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Chemical profile, somatic cell count and milk production of Holstein, Girolando and Jersolando cows

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The aim of this study was to evaluate the chemical profile, somatic cell count (SCC) and milk production of Holstein, Girolando and Jersolando cows. Fresh milk samples were collected from 34 high-production cows, averaging 31 L/day, belonging to three genetic groups (Holstein, Girolando and Jersolando). Experimental design was completely randomized, in which data collected were submitted to analysis of variance considering the effects of genetic group on milk quality and production. Correlations between milk volume and fat, protein, lactose, total dry extract, defatted dry extract and SCC were assessed. Jersolando herd produced milk with higher content of solids compared to the Holstein and Girolando. In relation to milk production, Girolando cows stood out over the others. Correlations between volume and fat, protein, total dry extract and defatted dry extract were negative; however, lactose showed positive correlation. The dairy system evaluated in this study demonstrated potential to meet the quality requirements of milk related to SCC in the current period and also from 2014, showing that large investments in facilities are not required to obtain quality milk.

Key words: Correlation, mastitis, racial group, productivity, milk quality.

INTRODUCTION

Milk composition has increasing importance for the dairy industry and producers, as it is directly related to processing, industrial production and price. In payment programs, parameters such as fat and protein contents, SCC, total bacterial count (TBC) and milk volume are evaluated.

In these programs, crossbreeding now has the possibility of becoming more popular, since payment is based on the content of solids, production and quality. In tropical countries, native breeds compromise the increase in milk production due to low production levels and European breeds due to adaptive difficulties.

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Crossing involving breeds of Indian origin (Zebu) and breeds of European origin (Taureans) provide the rational use of adaptation to the tropical climate of Indian breeds combined with the productive potential of European breeds.

The interest in crossing, in particular with the Jersey breed, is driven by the profitability potential (Lopez-Villalobos et al., 2000), fertility (Auldist et al., 2007) and longevity (Harris et al., 1996), and with the Holstein breed, the goal is to improve production yields, since this breed produces large milk volumes.

Zebu breeds, especially Gyr, play an important role in Brazilian dairy chain due to their good adaptability and performance under the management conditions prevailing in Brazil, both as a pure breed, as in crosses with specialized dairy breeds, especially Holstein (Santiago, 1975). Due to the importance of knowing the characteristics of the milk produced by animals of different genetic groups in order to fit to quality payment program, the aim of this study was to evaluate the chemical composition and SCC of milk, as well as the milk production of Holstein, Girolando and Jersolando cows, in the dry period.

MATERIALS AND METHODS

Study location and description

The study was conducted according to the ethical principles of animal experimentation of the "Ethics Research Committee with Animal Models", Federal Institute of Education, Science and Technology of Goiás - Rio Verde Campus - GO under No. 031/2012. The study was conducted on a dairy farm at the municipality of Rio Verde - Goiás, located on Highway GO 174, Km 05, which had a herd of 94 Holstein, Gyr Girolando and Jersolando cows divided into three different groups namely, animals with high (31 L milk / day), intermediate (16 L milk / day) and low (10 L milk / day) milk production. The milk produced in the farm was transferred to a dairy industry located in the city of Goiania - Goias. The study was conducted in the dry period.

Fresh milk samples were collected during morning milking (5:30 am) only from the first group (animals of high production), which had the same average milk production and received the same diet. The group consisted of 34 high-production cows, with average 31 L milk / day, belonging to three distinct genetic groups, which were selected from the blood degree as follows: Group 1 (13 Holstein cows), Group 2 (16 cows with genetic composition from ¾ to ⅞ Holstein / Gyr, called Girolando) and group 3 (five cows with genetic composition ¼ Holstein and ¾ Jersey, called Jersolando). All cows were on average at 100 days of lactation, 90 months of age and 510 kg of body weight.

Animals were submitted to two daily milkings in a mechanized milking system with closed circuit and six sets provided of collectors. Morning milking began at 5:30 am and the afternoon milking at 04:30 pm, lasting two and a half hours each milking. All animals were submitted to artificial insemination. Milk production was monitored throughout the experimental period (3 months) through milk meters connected to the milking machine in the morning and afternoon milking, totaling the daily production of animals. The result was expressed in kg.

Animals had access to clean water and balanced diet, offered according to the nutritional requirements and between milkings, cows remained on pasture that was not the main source of food but rather a resting place. Diets were formulated according to NRC (2001) for dairy cows with an average of producing 31 kg milk/day with 3.0% milk fat.

During the experimental period, cows received the following in the trough during milking (twice daily): 4 kg of feed, distributed into two milkings and 8 kg of feed and corn silage *ad libitum* in trough outside the milking room. The feed consisted of corn germ, soybean meal, corn grits, cotton cake, uremax, optigem and cooked soybean core, according to Table 1.

Sample collection and milk analysis

The collection procedure followed the norms of good milking practices: teats were washed with water and the first three milk jets were discarded in a black bottom mug to verify the presence of lumps, then, with the aid of an applicator, teats were immersed in pre-milking solution based on sodium hypochlorite and waiting 25 s to obtain total product efficiency. After cleaning, teats were dried with paper towels for the coupling of teatcups, milk samples were collected in individual collectors and after complete milking of animals, the amount of milk produced was individually recorded in field record; subsequently, milk was packaged in sterile flasks containing preservative Bronopol®, homogenized and stored in isothermal boxes containing ice and sent to the Laboratory of Milk Quality, Food Research Center, School of Veterinary and Animal Science, Federal University of Goiás (LQL / CPA / UFG) for the performance of electronic analyses to determine milk components (fat, protein, lactose, defatted dry extract (DDE), total dry extract (TDE) and SCC. At the end of milking, post-milking solution was used, whose base was 0.25% glycerin iodine.

Milk quality assessment

Proximate composition

Fat, protein and lactose contents, DDE, TDE were determined using the analytical principle based on the differential absorption of infrared waves by milk components using equipment MilkoScan 4000 (Foss Electric A / S. Hillerod, Denmark) (International Dairy Federation, 2000). The results were expressed as percentage (Table 1).

Somatic cell count

SCC, whose analytical principle is based on flow cytometry, was performed using equipment Fossomatic 5000 Basic (Foss Electric A / S. Hillerod, Denmark), (International Dairy Federation, 2006). The result was expressed in SC / ml.

Statistical analysis

Animals were divided into three groups according to breed. Group 1 (13 Holstein cows with 135 repetitions), Group 2 (16 Girolando cows with 162 repetitions) and Group 3 (05 Jersolando cows with 81 repetitions) totaling 34 animals. The experimental design was fully randomized and data collected were submitted to analysis of variance considering the effects of genetic group on milk quality and productivity. Analysis also used Tukey's test at 5% probability and SISVAR software (Ferreira, 2003). Linear correlations between milk volume and fat, protein, lactose contents, DDE, TDE and SCC were assessed. Statistical procedures were performed using the ASSISTAT software.

Table 1. Proximate and chemical composition of diets offered to cows.

Total diet ingredients	%
Corn silage	48.13
Corn germ	24.24
Soybean meal 44%	06.28
Corn grits	05.04
Cotton cake	07.14
Uremax	00.55
Optigem	01.10
Cooked soybean core	07.52
Total	100
Chemical composition of total diet	**%**
Crude protein	16.7
Ether extract	04.5
Neutral detergent fiber	31.9
Acid detergent fiber	16.8
Total digestible nutrients	69
Calcium	00.8
Phosphorus	00.4

Table 2. Influence of breed on chemical composition and milk production.

Breed	Chemical composition (%)					Milk production (Kg)
	Fat	Protein	Lactose	TDE	DDE	
Holstein(n=135)	2.93 [b]	3.03 [ns]	4.67 [b]	11.60 [b]	8.67 [b]	31.72 [b]
Girolando (n=162)	2.70 [c]	3.01 [ns]	4.59 [c]	11.27 [c]	8.57 [c]	34.40 [a]
Jersolando (n=81)	3.18 [a]	3.06 [ns]	4.80 [a]	12.04 [a]	8.86 [a]	22.36 [c]
Mean	**2.89**	**3.03**	**4.66**	**11.55**	**8.66**	**30.86**
CV (%)	**22.32**	**7.4**	**4.91**	**6.85**	**4.02**	**16.92**

Means followed by different letters in the column are statistically different * ($p<0.05$). * NS = not significant ($p>0.05$). TDE: Total Dry Extract; DDE: Defatted Dry Extract; CV: Coefficient of Variation.

RESULTS AND DISCUSSION

In Brazil, there are few studies on dairy cattle evaluating the productivity of cows, especially with Jersolando animals. The evaluation of the milk production of these animals in breeding systems used in Brazil, especially in southwest Goiás, enable obtaining results that demonstrate the productive potential and the characteristics of milk of these animals in this particular environment and management conditions.

Table 2 shows the fat, protein and lactose contents, TDE, DDE and milk production of Holstein, Girolando and Jersolando cows mechanically milked at a dairy farm in the Southwestern region of the state of Goiás. Regarding the chemical composition of milk, effect ($p<0.05$) of the different breeds on the fat and lactose levels, TDE and DDE was observed, as well as on milk volume (Table 2). By analyzing the coefficient of variation (CV), it was observed that the experimental precision was adequate for all variables under study, and fat content was the most unstable response with respect to CV, equal to 22.32%, due to the increased variation range in relation to other components. The fat content of milk from Jersolando cows was higher (3.18%), followed by Holstein cows (2.93%) and Girolando cows, whose milk showed the lowest fat percentage (2.70%). The fat contents of 2.93 and 2.70%, which refer to Holstein and Girolando breeds respectively, are not within the limits established by Brazilian legislation, Normative Instruction 62 of 2011, which recommends minimum values of 3.0% (Brazil, 2011); however, the fat content of milk from Jersolando cows (3.18%) was above the minimum required by Normative Instruction 62 of 2011 (IN 62/2011).

This result may be related to the lower volume of milk produced by Jersolando cows, explaining the higher fat content, since as the production potential increased, the fat percentage decreased. Studies on the quality of milk from Jersolando cows are scarce and there are no scientific reports on the characteristics and volume of milk produced by these animals. Fat contents lower than those found in this experiment were observed by Raimondo et al. (2009) in a study conducted in the state of São Paulo with Jersey cows in the first month of lactation, obtaining 2.39 to 2.97% fat.

Similar to our findings, but with Jersey cows, Botaro et al. (2011), in a study in the state of São Paulo from 2007 to 2008 found higher fat contents in the milk from Jersey cows (3.97%) compared to Holstein and Girolando cows, which showed no significant difference from each other (3.54 and 3.45%, respectively). The result of this study in relation to the fat percentage of milk from Holstein cows (2.93%) was lower than that found by Santos et al. (2009), who observed high fat content in the milk from Holstein cows (4.30%) using soybean oil in the diets of cows during the transition period. Paula et al. (2008) and Stelzer et al. (2009) observed similar fat contents (3.40%), but higher than those found in this work.

Dairy breeds of European origin have specialized function for milk production and high feed utilization efficiency, but suffer from physiological and behavioral problems caused by heat stress, slowing production and consequently concentrating nutrients; on the other hand, animals of Indian origin are more adapted to tropical climate. The protein content in milk of the present study did not differ between breeds ($p>0.05$), regardless of genetic group evaluated, and the minimum protein content was achieved according to Brazilian legislation, which recommends values above 2.9%. Unlike this research, Botaro et al. (2011) observed significant differences among breeds (Jersey, Holstein and Girolando), where Jersey cows showed higher protein percentage in milk (3.38%) compared to the other groups that showed no difference from each other (3.21 and 3.22%, respectively).

As found in this study, Deitos et al. (2010) also observed no difference ($p>0.10$) between breeds (Holstein and Brown Swiss) in the state of Paraná, with mean values of 3.15 and 3.17% protein, respectively. Changes of protein content of milk are less significant and although influence total production, have little variation in milk (Dürr, 2002).

The average lactose content in milk was 4.80, 4.67 and 4.59% for Jersolando, Holstein and Girolando breeds, respectively, showing significant difference among themselves ($p<0.05$). Similarly to results obtained in this study, Deitos et al. (2010), in a study with 32 ½ blood Holstein and Brown Swiss cows found no variation between groups ($p>0.10$), with average content of 4.61% lactose in milk. Smaller lactose percentages were observed by Botaro et al. (2011), who obtained average lactose content in the milk of Holstein, Jersey and Girolando cows of 4.42, 4.30 and 4.45%, respectively.

In this study, it was observed that there was variation in the lactose percentages according to breed, and Jersolando cows showed lower production potential compared to the other breeds in this study, which may explain the higher concentration of lactose in the milk from these animals. Furthermore, the lactose levels in milk depend on the glucose produced in the liver from the propionic acid produced in the rumen, and this acid is produced in greater proportion when adequate amounts of concentrate is supplied to animals (Pereira, 2000) and milk collections in this work were carried out during the dry season when forage availability is scarce and animals receive concentrate-based diets. The Brazilian legislation does not establish minimum lactose content for refrigerated raw milk.

Total dry extract, which results were 12.04, 11.60 and 11.27% for Jersolando, Holstein and Girolando animals, respectively, showed significant difference among breeds ($p<0.05$). Data obtained in this study were lower than those found by Ponce (1996), who reported average values of 13.83% for Zebu cows due to the characteristics of the breed of raising the fat content in milk and consequently increase total solids.

Similar to results of this study, but with different breed, Deitos et al. (2010) also found significant difference ($p<0.10$) in the TDE content of milk from Brown Swiss (12.17%) and Holstein cows (11.72%). Total solids in milk represents the sum of all milk constituents (except water) and fat is most responsible for its change, thus, the results found in this study can be attributed to the higher fat and lactose contents present in milk from Jersolando and Holstein cows. The DDE percentage was influenced by breeds ($p<0.05$), and the highest DDE concentrations were observed in milk from Jersolando cows (8.85%) compared to Holstein (8.67%) and Girolando cows (8.57%).

In contrast to our study, Deitos et al. (2010) found no significant differences ($p>0.10$) in relation to DDE between genetic groups (Holstein and Brown Swiss), obtaining mean value of 8.75%. Defatted dry extract includes all milk constituents except fat, thus, it is related to the amount of milk nutrients aimed at cheese production. The differences among genetic groups evaluated in this study for DDE can be attributed to variations in the milk constituents of the different groups. Brazilian law recommends minimum DDE content of 8.4% for fresh milk (Brasil, 2011). Girolando cows demonstrated greater production potential (34.40 L milk /day) compared to Holstein (31.72 L milk/day) and Jersolando cows (22.36 L milk/day). These results confirm that Girolando cows produce higher milk volume due to the robustness of Gyr and good productivity of Holstein cows. Although animals of European origin are known for high production potential, in this study, Holstein and Jersolando cows showed lower productivity, and this

Table 3. Influence of breeds on somatic cell count of fresh milk.

Breeds	Somatic cell count	
	SC/ml x 1000	Log
Holstein	294.68 ns	2.16 ns
Girolando	333.86 ns	2.18 ns
Jersolando	454.12 ns	2.02 ns
Mean	**345.64**	**2.14**
CV (%)	**272.92**	**24.23**

*NS = not significant (p>0.05). CV: Coefficient of Variation.

result may have occurred due to the greater sensitivity of these animals to higher temperatures, since sampling was performed during the dry season. According to Aguiar and Baccari (2003), high temperatures associated with high humidity and intense solar radiation are responsible for decrease in milk production of cows of intermediate and high production.

Similarly to this study, Heins et al. (2008) in confined system in the United States, observed higher milk production in Holstein cows compared to ½ Holstein x Jersey (7705 vs.7147 kg). Several studies such as Lopez-Villalobos et al. (2000); Auldist et al. (2007) and Heins et al. (2008) found that Holstein x Jersey crossbred cows produced approximately 93% of the amount of milk of pure Holstein cows, regardless of production system. Thus, crossbreeding offers advantages such as complementarity and hybrid vigor and most crosses between specialized dairy animals are based on Holstein breed, with higher milk production, a feature that was not observed in this study due to the lower adaptation to the tropical climate of the southwestern region of the state of Goiás. Jersey, known for high concentration of solids in milk, as could be observed in this study, rapid maturity and higher fertility (Freyer et al., 2008) and Gyr, for good adaptability and performance under the management conditions prevailing in Brazil, also observed in this experiment.

Table 3 shows the SCC results of milk from Holstein, Girolando and Jersolando cows mechanically milked at a dairy farm in the Southwestern region of the state of Goiás, which also showed the SC values according to breed, with no significant results (p>0.05). The results are presented as arithmetic mean, but when analyzing the CV (272.92%), it was observed that the experimental accuracy was not appropriate due to the lack of normal distribution of data, so the data were transformed using the logarithmic function and also presenting in logarithm with CV (24.23%).

Regardless of genetic group evaluated, it was observed that the milk SCC is within values recommended by Normative Instruction 62 of 2011, which establishes maximum count of 600,000 SC/ml, up to June 30, 2014, when it will be reduced to 500,000 SC/ml; however, even considering that the average SCC values are within current legislation, improving measurement and mastitis control should be performed, since the milk from the mammary glands of healthy animals contains 50 to 200,000 SC/ml (Kitchen, 1981).

Results above those found in this study were found by Botaro et al. (2011), who obtained scores of 639,000 SC/ml.; 567,000 SC/ml and 578,000 SC/ml for Holstein, Jersey and Girolando cows, respectively.

According to Souza et al. (2005), factors such as milking system, type of equipment, cleaning and disinfection of teats, number of calving, stage of lactation and diet can influence the SCC in milk. Thus, the SCC present in milk is a general indicator of the mammary gland health, widely used as an indicator of subclinical mastitis, being also accepted as a standard measure for determining the quality of refrigerated raw milk (Tsenkova et al., 2001). Table 4 shows the results of the simple linear correlation analysis among variables milk volume and quality. There was a negative correlation (p<0.01) between milk volume and fat content of Holstein and Girolando cows. This result indicates that the higher the milk volume, the lower the fat content in milk due to the dilution effect; fat concentrations in this study tended to be lower as there was an increase in milk production in the different breeds analyzed (Table 3). For Jersolando cows, milk fat and volume were not correlated (p>0.05), and this may have occurred due to the decreased milk production observed in this group as well as to the higher fat percentage in milk, which is concentrated as a function of the lower milk volume.

Similarly, Ribeiro et al. (2009) found mean fat content of 4.42% in the milk from animals producing up to 10 kg/milk/day, demonstrating that in lower milk volume, fat concentration is higher. Negative correlation was also observed (p<0.05) between production volume and protein content of milk from Girolando and Jersolando cows, with no correlation for variables among Holstein cows (p>0.05). This result is also related to the higher milk volume produced, with average of 31 L of milk/day, diluting the protein content (Table 4). These data corroborate those found by Galvão Junior et al. (2010), who observed a decrease in the protein content as the production of animals increased from 3.88% protein in the milk of animals producing 8.41 L milk/day; 3.56%

Table 4. Linear correlation between volume and quality of milk from Holstein, Girolando and Jersolando cows.

Correlation	Breeds		
	Holstein	Girolando	Jersolando
Volume x Fat	-0.2396 **	-0.3243 **	-0. 0858ns
Volume x Protein	-0.1635 ns	-0.1685 *	-0.2448*
Volume x Lactose	0.1950 *	-0.0909 ns	0.0097 ns
Volume x TDE	-0.1727 *	-0.3317 **	-0.1336 ns
Volume x DDE	0. 0543 ns	-0. 1841 *	-0.1707ns
Volume x SCC	-0.1487 ns	0.0654 ns	0.1341ns

** Significant at 1% probability level (p<0.01). * Significant at 5% probability (0.01<p<0.05). NS: not significant (p>0.05). TDE: total dry extract; DDE: defatted dry extract; SCC: somatic cell count.

protein for milk production of 12.63 L/day and 3.43% protein when cows produced more milk (milk 20.28 L/day).

There was a positive correlation (p<0.05) between production and lactose content in milk from Holstein cows. For Girolando and Jersolando cows, variables milk volume and lactose were not correlated (p>0.05). The synthesis of lactose by the glandular epithelium significantly affects the amount of milk produced due to the critical role of lactose as an osmotic regulator of milk volume (Machado et al., 2000). This result demonstrates that the greater the milk volume, the higher the lactose concentration, because the higher the lactose synthesis, the larger the amount of water drained into alveolar cells. Since Holstein cows are known for their high production potential, this correlation could be observed in their milk. Unlike results obtained in this study, Galvão Junior et al. (2010) observed that the average lactose content (4.82%) was higher when animals produced lower milk volume (15 L milk/day).

Negative correlation was also observed between production volume and TDE content in milk from Holstein (p<0.05) and Girolando cows (p<0.01), and no correlation was found for this variable in the Jersolando herd (p>0.05). Increase in milk production tends to dilute components of the dry extract. Thus, variables negatively correlated with milk production in this study are mainly components of the milk dry extract (fat and protein).

Similarly to our study, Galvão Junior et al. (2010) observed correlation coefficient of -0.3358 for TDE, according to the average daily production of Zebu cows.

In this study, DDE was only correlated with milk volume in Girolando cows (p<0.05), thus, the variation in protein content observed in the milk from these animals can justify the decrease in DDE obtained in this study, since DDE includes all milk constituents except water and fat. As in this research, Galvão Junior et al. (2010) found negative correlation between milk volume and DDE (-0.4700) in zebu cows. There was no correlation (p>0.05) between milk volume and SCC in the different breeds. Corroborating the results observed in this study, Galvão Junior et al. (2010) found no correlation between milk production and SCC (0.0629) in zebu cows. There are several factors that affect SCC such as the level of infection of the mammary gland, season, stage of lactation and age; however, milk volume did not affect SCC of milk from cows studied in this research.

A peculiar feature of the Brazilian livestock, especially in dairy cows, is the great variability of production systems. This makes the correct choice of a certain breed or crossing of breeds for these herds even more difficult. Thus, the production potential of every breed and production systems used in the country should be studied for the correct selection of a particular breed for the different production systems. Since the choice of the genetic group is an optimization element, investigating the characteristics of the milk produced among the major milk-producing breeds in Brazil and used mainly in the southwestern of the State of Goiás is relevant, since payment programs evaluate quality parameters such as production, content of solids and SCC.

Conclusions

The results of this research indicated that the use of Jersolando cows in dairy herds is a good alternative to increase fat, protein and DDE contents, which are the main parameters used in payment programs for milk produced by dairy systems. In the environmental conditions of the southwestern region of Goiás, Girolando cows showed better milk production potential compared to Holstein and Jersolando cows. However, considering that payment programs in the southwestern region of Goiás prioritize volume and concentration of milk nutrients, Holstein cows may result in better financial returns to the dairy producer because these cows show good production potential and chemical composition of milk compared to Girolando cows. The dairy system evaluated in this study demonstrated potential to meet the quality requirements of milk related to SCC in the current period and also from 2014, showing that large investments in facilities are not required to obtain quality milk.

Conflict of Interest

The authors have not declared any conflict of interest.

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