adipose tissue, this difference may reflect the disparity in muscularity and adiposity among the breeds. Body condition score has been reported to affect plasma leptin (Delavaud, 2002). In sheep, leptin plasma concentrations have been reported to be highly correlated with body fat mass (Kumar *et al*., 1998), The White Fulani x Muturu cross was intermediate in its leptin concentrations. Our data indicated that bodyweight is a strong predictor of leptin level and this was consistent with results of previous studies by Thomas *et al.* (2002). No diurnal effect was seen in this study, this was in agreement with Daniel *et al.* (2002) and also consistent with the observations of others who have also failed to detect a diurnal rhythm rams (Blache *et al.,* 2000;

Marie *et al.,* 2001).

The inability to detect a diurnal rhythm in plasma concentrations of leptin in cattle may be due to differences in the physical digestion processes and metabolism of nutrients between ruminant and monogastric animals. The lack of diurnal effect on plasma glucose indicated that other sources of energy, namely the volatile fatty acids, exist in ruminants. In both humans and rodents, the diurnal rhythm seems to be associated with changes in meal timing (Taylor *et al.,* 1999; Ahre´n, 2000). The rumen of the cattle allows for a more constant supply of nutrients without the dramatic changes in concentrations in glucose and insulin observed in monogastrics. However, glucose and insulin have been implicated in the regulation of leptin concentrations.

The observed difference in leptin concentration may be indicative of the reproductive potentials of these breeds. The animals in this study were maintained under traditional range grazing management as animals on this system are characterized by low productivity (Nweze *et al.,* 2012). The low levels of glucose observed were typical of animals maintained solely on pastures. These data indicated that breed affected plasma leptin levels in tropical cattle and that plasma glucose was comparatively low in these animals. The data from this study allow for the conclusion that diurnal rhythms in leptin concentrations in ruminant species do not exist to the same degree as in monogastric species, where nutrient ?uxes may be creating a diurnal rhythm in leptin secretion.

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References

Ahima, R. S., Prabakaran, D. and Mantzoros, C. 1996. Role of leptin in the neuroendocrine response to fasting. *Nature,* 382:250–252.

Ahre´n, B. 2000. Diurnal variation in circulating leptin is dependent on gender, food intake, and circulating insulin in mice. *Acta Physiol. Scand.*, 169:325–331.

Blache, D., Tellam. R. L., Chagas, L. M., Blackberry, M. A., Vercoe, P. E. and Martin, G. B. 2000. Level of nutrition affects leptin concentrations in plasma and cerebrospinal fluid in sheep. *J. Endocrinol.*, 165:625–637.

Bocquier, F. 2001. Leptin in ruminant. Gene expression in adipose tissue and mammary gland, and regulation of plasma concentration. *Domestic Animal Endocrinology,* 21:271–295.

Chilliard, Y., Bonnet, M., Delavaud, C., Faulconnier, Y., Leroux, C., Djiane, J. and Bocquier, F. 2001. Leptin in ruminant. Gene expression in adipose tissue and mammary gland, and regulation of plasma concentration. *Domestic Animal Endocrinology,* 21:271–295.

Daniel, J. A., Whitlock, B. K., Baker, J. A., Steele, B. Morrison, C. D, Keisler, D. H. and Sartin, J. L. 2002. Effect of body fat mass and nutritional status on 24-hour leptin profiles in ewes. *J. Animal Science,* 80:1083-1089.

Delavaud, C., Ferlay, A., Faulconnier, Y., Bocquier, F., Kann, G. and

Chilliard, Y. 2002. Plasma leptin concentration in adult cattle: effects of breed, adiposity, feeding level, and meal intake. ***Journal Animal Science***, 80: 1317-1328.

Geary, T. W., Mcfadin, E. L., Macneil, M. D. and Grings, E. E. 2003. Leptin as a predictor of carcass composition in beef cattle. *J. Anim. Sci.,* 81:1-8.

Higashiyama, Y., Abe, H., Hayashi, M. and Hodate, K. 2003. The comparison of plasma level and mRNA expression of leptin from Japanese Black steers and Holstein steers. *Livestock Production Science,* 81:247–255.

Jahnke, H. E., Tacher, G., Keil, P. and Rojat, D. 1988. Livestock production in tropical Africa, with special reference to the tsetse-affected zone: *Livestock production in tsetse affected areas of Africa*. *Proceedings of a meeting held 23-27 November 1987*. ILCA/ILRAD, Nairobi, Kenya.

Kawakita, Y., Abe, H., Hodate, K., Iguchi, A., Kobayashi, M., Mori, T., Kasai, K., Tanai, Y., Kanbe, Y. and Mashiyama, H. 2001. The relation between plasma leptin concentrations and carcass lipid contents in Japanese Black steers. *Livestock Production Science,* 73:25–34.

Kumar, B., Francis, S. M., Suttie, J. M. and Thompson, M. P. 1998. Expression of obese mRNA in genetically lean and fat selection lines of sheep. *Comp. Biochem. Physiol.,* 120:543–548.

Larsson, H., Elmstahl, S., Berglund, G. and Ahren, B. 1998. Evidence for leptin regulation of food intake in humans. J. Clin. Endocrinol. Metab., 83:4382– 4385.

Licinio, J., Mantzoros, C., Negrao, A. B., Cizza, G., Wong, M. L., Bongiorno, P. B., Chrousos, G. P., Karp, B., Allen, C., Flier, J. S. and Gold, P. W. 1997. Human leptin levels are pulsatile and inversely related to pituitary-adrenal function. *Nat. Med.,* 3:575–579.

Marie, M., Findlay, P. A. Thomas, L. and Adams, C. L. 2001. Daily patterns of plasma leptin in sheep: Effects of photoperiod and food intake. *J. Endocrinol*., 170:277–286.

Nweze, B. O., Ekwe, O. O., Alaku, S. O., Omeje, S. I. 2012. Productivity of Two Indigenous Nigerian Cattle Breeds and Their Crossbreed Under Range Grazing Management. *World J Life Sci. and Medical Research,* 2(1) 1-7.

Taylor, A. E., Hubbard, J. and Anderson, E. J. 1999. Impact of binge eating on metabolic and leptin dynamics in normal young women. *J. Clin. Endocrinol. Metab*., 84:428–434.

Thomas, M. G., Enns, Hallford, D. M., Keisler, D. H., Obeidat, B. S., Morrison, C. D., Hernandez, J. A., Bryant, W. D., Flores, R., Lopez, R. and Narro, L. 2002. Relationships of metabolic hormones and serum glucose to growth and reproductive development in performance-tested Angus, Brangus, and Brahman bulls. *J. Animal Science* 80:757-767.

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