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Productive response of dual-purpose cows supplemented with chelate minerals and calcium salts

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ABSTRACT

Objective: To evaluate milk production, body condition and ethological behavior of grazing cows supplemented with chelated minerals and calcium salts, in dry tropical conditions.

Design/methodology/approach: Two treatments were evaluated, T1=Base feeding (grazing+4 kg of concentrated feed cow^{-1} day^{-1} (CF); T2=CF+300 g cow^{-1} day^{-1} of nucleus (chelated minerals+calcium salts) (N). Milk production data were evaluated during 32 days in four periods of seven days, the body condition at the beginning, 15 and 30 days after the evaluation, and the ethological behavior of the cows.

Results: In cows supplemented with nucelus, milk production increased 19.9% ($P \leq 0.05$); body condition improved 0.5 units, there was no difference in grazing time ($P > 0.05$) and rumination time was longer ($P \leq 0.05$).

Limitations on study/implications: The response to reproductive variables was not assessed in this study/reproductive activity is likely to improve in response to improved body condition.

Findings/conclusions: By supplementing dual-purpose cows in the first third of lactation with chelated minerals and calcium salts, milk production increases, and body condition and rumination time improve.

Keywords: feeding, livestock farming, milk production, tropics.

INTRODUCTION

In Mexico, bovine livestock farming for milk production represents around 40% of the production units, and it is important due to the contribution of foods for human consumption such as milk, meat and dairy products (Loera and Banda, 2017). The dual-purpose (DP) system predominates in tropical regions, the animals used are racial crosses of

Bos indicus×*Bos taurus* because of their greater adaptation to conditions in the tropics, the producers obtain income from the sale of milk and weaned calves in the regional market (Orantes *et al.*, 2010; Cortes *et al.*, 2003). The milk production reported in the extensive system is 4.5 kg per cow day^{-1} and low profitability (Pech *et al.*, 2007). Livestock feeding is based on extensive grazing, where the availability and amount of fodder is dependent on rainfall, and under these conditions the animals can present deficiencies in consumption of dry matter, protein, energy and microelements, which result in low productive and reproductive indices (Díaz, 2014; Spears, 2000). To correct nutritional deficiencies and improve productivity, it is necessary to complement the livestock with sources of nutrients which preferably are regionally available (Gómez *et al.*, 2019). Lactating cows require higher consumption of energy and minerals, due to their functions in growth, gestation and lactation (Lipps and Bravo, 2016; Garmendina, 2005).

The aim of the study was to evaluate the effect of the supply of a nucleus based on chelated minerals and calcium salts to dual-purpose cows, on milk production, body condition, and ethological behavior.

MATERIALS AND METHODS

The study was carried out in the "San Isidro" Livestock Production Unit, municipality of Villaflores, Chiapas, located at 16° 14' 31.03" latitude North and 93° 13' 41.10" longitude West, at an altitude of 540 masl with an average temperature of 26 °C and mean annual precipitation of 813 mm; and in the Agriculture and Livestock Health Laboratory of the "San Ramón" CUTT of the Agronomic Sciences School Campus V of Universidad Autónoma de Chiapas.

In the study, 12 second-birth F1 cows (Swizz×Zebu) were used in the first stage of lactation; six cows per treatment with average weight of 470±5 kg of LW. Feeding of control cows was rotational grazing in African Star grass (*Cynodon nlemfuensis*; Vanderyst) pasturelands, and 4.0 kg of concentrated feed were allotted on mornings at the time of milking (Table 1); in T2, 300 g cow^{-1} day^{-1} were allotted in addition from the nucleus based on chelated minerals and calcium salts (Table 1).

Preparation of the nucleus based on chelated minerals and calcium salts

To obtain calcium salts, the process of saponification of African palm oil (*Elaeis guineensis* Jacq.) was carried out, which consisted in taking the oil to 80 °C to add the sodium hydroxide, and in a second step to add the calcium chloride to obtain calcium soap or calcium salt, and then mix with the chelated microminerals that were purchased from a commercial house[¥].

Management of cows and data collection

The cows had an adaptation period of eight days, followed by 32 days for data collection. Milking started at 6:00 hours, the livestock entered the waiting hall, and then went into individual pens, where they were given 4.0 kg of concentrated feed (Table 1). Milking was done manually, with pre-sealed management and disinfection of each the cow's nipples,

Table 1. Proportion of ingredients and chemical composition of concentrated feed and the nucleus.

Variable	Balanced meal	Mineral base
Ingredient	**Proportion (%)**	
Wheat bran	24.0	0.0
Ground corn	44.5	0.0
Palm kernel cake	16.0	0.0
Soybean cake	12.0	0.0
Urea	1.5	0.0
Micro mineral mix	2.0	0.0
Vehicle (inert material)	0.0	23.0
Macro mineral mix	0.0	45.0
Biuret	0.0	7.0
Chelated micromineral[¥]	0.0	1.0
Calcium salts	0.0	24.0
Chemical composition		
Dry matter	88.90	--
Crude protein	18.40	--
Ether extract	3.14	--
NDF	26.90	--
Calcium	0.7	--
Phosphorus	0.6	--
NLE (Mcal kg^{-1} dry matter)	1.6	--

DM: Dry matter; NLE: Net lactation energy; NDF: Neutral detergent fiber; ND: non-determined. [¥] for every 100 grams, it contains: Selenium, 0.03 g; Zinc, 11.0 g; Chromium, 0.040 g; Cobalt, 0.050 g; Copper, 3.0 g; Iodine 0.20 g; Manganese, 10.0 g; and Iron, 12.0 g.

and then the milking process began, which takes approximately 7 to 10 minutes per cow depending on production. After milking, the cows nursed the calves for 30 minutes, and they were transported to the star grass (*C. nlemfuensis*; Vanderyst) pastureland with availability of clean water, where they remained until the following day.

Evaluated variables

Milk production. At the end of milking, the milk produced by each cow was weighed with an electronic scale with capacity of 100 kg and accuracy of 100 g, with the aim of obtaining the productive data of cows in each treatment, taking daily data during 32 evaluation days.

Body condition. The scale of 1 to 5 from the NIRD (National Institute of Research in Dairying) was used to assess the body condition. The assessment was carried out on days 1, 15 and 30.

Ethological behavior. It was evaluated for 24 days on days 15 and 25 of the experimentation period, on all the cows from each treatment. It consisted in taking the

time that each animal devoted to performing the activities of: grazing, milking, moving to pastureland (walking), moving to milking room, movingo to resting pastureland, standing rumination (rest), lying rumination (rest), water consumption, urination, and defecations. The data obtained were added and averaged to determine the time devoted to each activity.

Statistical design and analysis

The experimental design was completely random with two treatments and six repetitions each. The data of milk production, body condition, and ethological behavior were analyzed using the procedure of the general linear model (Proc GLM) of SAS (2011). The means were compared with Tukey's test ($P \leq 0.05$).

RESULTS AND DISCUSSION

Table 2 shows that milk production was higher in the cows with treatment 2 (with nucleus), during the four periods ($P \leq 0.05$).

The cows that consumed the nucleus (T2) produced 19.94% more milk than cows in the control group. The effect of calcium salts in milk production was reviewed by Moallem *et al.* (2007); they mention that fats protected from ruminal digestion increase milk production in Holstein multiparous cows, due to extraruminal effects and higher energy contribution. Duque *et al.* (2011) indicate that the cows in their first phase of lactation use most of the energy for milk production. The digestibility of palm oil calcium salts is 93 to 96%, they are a source of energy highly used by the ruminant at the level of small intestine, and it can be provided to cows with mean production of 4000 to 5000 liters, in amounts of 300 to 500 g cow^{-1} day^{-1}, during the first third of lactation (SAC Battilana Nutrición., 2019).

The use of chelated minerals in milking cows feed has shown favorable results in production and reproduction, as a result of their functions in the animal's metabolism, improving the assimilation of other nutrients, the functions of the immune system and of reproduction. When chelated minerals are supplied to milking cows, it has been observed that the number of somatic cells in milk decreases, and production and fertility increases (Gómez, 2020).

In studies developed by Gómez and Fernández (2020), Romero (2014), Méndez (2013), and Gagliostro *et al.* (2002), the authors observed increases in milk production when including calcium salts and chelated minerals in the diet. The different studies indicate

Table 2. Effect of the supply of chelated minerals and calcium salts on milk production in post-partum cows.

Treatments	Daily milk production (kg cow^{-1})			
	1*	2*	3*	4*
Without mineral base	9.0b	9.8b	9.9b	9.4b
With mineral base	11.3a	12.2a	11.6a	10.6a
SEM	0.89	0.27	0.42	0.19

*Period of eight days each; a, b: different letters in the same column indicate statistical difference according to Tukey's test ($p<0.05$); SEM: standard error of the mean.

that during the first 90 days of lactation, it is the best stage to supplement with bypass fat (Romero, 2014).

Body condition

Table 3 presents the mean values obtained for body condition in the three periods analyzed. The body condition was similar at the start and at 15 days of supplementation ($P>0.05$), while at 30 days, it was higher ($P<0.05$) in the cows that consumed the nucleus of calcium salts and chelated minerals; in these animals, it was also seen that the body condition increased from 2.5 to 3.0 during the assessment period. Salgado *et al.* (2008) mention that when supplementing milking cows with calcium salts, more energy was contributed, which is used to recover their body reserves and to improve their productivity. In studies carried out by Castañeda *et al.* (2009), they observed that the body condition of lactating cows improved when they were supplemented with calcium salts. For their part, Tyagi *et al.* (2010) and Aguilar *et al.* (2009) reported that the body condition improved significantly in cows supplemented with calcium salts.

Ethological behavior

Table 4 shows the results obtained from the ethological behavior of each group. There was no difference in the time of grazing ($P>0.05$); the time devoted to standing grazing was

Table 3. Body condition of cows in the first third of lactation.

Treatment	Day 1 of suplementation	15 days of suplementation	30 days of suplementation
Without mineral base	2.50	2.55b	2.80
With mineral base	2.55	2.70a	3.30
SEM	0.057	0.053	0.315

a, b: different letters in the same column indicate statistical difference between treatments according to Tukey's test ($P<0.05$); SEM: standard error of the mean.

Table 4. Ethology of lactating cows with and without supplementation of calcium salts and chelated minerals.

Activity	Time (hours)		SEM
	Whitout mineral base	Whit mineral base	
Grazing	7.57	7.30	0.24
Time of milking	0.06	0.07	0.01
Walk to the pasture	0.10	0.10	0.05
Walk to the parlor	0.07	0.07	0.01
Walk to the pasture rest	0.10	0.10	0.01
Standing rumination	6.18a	4.05b	0.25
Lying rumination	9.58b	11.94a	0.54
Water consumtion	0.15	0.17	0.03
Urinations	0.08	0.09	0.01
Defecations	0.11	0.11	0.01

a, b: different letters in the same column indicate statistical difference between treatments according to Tukey's test ($P<0.05$); SEM: standard error of the mean.

higher in cows that did not consume nucleus ($P \leq 0.05$), while the time of lying rumination was higher in cows that consumed nucleus ($P \leq 0.05$). According to the results obtained, there is a difference of 2.36 more hours of rest in the group of cows that consumed nucleus. The milking cows must rest approximately 10 to 12 h per day. The time that cows devoted to rest is important; the rumination is optimized when a cow is lying down, it produces more saliva, and the risk of ruminal acidosis decreases. Likewise, the blood flow to the udder is higher in a lying cow (around 5 liters min^{-1}) than in a standing cow (around 3 liters min^{-1}); this improves the function of the udder and increases milk production (Temple *et al*., 2016). In the same sense, Blanco (2019) mentions that the cows that produce most are the ones that rest most (in rest and rumination), because the udder's irrigation improves, there is more rumination time, more salivation, and there is more rest for the feet and relaxation of articulations.

CONCLUSIONS

In the dual-purpose system, milk production increased 19.94% by supplementing lactating cows in the first third of lactation with chelated minerals and calcium salts; during the assessment period, the body condition improved 0.5 units and the time devoted to rumination was 2.36 more hours.

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