BODY CONDITION SCORE (BCS) AND CALVING ORDER ON MILK PRODUCTION AND COMPOSITION IN ZEBU CATTLE

[*Escore de condição corporal (ECC) e ordem de parto sobre a produção e composição de leite de vacas zebuínas*]

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ABSTRACT – The present study aimed to evaluate the effect of body condition score (BCS) and calving order on milk production and composition in zebu cattle participating in an official dairy cow tournament. We analyzed milk samples from 47 Gyr, Guzerat and Red Sindhi cows, distributed into classes with respect to lactation stage, milk production, and body condition score. Means for milk composition were within standard ranges for zebu cattle, with the greatest variation recorded for fat and protein content. Fat content was higher for animals in the first month of lactation, with a mean of 5.69%, and protein content was highest after 60 days with an average of 3.55%. A positive correlation of 0.38% ($p<0.05$) was observed between milk fat and protein content. First calving animals exhibited lower mean of milk production than those in their second calving or more. Animals with a BCS in class II demonstrated higher daily production up to 30 days of lactation. Body condition score influenced the milk production of zebu cows participating in a dairy cow competition up to the 30th day of lactation.

Keywords: fat content of milk; milk components; milk protein.

RESUMO – Objetivou-se avaliar o efeito do escore de condição corporal (ECC) e da ordem de parto (OP) sobre a produção e composição do leite de vacas de raças zebuínas participantes do torneio leiteiro oficial. Foram analisadas amostras de leite proveniente de 47 fêmeas das raças Gir, Guzerá e Sindi, distribuídas em classes quanto ao período de lactação, produção de leite e escore de condição corporal. As médias de composição do leite se encontram dentro dos padrões das raças zebuínas, sendo a maior variação observada para os teores de gordura e proteína. O teor de gordura foi maior para os animais no primeiro mês de lactação, com média de 5,69% e o de proteína após os 60 dias, com média de 3,55%. Houve correlação positiva entre o teor de gordura e proteína no leite que foi de 0,38% ($P < 0,05$). Os animais de primeira ordem de parto apresentaram média de produção de leite inferior aos de segunda ou mais. Os animais com ECC da classe II apresentaram superioridade para produção diária até os 30 dias de lactação. O escore de condição corporal influenciou a produção de leite de vacas zebu participantes do torneio leiteiro até os 30 dias de lactação.

Palavras-Chave: constituintes do leite; gordura do leite; proteína do leite.

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INTRODUCTION

Assessing the body condition score (BCS) ascertains the animal's energy reserve and is based on visual observation, as well as palpation of specific areas of the body to quantify fat deposits and muscle mass. It is a subjective mean of estimating the amount of metabolic energy stored as subcutaneous fat and muscle. Despite its subjective nature, it is an low-cost, practical and non-invasive technique used to quantify the deposited or mobilized reserves of an animal's body (Machado et al., 2008).

The BCS varies according to the method used; however, possibly the most important factor is knowledge and experience of the evaluator. The highest values on the scale always indicate animals with greater body reserves. Noteworthy assessment techniques for dairy cows are those of Wildman et al. (1982) and Edmonson et al. (1989), which are based on visual and tactile inspection of body reserves and use a scale of 1 to 5, with subunits of 0.25 points.

Dairy cows with a low BCS after calving generally exhibit poor reproductive performance postpartum. From approximately one to two weeks prior to calving, ingestion of dry matter decreases. On the other hand, immediately after calving and at the onset of lactation, demand for energy for the purpose of milk production increases, reflecting the energy requirements of the mammary gland for milk synthesis. The rapid rise in nutritional requirements needed for lactation contributes significantly to insufficient consumption of the cows of the energy required to meet maintenance and production demands, leading to negative energy balance (NEB). This may begin during or before calving and last several weeks throughout the postpartum period (Bewley & Schutz, 2008; Leblanc, 2010; Šamanc et al., 2010; Nobre et al., 2012).

Visual analysis of the cow's body is an aid to obtain a better body condition score by palpation. It is important to note that in addition to establishing the body's probable energy reserve, the BCS is independent of body size, degree of repletion of the intestinal tract, and gestation. Furthermore, it serves as a support tool for the establishment or not of management practices, particularly the feeding and nutrition of dairy female and beef cattle (Sonohata et al., 2009; Dochi et al., 2010; Pellegrini et al., 2012; Reis & Saturnino, 2012). Thus, the importance of assessing the BCS is derived from knowledge regarding the partition of nutrients in the diet according to the needs of the animal. Determining the BCS positively influences decision-making regarding measures of impact in production and the costs of agricultural undertakings (Machado et al., 2008).

Several studies have been conducted on Taurine cows correlating BCS with milk production and composition, although research on BCS in zebu cows is scarce in the literature. As such, the present study aimed to evaluate the effect of body condition score (BCS) on the production and composition of milk in zebu cattle participating in a dairy cattle competition.

MATERIAL AND METHODS

Data were obtained from official records during the Zebu Dairy Cattle Tournament at the 49th Agricultural Exposition in the city of Parnamirim, Brazil, located in the municipality of Natal, from records provided by the Brazilian Zebu Breeders Association (ABCZ). The city has mean annual rainfall of 1361 mm, average temperature of 27.1°C and mean relative humidity of 79% (EMPARN, 2009).

The data are related to female Gyr, Guzerat and Red Sindhi cattle, with information on name and registration, lactation stage and parity, generating a database containing data on 47 PB (purebred) animals, as follows: 15 Guzerat, 12 adults and three heifers; 26 Red Sindhi, 14 adults and 12 calves; and six (06) Gyr, 4 adults and 2 calves.

Animals participating in the tournament were grouped into categories based on purebred (PB) records and age in months, according to ABZC regulations for the dairy cattle tournament: heifers, less than 36 months; young cows, older than 36 and younger than 48 months or with six teeth; adult cows, older than 48 months or with eight teeth – full mouth.

The animals were housed in covered stalls containing concrete linear feeders, troughs and a cement floor covered with sawdust bedding, where clean water and formulated feed was available, supplied in accordance with nutritional requirements. Removal of the animals from the tournament venue was only permitted for cleaning purposes and veterinary care. Stalls were cleaned daily and the sawdust bedding was changed as needed. Milking was performed manually, with a maximum time limit of 15 minutes and at eight-hour intervals: 6am, 2pm and 10pm. The milk production of each animal was recorded over the three-day event.

Milk was collected individually for analysis during the three days of the event. At the end of each day, the milk from each animal was homogenized to obtain composite samples proportional to the

respective milkings. Flasks holding the samples were labeled with a code and the animal's name, stored in isothermal boxes containing ice between 2°C and 7°C, and transported to the Milk Quality Laboratory (LABOLEITE) at the Federal University of Rio Grande do Norte (UFRN), in Natal, Brazil. Analyses were conducted in the laboratory with respect to composition: fat, protein, lactose, total solids, minerals and nonfat dry extract, using an ultrasonic method and LACTOSCAN® equipment (Milkotronic Ltd, Bulgaria).

BCS assessment was carried out through visual and tactile evaluation of body reserves at specific points of the cow's body, on a scale of 1 to 5, with subunits of 0.25 points as described by Wildman et al. (1982) and Edmonson et al. (1989).

Each record consisted of the following information: code and name of the animal, daily milk production, lactation stage, analysis of milk components, number of calving and BCS.

Data were distributed into classes based on lactation stage, average daily production and BCS. In the lactation stage class, cows were divided according to days of lactation such that animals from class I were up to 30 days into lactation, those from class II, 31 to 60 days, and cows from class III had been lactating for over 60 days.

Mean daily production was also divided into three classes. Animals from class I had an average production less than or equal to 15.0 (kg/day) of milk, those from class II produced between 15.1 and 20.0 (kg/day) of milk and those in class II over 20.0 (kg/day) of milk. In regard to BCS, cows from class I exhibited scores less than or equal to 3.75 and animals in class II had scores higher than 3.75.

The following statistical procedures were performed: descriptive statistics, analysis of variance and correlation analysis using the Statistical Analysis System - SAS and measurements were compared via Tukey's test ($\alpha = 0.05$).

RESULTS AND DISCUSSION

Means and standard deviations of milk composition and body condition score (BCS) are shown in Table 1.

Table 1. Means and standard deviations of milk composition (%) and BCS for Gyr, Guzerat and Red Sindhi cows

Milk Composition	Mean	Standard Deviation	Maximum	Minimum
Fat	5.61	0.94	7.90	3.32
Protein	6.02	0.61	9.72	2.33
Lactose	4.73	0.41	5.99	3.48
Total Solids	14.88	1.50	19.29	10.47
Nonfat dry extract	8.63	0.70	10.91	6.35
Minerals	0.70	0.06	0.89	0.52
BCS	4.00	0.50	4.75	3.00

Body condition score (BCS).

Results show that the means recorded were in accordance with standards for the Zebu breed. The highest variations observed were for fat (5.61%) and protein (6.02%). Banos & Coffey (2009) state that fat is the most variable component in milk. There are a series of factors and mechanisms of action in feeding that may influence its final fat content. However, other factors such as breed, lactation stage, intervals between milkings and age of the cow may also cause changes in milk composition.

In contrast to the findings described here, Araújo et al. (2011), reported lower results when analyzing the influence of different environmental factors on the quality and composition of milk from Gyr cows, including thermal stress, food and nutrition management, season, and lactation stage, among others. Means recorded were 3.91% for fat; 3.31% for protein; 4.55% for lactose and 12.82% of dry extract. When assessing the physical and chemical composition of milk from Holstein dairy cattle. Banos & Coffey (2009) reported lower results (2.4) when analyzing the body condition score in Holstein cows.

Figure 1 shows in mean fat and protein variation, according to days of lactation and the relationship between protein and fat.

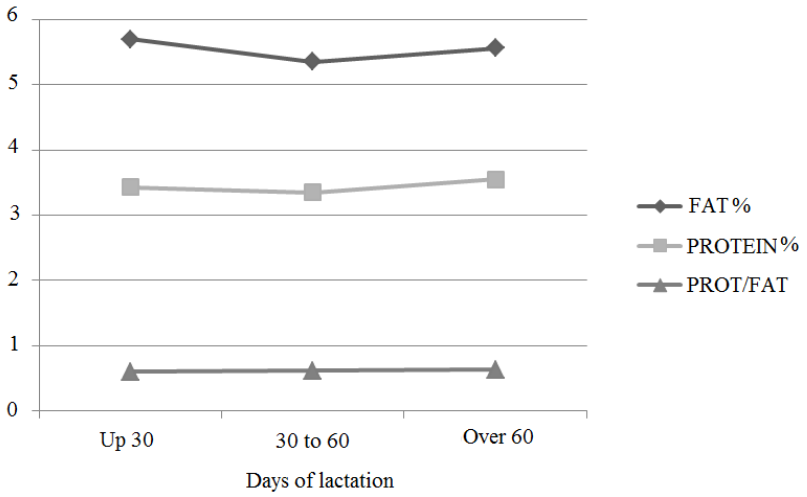

Figure 1. Means, % fat and protein content and the relationship between protein and fat (Prot/Fat), in accordance with days of lactation

Fat content was found to be highest in the first month of lactation, with a mean of 5.69%, which declined to 5.56% after 60 days. Although this decrease was not significant, it contrasts with Oliveira et al. (2010), who described fat content in crossbred cows (Holstein-Nellore) varying from 2.39% to 7.81%, with higher fat percentages in milk for longer periods of lactation. Fat values for up to 30 days of lactation were greater than those described by Jílek et al. (2009), who recorded a fat content of 4.07% for Czech Fleckvieh milk's cow. The protein content found here was greater after 60 days of lactation, with a mean of 3.34%. In general, the longer the period of lactation the higher the protein percentage. Oliveira et al. (2010), observed a maximum of 3.91% in a sample collected at 12 months of lactation and a minimum of 2.60% in a sample from the first month of lactation. The differences in fat and protein content between the investigations cited may be due to the different conditions involved in livestock exploitation, such as food and nutrition management, promoting the health of the mammary gland, level of production and genotype, among others.

The correlation coefficient between the fat and protein content of milk in Gyr, Guzerat and Red Sindhi cows participating in a dairy cattle tournament was 0.38 ($p < 0.05$). Thus, as fat content increases, protein content rises by 38%. The positive correlation between fat and protein percentages occurs because these elements are the main components of total solids, contributing to their composition with 30.0% and 26.0%, respectively.

The means for daily milk production of classes I, II and III are shown in Table 2. We analyze milk production, fat and protein content, lactose, total solids, nonfat dry extract, minerals, parity and body condition score (BCS).

Table 2. Mean content for milk production (MP), fat (FAT), protein (PROT), lactose (LACT), total solids (TS), nonfat dry extract (NDE), parity (P) and BCS of animals scored 1, 2 and 3

CLASS SCORE	MP	FAT	PROT	LACT	TS	NDE	Calving order	BCS
I	13.23	5.89	3.57	5.13	15.16	9.28	1.95	4.02
II	17.48	5.42	3.24	5.07	14.67	9.25	2.05	4.06
III	24.78	5.20	3.30	4.92	14.24	8.98	3.38	4.00

$P > 0.05$ between means and categories.

In sample analyses, although a non-significant variance was observed among classes, production class I exhibited higher values for fat, protein, lactose, total solids, and nonfat dry extract. In this same class, composed of first and second calving cows, this factor may have affected the values recorded, particularly for fat percentage and milk production.

Rangel et al. (2008) investigated Jersey cows and reported that the variable age or calving order exerted a significant quadratic effect ($p < 0.05$) on milk production and fat. Santos et al. (2010) studied Holstein cows and observed different results for milk production according to number of calving. In the present study, it is important to note the

presence of third calving cows in class III, which may explain the greater milk production in this class. Due to the dilution effect, fat and protein content tend to decline with the rise in milk production in the different classes analyzed (Galvão Junior et al., 2010).

The means and standard deviations recorded for average daily milk production and BCS of the three genotypes in different parities are shown in Table 3.

Table 3. Means and standard deviations for daily milk production (MP) and BCS of Gyr, Guzerat and Red Sindhi cows as a function of calving order

Calving order	Breed			BCS
	Gyr	Guzerat	Red Sindhi	Class
	Milk production (kg/day)			
Primiparous	20.21±9.10	-	14.46±3.81	II (4.15) **
Multiparous	24.36±5.50	19.17±6.17	18.15±5.38	I (3.75) *

* Class I – less than/equal to 3.75 / **Class II – Greater than 3.75

No statistically significant differences were recorded for average daily milk production among breeds and calving classes. However, primiparous animals displayed lower mean milk production than second calving or multiparous cows. This can be explained by the fact that milk production increases with age, reaching its maximum at physiological maturity and declining as the animal ages. Corroborating this finding, Salmazo et al. (2012) studied milk production in indigenous cows and concluded that younger animals exhibited lower initial production and rate of decline for milk production in comparison to older animals. When investigating Holstein cows, Santos et al. (2010) reported the effect of number of calving on peak lactation and total milk production ($P < 0.05$).

Souza et al. (2010) found a significant effect ($P < 0.05$) of calving order on milk production in Holstein cows. Animals in the 3rd and 4th lactation demonstrated higher milk production, followed by those in the 2nd lactation, while primiparous cows and those in the 5th lactation were less productive. Soares et al. (2009) assessed the influence of parity on milk production in Gyr, Guzerat and Red Sindhi cows in a dairy cattle tournament, demonstrating the longevity of the Zebu breed. However, Ribeiro et al. (2009) found no significant difference ($P > 0.05$) for mean milk production (7.12 ± 1.81 kg/day) when analyzing the interference of parity, milk production and milk composition of Gyr and Guzerat cattle, and between primiparous and multiparous cows.

The results of the present study are in line with those described in the literature (Bewley & Schutz, 2008; Leblanc, 2010; Šamanc et al., 2010). The similarity of findings between breeds may be attributed to environmental and management conditions, suggesting that both breeds have similar genetic potential for this variable.

A summary of the means for milk production (kg/day), fat (kg/day), fat (%), protein (kg/day), protein (%) are detailed in Table 4.

A significant difference was only recorded for milk production ($p < 0.05$) in the period up to 30 days of lactation. It can be inferred that the body condition score below 3.75 up to 30 days of lactation interferes in the milk production of Zebu cows until peak lactation. The results suggest that the BSC recommendations at calving of 3.5 to 3.75 made by Edmonson et al. (1989) and Ferguson et al. (1994) can also be adopted for Zebu cattle. Thus, we can assume that cows recover rapidly from postpartum negative energy balance and return to reproductive activity.

Bewley & Schutz (2008) reported higher production of milk and its components when cows presented a BCS between 3.25 and 3.75 at calving in comparison to those with BSC < 3.0. Šamanc et al. (2010) reviewing the effect of BCS on the production and composition of milk and reported greater production of milk and its constituents in dairy cows with a BSC of 3.5 at calving.

Jílek et al. (2009) observed differences in production and fat percentage between the classes of number of calving and BCS. Primiparous cows exhibited more fat (kg) and greater fat (%) than (%) multiparous animals. The elevated fat percentage in primiparous animals may be related to mobilized body reserves in cows with higher BCS at calving, resulting in a substantial release of non-esterified fatty acids from adipose tissue into the bloodstream (Leblanc, 2010; Šamanc et al., 2010).

Table 4. Means of milk production (kg/day), fat (kg/day) and protein production (kg/day), and percentage of fat and protein between the different lactation classes

Variable	Classes	Days of lactation		
		Up to 30	31 to 60	Over 60
Milk Production (kg/day)	1	14.56a	17.56a	17.96a
	2	17.43b	18.46a	11.38a
	P<	0.029	0.36	0.48
Fat (%)	1	5.40a	5.65a	5.39a
	2	5.40a	5.70a	5.81a
	P<	0.33	0.36	0.35
Fat Production (kg/day)	1	0.78a	0.36a	0.48a
	2	0.90a	0.93a	0.66a
	P<	0.28	0.30	0.31
Protein (%)	1	3.32a	3.45a	3.34a
	2	3.43a	3.29a	3.83a
	P<	0.47	0.43	0.48
Protein Production (kg/day)	1	0.48a	0.60a	0.59a
	2	0.57a	0.61a	0.43a
	P<	0.33	0.35	0.29

Class 1: Body condition score (less than/equal to 3.75) / Class 2: Body condition score (greater than 3.75) / P<: Significance level.

In agreement with these results, Freitas Jr et al. (2008) found no significant difference in fat production on different days of lactation or in fat percentage 15 days postpartum. According to Leblanc (2010) and Dochi et al. (2010), this can be attributed to greater mobilization of body fat in the initial phase of lactation, producing an elevated level of non-esterified fatty acids in the bloodstream. These can be used by the mammary gland in conjunction with dietary nutrients for milk fat synthesis.

CONCLUSION

The positive correlation of around 0.38% between milk fat and protein favors simultaneous genetic selection for both parameters. A body condition score below 3.75 at calving for Zebu cows compromised milk production up to the thirtieth day of lactation, but did not influence its composition.

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