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Producción y calidad de la leche de una lechería comercial en la provincia Matanzas, Cuba

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Scientific Paper

Milk production and quality of a dairy farm in Matanzas province, Cuba

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Abstract

Objective: To evaluate the milk production and physical-chemical quality in a dairy farm of Matanzas province, Cuba.

Materials and Methods: This study was conducted in a dairy farm, belonging to the Genetic Enterprise of Matanzas. The dairy farm has a total area of 72,4 ha. From them 57,8 are for grazing, distributed in 29 paddocks of 1,9 ha.

Results: Significant differences were found ($p < 0,001$) among the milk production average (kg/animal/day) of the two-month period July-August (8,24) with regards to November-December (4,80) and January-February (6,03). There were also significant differences ($p < 0,001$) for the days of average lactation among the different production two-month periods. The productive efficiency behaved over 85 %, except in January-February and March-April, with 71,9 and 38,8 %, respectively. The milk quality differed between seasons ($p < 0,05$) for the average of fat and total solids (3,08; 4,81 and 12,21; 12,88) in the rainy and dry seasons, respectively.

Conclusion: The best productive responses were reached in the rainy season, although the nutritional requirements were not covered throughout the year. In turn, the body condition values in the milking cows were low in both seasons.

Keywords: dairy farms, milk production, natural pastureland

Introduction

Mankind faces one of its greatest challenges: the growth of the world population, along with a non-proportional increase of food production that can endanger man's existence (FAO, 2019).

Animal production represents, approximately, 40 % of the agricultural production in the world, which is considered the support of food availability for approximately one billion inhabitants. Animal husbandry activities are the ones that contribute 15 % of the total food energy, and also contribute 25 % of the proteins incorporated to the diet if it is considered that milk and meat stand out for being foodstuffs that are considered of first necessity, because they are highly demanded, thanks to their high nutritional value (Arciniegas-Torres and Flórez-Delgado, 2018).

In tropical regions, most of the animal production systems are extensive. They are supported on native or cultivated forages, whose utilization is based on grazing, which indicates that they are inadequately managed, regarding enclosed pasture size, rotation, fertilization, weed control, stocking rate and others. This affects the quality of the selected feedstuff, as well as pasture frequency and intake, this being one of the causes that limit milk production and quality (Guevara-Vieras *et al*., 2016).

Cuban animal husbandry covers a little more than two million hectares. From them, cultivated pastures represent from 16 to 20 %; weeds occupy, partially or totally, 38 % and the rest corresponds to natural pastures of low productivity. The cattle stock is of 3 817,3 thousand heads, including, as average, 312,9 thousands of milking cows (ONEI, 2019).

The cause of this deterioration is the non-rational management of grazing, because of the lack of paddock making and the utilization of high stocking rates, which are over the ones allowed in the pastureland. In addition, grass monoculture (and subsequent decrease of biodiversity), inappropriate use of water sources, poor utilization of silvopastoral systems and little extended sustainable agricultural practices, stand out (Vega *et al.,* 2016; Hernández-Rodríguez *et al*., 2020).

In the face of this situation, among the strategic aspects to be implemented is the identification and

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selection of productive and economic indicators, in order to design a baseline that allows the description and evaluation of the productive process, besides establishing a development plan, program or project that allows to reverse the situation of Cuban animal husbandry.

The objective of this research was to evaluate the milk production and physical-chemical quality in a commercial dairy farm of Matanzas province, Cuba.

Materials and Methods

Location. The study was conducted in a commercial dairy farm, belonging to the State Animal Husbandry Enterprise of Matanzas province, Cuba.

Edaphoclimatic conditions. The soil of the farm was classified as Ferralitic red (Hernández-Jiménez *et al.,* 2015), with slightly undulated relief. The mean temperature is 25,5 and 22,4 ºC for the rainy (RS) and dry season (DS), respectively (table 1).

Characteristics of the farm. The dairy farm is a typical unit, with capacity for 120 cows. It has a total area of 72,4 ha. From them, 57,8 ha are dedicated to grazing, with 29 paddocks of approximately 1,99 ha each.

Herd management and feeding. The cows are milked twice per day, in a mechanized way, with first milking at 3:00 a.m., supplying concentrate feed at a rate of 580 g/animal. Afterwards, they are taken to the grazing area where they remain until 9:00 a.m., moment at which they return to the sheds until 3:00 p.m. and are milked again. Then, they return to grazing until the next day, when the early morning milking begins. The system that is used is rotational grazing. The prevailing genotype comes from crossings of Mambí de Cuba fathers with Holstein x Zebu mothers.

Milk production. To determine the individual milk production, milk weighing was performed on 100 % of the milking animals, with bimonthly frequency. From these data, the influence of the production two-month period and season on milk production during the study was analyzed.

Real and potential lactation curves. They were calculated from the milk production obtained in the dairy farm, grouped by production two-month period. In addition, the production efficiency was determined from the recommendations proposed by Senra (1982).

Monitoring of body condition. It was performed with monthly frequency on 100 % of the milking cows and dry cattle, in a scale from 1 to 5, through the methodology proposed by Castro-Álvarez (2018), which consists in the visual inspection and palpation, according to the quantity of subcutaneous fat tissue in specific areas. The body condition index (BC) was controlled at parturition and on the sampling day. The results were analyzed by season. For their interpretation descriptive statistics was used with the utilization of tables and graphs.

Instantaneous feeding balance. The instantaneous feeding balance for the experiment cows was calculated, regarding the results obtained according to the nutrients contributed in the used diets. For the interpretation of the results descriptive statistics was applied using tables and graphs. For the estimation of the variables the tables included in the handbook elaborated by EEPFIH (2000) were used.

Milk quality. It was determined by seasons, according to the infrared method (FIL-141: B, 1997) and using the piece of equipment MilkoScan 104 A/S Foss Electric, of the animal nutrition laboratory of the Pastures and Forages Research Station Indio Hatuey. The samples were obtained from 100 % of the milking cows and the fat percentage, protein content, lactose and total solids (TS), were determined.

Statistical analysis. With the available information variance analysis was carried out on the variables milk production and average lactation days, after testing the variance homogeneity and normality assumptions, according to Levene's and Kolmogorov-Smirnov tests, respectively. For finding the differences among the studied variables, the production two-month period and season were considered as effect, and Duncan's multiple range comparison test was used to find inequalities among

Table 1. Performance of the climate variables per season.

Variable	RS	DS
Average temperature, °C	26,5	22,4
Average relative humidity, %	79,6	73,5
Cumulative rainfall, mm	1 338,8	222,4

DS: dry season RS: rainy season

means. The milk quality variables were compared through Student's T-test for independent means. The statistical package IBM SPSS Statistic version 22 was used.

Results and Discussion

Highly significant differences ($p < 0,001$) were found between the individual milk production average of the cows in the two-month period July-August (8,24) and the other two-month periods (table 2). November-December (4,80) and March-April (5,33), belonging to the DS, were the ones with the lowest values.

In the others, the cows showed moderate milk productions, higher than 6,0 kg per day, although the significant differences prevailed between the rainy and dry two-month periods, because in the RS the dry matter (DM) availability under grazing improved, which allowed higher supply per animal per day and the increase of the selection capacity of the animals.

In the case of the performance per seasons, significant differences were also observed in the individual production, with the highest values (7,22) in the RS. The lowest production of the DS was related to a low pasture availability (with predominance of the natural ones).

Soto-Senra *et al.* (2020) reported that during the DS the pasture has low concentration of crude protein, high concentration of neutral detergent fiber (NDF), low apparent digestibility and, thus, low concentration of metabolizable energy (ME), for which in this season the DM intake of ruminants is reduced. Their ME requirements for maintenance cannot be covered, which is translated into a negative energy balance and into weight losses, which has repercussions on low milk productions per cow.

Significant differences ($p < 0,001$) were found for the average lactation days among the different two-month periods (table 3). July-August, September-October and November-December did not differ among them, and their values were over 160 days. In the other two-month periods these values oscillated between 134 and 155 days, without significant differences among them. In addition, no differences were found for this indicator per season.

These values coincide with the criteria expressed by Rodríguez-Aya (2017), who recommends that the mean lactation of the herd should move

Table 2. Effect of the production two-month period and season on the milk production per cow per day.

Effect		Milk production kg/animal/day	SE ±	P - value
Production two-month period	JF	$6,0^{c}$	0,208	0,001
	MA	$5,3^{d}$	0,215	
	MJ	$6,9^{b}$	0,191	
	JA	$8,2^{a}$	0,252	
	SO	$6,7^{b}$	0,209	
	ND	$4,8^{d}$	0,182	
Season	RS	7,22	0,128	0,025
	DS	5,39	0,118	

a, b, c and d: values with different superscripts in the vertical differ for $p < 0,05$

Table 3. Effect of the production two-month period and season on the mean lactation days per cow.

Effect		Mean lactation, days	SE ±	P - value
Production two-month period	JF	141^{bc}	6,535	0,000
	MA	134^{c}	6,429	
	MJ	155^{bc}	6,899	
	JA	163^{ab}	7,128	
	SO	169^{a}	6,275	
	ND	169^{a}	7,156	
Season	RS	162	3,791	0,310
	DS	148	3,749	

a, b and c: values with different superscripts in the vertical differ for $p < 0,05$

between 150 and 170 days, and that when it is higher than 170 days it means that the open days are enlarged and, thus, the calving-calving interval is also increased.

Figure 1 shows the efficiency values of milk production. The best performance corresponded to the two-month periods of the RS (May-October), because the real and potential production were similar (approximately 90 % of fulfillment). However, in the two-month periods of the DS, which coincide with very low availability of natural pasture, it had low quality. In addition, there was lower efficiency, mainly in the two-month period March-April (with only 38,8 %), which also coincided with the fact tht it was the one with the lowest number of newly-calved cows, and with the lowest percentage of milking cows, which considerably affected milk production.

When analyzing the feeding balance of the animals under production (table 4), it was proven that the nutritional requirements of the animals were not covered during the year.

As can be observed, the pasture occupied a low percentage in the diet (46,4 and 65,14 % for the DS and RS, respectively), because its availability during the study period did not exceed 16 kg DM/animal/day, which has direct incidence on productive results. This low availability caused that the animals could not cover their CP and ME requirements, which is translated into negative energy balance, weight loss and decrease of milk production (Campos-Ganoa *et al*., 2020). When the protein and energy requirements of cows are not covered, this becomes a limitation for milk production, because the energy requirement of one cow increases from 1 kg/day of glucose during the end of pregnancy to 2,5 kg/day during the first three weeks postpartum. This causes an extensive mobilization of body tissue, mainly of its fat reserves, but also of amino acids, minerals and vitamins, to supply the demand of nutrients of the mammal gland in the milk synthesis process (Ruíz-Albarrán *et al*., 2012). The deficiency of these nutrients in the diet causes delay in growth and ovarian activity, as indicated by Arcos-Álvarez *et al.* (2019).

From this reality it is urgent to design a feeding strategy for this productive unit, mainly in the periods of low efficiency. This could include complementation with energy and protein forages, which were not used in the dairy farm during the research, or some differentiated supplementation strategy aimed at high-producing cows, so that the seasonal unbalance can be compensated. Ruíz-Albarrán *et al.* (2012) indicated the need that each productive unit has feed self-sufficiency. That is, that throughout the year it has the necessary feedstuff basis, in quantity and quality, for feeding its herd. The utilization of cultivated pasture varieties and planting of complementary areas with sugarcane and king grass clones, as well as the use of protein forage plants, such as mulberry, Mexican sunflower and drumstick tree, constitute important choices to supply the feedstuff deficit in the dry season. The establishment of silvopastoral systems (protein banks, living fences, multiple associations) also constitutes an option in animal production, because it increases productivity and guarantees higher forage quality and availability with regards to the systems based on grasses only.

The body reserves are considered an important energy source to face the negative energy balance

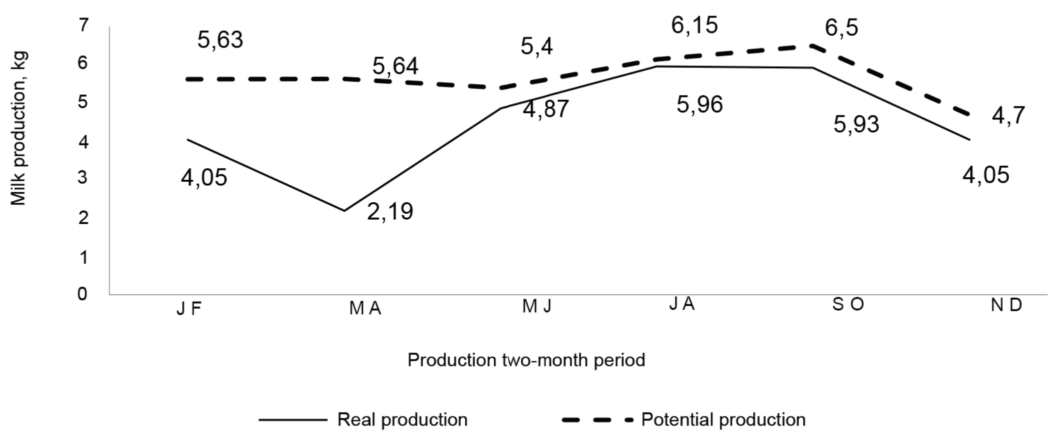

Figura 1. Producción real y potencial del baño.

Table 4. Feeding balance per season.

Feedstuff	Intake, kg DM	ME, Mcal/ kg DM	CP, g/kg DM	DPIN, g/ kg DM	DPIE, g/ kg DM	Ca, g/kg DM	P, g/kg DM
Dry season							
Requirements	10	19,2	615,2	448,2	448,2	31,8	21,7
Total contribution	5,14	10,7	371,8	139,2	310,7	27,5	21,7
Difference	-4,86	-8,5	-243,4	-309	-137,5	-4,3	0
Rainy season							
Requirements	10,5	24,8	936,4	662,3	662,3	46,5	25,2
Total contribution	7,34	14,9	562,8	334,9	453,2	38,9	42,2
Difference	-3,16	-9,9	-373,7	-328	-209,1	-7,6	17,0

DPIN: digestible protein at intestinal level from nitrogen; DPIE: digestible protein in the intestine according to energy content

(NEB). This unbalance occurs at the beginning of lactation, due to the decrease of intake, which is characteristic of this stage, and to the physiological trend of the animal to express its maximum productive potential.

Figure 2 shows the performance of body condition (BC), which was between 2,55 and 2,77 for the DS and RS, respectively. These values are considered unfavorable if it is desired that the animals express their maximum productive potential. Castro-Álvarez *et al.* (2018) refer that cows with BC lower than 2,5 show higher mobilization of their body reserves, located in intramuscular subcutaneous tissues, which causes their deterioration and the subsequent decrease of milk production. That is why it is recommended to implement adequate management and feeding practices in the final lactation stage, in order to achieve a BC over 3,5 at the moment of calving and, thus, reduce the effects of the NEB. In addition, if the losses in BC are maintained, the animals can show reproductive failures such as anestrus, which constitutes a determinant factor for removing a cow from the herd.

Regarding the reproductive status of the herd, significant differences ($p < 0,001$) were found among the production two-month periods for the newly-calved and the inseminated cows (table 5). The lowest number of newly-calved cows was in the two-month period September-October, without significant differences between March-April and July-August.

The analyzed period showed inadequate distribution of the reproductive categories. There was a large number of empty cows and, thus, a low number of pregnant and newly-calved cows. Only the inseminated ones were within the established parameters, result that coincides with the description made by Brito (2010), who states that, in dairy farms, the inseminated animals should be between 25 and 35 %. This same author reported that the pregnant cows should represent between 50 and 60 %, the newly-calved ones 15-16 % and the empty ones less than 5 %.

The increase of empty cows implies lower number of pregnant cows, lower birth rate and lower quantity of produced milk, according to Vargas *et al.* (2015).

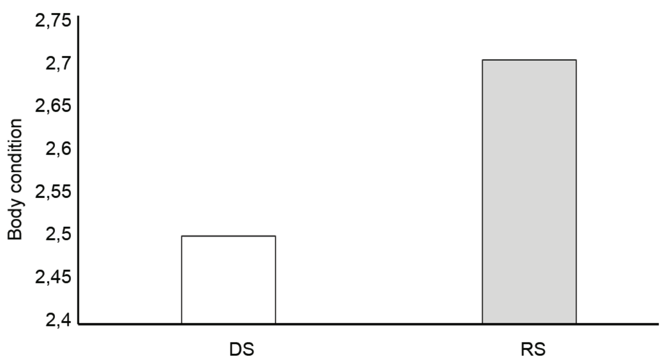

Figure 2. Performance of the body condition per season.
RS: Rainy season; DS: Dry season

Table 5. Effect of the production two-month period on the reproductive status of the herd.

Effect	Period	Newly-calved	Empty	Pregnant	Inseminated	Total
Production two-month period	JF	16[a]	21	40	21[a]	105
	MA	8[bc]	23	36	30[ab]	102
	MJ	11[b]	24	33	26[ab]	99
	JA	9b[c]	26	37	30[ab]	104
	SO	7[c]	25	39	35[b]	107
	ND	11[b]	22	37	35[b]	108
SE ±		0,788	1,781	7,533	1,723	1,739
P - value		0,002	0,981	0,96	0,115	0,223
Season	RS	12	22	38	28	105
	DS	9	25	36	30	104
SE ±		1,501	3,586	3,906	3,5	3,535
P - value		0,151	0,016	0,366	0,795	0,005

a, b and c: values with different superscripts differ for $p < 0,05$
RS: rainy season; DS: dry season

This increases the productive costs and decreases profits, which is expressed in reproductive, productive and economic inefficiency of the dairy cattle herd. Avilés *et al.* (2002) also reported deficient reproductive performance in dairy herds characterized by the prolongation of the interval between parturitions and low birth rate.

The deficient estrus detection is one of the causes of the increase of empty cows. In a study conducted by Loyola (2004) it was reported that more than 30 % of the females in the category of empty showed ovarian activity, for which it is assumed that the opportunity of insemination is lost due to technical and management incapacity.

Table 6 shows that the contents of fat, protein, TS and non-fatty solids (NFS) fulfill the minimum quality indicators established in the Cuban norm NC 448:2006 (ONEI, 2006), referred to the specifications about the quality of raw milk. Nevertheless, significant differences ($p < 0,05$) were found between seasons for the indicators fat average and TS. The latter were in agreement with the existing relation between milk production and and such indicators, which is inversely proportional: at more milk production less fat. This relation is reflected, in turn, on the content of TS.

In this study, the results of the content of fat, protein, TS and NFS are similar to those published by Martínez *et al.* (2017) for the Siboney de Cuba breed, when evaluating the raw milk of a production chain of small farmers of the western region of Cuba.

Conclusions

The best productive responses were reached in the rainy season, although the nutritional requirements were not covered throughout the year. In turn, in both seasons, the body condition values in the milking cows were low.

Table 3. Analysis of the nutritional quality of the milk.

Indicator, %	Season		P - value
	RS	DS	
	Mean (± SE)	Mean (± SE)	
Fat	3,1 (± 0,348)	4,8 (± 0,881)	0,000
Protein	3,1 (± 0,348)	3,1 (± 0,256)	0,328
Lactose	4,2 (± 0,307)	3,9 (± 0,432)	0,257
Total solids	12,2 (± 1,421)	12,9 (± 0,811)	0,030
Non-fatty solids	8,1 (± 0,523)	8,0 (± 0,446)	0,336

RS: Rainy season, DS: Dry season

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Conflict of interests

The authors declare that there is no conflict of interests among them.

Author's contribution

- Flavia García-Sánchez. Design and setting up of the research, data analysis and interpretation, manuscript writing and revision.
- Tania Sánchez-Santana. Design and advisory of the research, manuscript writing and revision.
- Luis Lamela-López. Design and advisory of the research, manuscript writing and revision.
- Dariel Morales-Querol. Advisory of the research, manuscript writing and revision.
- Miguel Ángel Benítez-Alvarez. Setting up of the research and data taking.

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