Scientific Paper

Effect of two cultivars of *Megathyrsus maximus* (Jacq.) on cattle milk production and composition

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Abstract

Objective: To evaluate the effect of *Megathyrsus maximus* (Jacq.), cultivars Agrosavia Sabanera and Tanzania, on the milk production and composition of crossbred Gyr x Holstein and Costeño con Cuernos cows in the dry Caribbean of Colombia.

Materials and Methods: The effect of *M. maximus,* cultivars Agrosavia Sabanera (T1) and Tanzania (T2, control), on the milk production and composition (concentration and production of total solids, protein, fat) of Gyr x Holstein (E1) and Costeño con Cuernos (E2) cows, was analyzed. The study was conducted in the Codazzi municipality, Cesar department. In each experiment four animals in early lactation were used, in order to analyze the effect of the animal and cultivar. For such purpose, a simple crossover experimental design was applied.

Results: In the two experiments there was no significant difference in milk production with the evaluated treatments. In experiment 1, the concentration of total solids in the milk was higher (12,6 *vs*. 12,2 %) with the cultivar Agrosavia Sabanera with regards to Tanzania ($p < 0,05$); while, in E2, the milk composition of the cows Costeño con Cuernos, did not vary with one or the other cultivar.

Conclusions: The two breed groups of cows had similar milk production with the two cultivars. Nevertheless, it improved the concentration of total solids in the milk with Agrosavia Sabanera, in the Gyr x Holstein cows.

Keywords: animal feeding, feed grasses, milk production

Introduction

Cattle husbandry in the Colombian Caribbean has diverse technological limitations that affect its competitiveness and sustainability (Lozano, 2017; Tapia-Coronado *et al*., 2019). Forages are the feeding basis of cattle (Guyader *et al*., 2016; Neel, 2018). The average production of sellable milk per cow (4,5 kg/day) and per hectare (6,3 kg/day) is limited, due to the low dry matter production (< 2 000 kg DM/ha) and nutritional quality of the forages, with crude protein values between 8 and 9 and NDF from 60 to 65 % (Mojica-Rodríguez *et al.,* 2013).

The breed groups that prevail in the dual purpose system are the crosses of Zebu breeds with European breeds, specialized in milk production (Holstein and Swiss Brown) and, to a lesser extent, with creole breeds that have dairy propensity, such as the Costeño con Cuernos cattle. This is a creole breed, which tolerates strong temperatures and humidity variations of the environment, typical of the swamp zones of Córdoba and Magdalena, of the dry savannas of Sucre and Bolívar and of the dry Valledupar plains, in the Colombian Caribbean (González *et al*, 2016; Martínez, 2019). This type of cattle has aptitude for quality milk production (Ossa *et al*., 2011).

In the dry Caribbean, the main grazing grasses that farmers use are the pastures colosuana [*Bothriochloa pertusa* (L.) A. Camus] and guinea grass [*Megathyrsus maximus* (Jacq.) B.K.Simon & Jacobs], cultivar Tanzania. In the farmers' farms, the production of sellable milk of crossbred dual purpose cows, fed with *B. pertusa* and *M. maximus* cv. Tanzania, at the beginning of lactation, is 4,4 and 4,0 kg/cow/day, with content of total solids of 12,2 and 12,0 %, respectively, in the rainy season (Mojica-Rodríguez *et al*., 2013).

The cultivar Tanzania was released from the selection of forage germplasm in Brazil, for its good forage production and nutritional quality (Peters *et al*., 2002). The Colosuana pasture is a naturalized species in the dry Caribbean, which has its origin in South and Southeast Asia. Its forage production and nutritional quality are low (< 750 kg DM/ha, crude protein-9 %, neutral detergent fiber-71 % and dry matter degradability-58 %), and are even more

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reduced during the dry season (Mojica-Rodríguez, 2017).

Farmers have used the pasture Tanzania as alternative to substitute Colosuana, due to its higher forage and nutritional quality (Mejía-Kerguelén *et al*., 2019). Nevertheless, when it is not adequately managed, its persistence in the paddocks is reduced and it is replaced again by the Colosuana pasture, which has higher seed production frequency with regards to Tanzania. This is an adaptation response to this type of edaphoclimatic conditions, which favors its propagation (Serrano *et al*., 2014; Yan *et al*., 2016).

Guinea grass, cultivar Agrosavia Sabanera, is a grass that originated from the ecotype CIAT 6799, selected in agronomic evaluations among several accessions, due to its excellent production, nutritional quality of the forage and frequent seed production (Atencio-Solano *et al*., 2018; Tapia-Coronado *et al*., 2019; Burbano-Erazo *et al*., 2019). The research line on grass evaluation and selection involves the evaluation of promising cultivars for animal response. For such reason, the objective of this study was to evaluate the effect of *M. maximus,* cultivars Agrosavia Sabanera and Tanzania, on the milk production and composition of crossbred Gyr x Holstein and Costeño con Cuernos cows in the dry Caribbean of Colombia.

Materials and Methods

Location. The study was conducted at the Research Center Motilonia (10° 0´7´´ N, 73° 14´ 51´´ W, 106 m. a.s.l.), of the Colombian Corporation of Agricultural Research, Agrosavia. This facility is located in the Agustín Codazzi municipality, in the Cesar department, Colombia.

Edaphoclimatic conditions. The zone has annual rainfall of 1 585 mm, with bimodal distribution from May to June and from September to November, average annual temperature of 28,7 ºC and relative humidity of 70 %. It corresponds to the ecological formation classified as tropical dry forest (TDF). The experiments were conducted in September, October and November, 2015. The soils of the experimental area were of limey-sandy texture, with pH between 6,4 and 6,6; organic matter from 0,7 to 1,4 %; without aluminum saturation and with good drainage.

Experimental design and treatments. Two experiments were conducted. In experiment 1, four Gyr x Holstein (GH) cows were used, with 32 ± 1,7 days into lactation and live weight of 475 ± 19,0 kg. In trial 2, four creole Costeño con Cuernos (CCC) cows were used, with 29 ± 1,3 days in lactation and average live weight of 435 ± 13,0 kg. The cows in the two breed groups had between two and four parturitions. In each experiment a simple crossover design was applied (Amezquita, 1999), with two treatments and four animals. The cultivars Agrosavia Sabanera (T1) and Tanzania of *M. maximus* (T2-control, commercial grass) were evaluated as treatments. Each experiment had a total period of 28 days of evaluation, in which the animals grazed in each cultivar (14 days) sequentially. In the two experiments, the result of the randomization of the sequence was cultivar Tanzania first, and then Agrosavia Sabanera.

Experimental procedure. The establishment of 2 ha was carried out, distributed in one hectare for each grass. The area of each cultivar was divided into two plots of 0,5 ha each. In the first one an adaptation of seven days was done, and in the second the measurements on the animals were developed (seven days).

The cultivars were established one year before conducting the experiments. In Agrosavia Sabanera (T1) vegetative material (tillers) was used and in the cultivar Tanzania (T2), seed (8 kg/ha). Before the experiments, a uniformity cutting of the cultivars was performed, at 30 cm of height from the soil level. Chemical fertilization was applied (25 kg/ha of nitrogen and 7,8 kg/ha of K_2O) and a resting period of 24 days was assigned to perform experiment 1. Then, the pastures had a recovery stage of 28 days, and experiment 2 was developed. In both, the stocking rate was 2 cows/ha.

Milking was performed with calf stimulation. Three mammary quarters were milked, and the remaining one was destined for milk consumption by the calf. The calves were weighed with an electronic scale, before milking and 30 minutes later, to estimate milk intake. Afterwards, they were separated from the cows (restricted suckling).

Measured variables. In the grasses the floristic composition and the forage in offer of leaves and stems were measured in each experimental period (Toledo and Schultze-Kraft, 1982). For analyzing crude protein, forage samples were taken simulating the plucking by the animals (AOAC, 2019). In addition, NDF and ADF (Van Soest *et al*., 1991), total fat by ether extraction and *in situ* dry matter degradability (Ørskov *et al.,* 1980), were determined.

In the animals, during the measurement period, the milk production per milking cow, total milk production per cow (including the one consumed by

the calf) were daily recorded and it was corrected by 4 % fat. The content of total solids, protein and fat was measured with a milk analyzer (Lactoscan, Model MA250, AGRILAC®).

Statistical analysis. In each experiment, the data were analyzed through a variance analysis (SAS version 9,3), which included as variation source the effect of animal and cultivar, after confirming its normal distribution and homoscedasticity through Shapiro-Wilk and Levene's tests, respectively. The following model was analyzed:

$$Y_{ijk} = \mu + \alpha_i + \rho_j + \varepsilon_{ijk,}$$

Where:

Y_{ijk} - variable of interest
μ – general average
α_i – effect of the animal (i = 1 a 4)
ρ_j – effect of the cultivar (j = 1, 2)
ε_{ijk} - experimental error

Results and Discussion

Floristic availability and composition of the pastureland. In trial 1, the cultivar Agrosavia Sabanera had higher production of total dry forage and of leaves and stems ($p < 0,05$) with regards to Tanzania, which showed higher ($p < 0,05$) leaf:stem ratio, compared with Agrosavia Sabanera. In experiment 2, there were no differences in these variables between both cultivars (table 1).

In this study, the total forage production in the two cultivars was higher than the one reported in the cultivar Tanzania in farms of northern Cesar (1,1 t DM/ha), without fertilization (Mojica-Rodríguez *et al*., 2013). Nevertheless, only the total forage production recorded in experiment 1 was higher than that referred in the study by Rodríguez-Fernández and Roncallo-Fandiño (2013) in Tanzania, with 45 days of resting (5,9 t/ha) in the Agustín Codazzi municipality. This is partially explained by the fertilization done on the cultivars, although they had lower regrowth age.

Based on the leaf production per hectare in the cultivars (table 1), in experiment 1 a daily offer of 50,0 and 38,5 kg DM/cow; while, in experiment 2, 30,0 and 24,3 kg DM/cow/day was offered, with the cultivars Agrosavia Sabanera and Tanzana, respectively. These offers represented between 1,5 and 3,1 times more the necessary quantity to achieve a maximum intake of 15,9 kg DM/cow/day in crossbred cows with tropical pastures, without supplementation (Aroeira *et al.,* 1999). This indicates that possibly the forage intake of the cultivars in each experiment was not limited.

Although there was higher presence of sedges in Agrosavia Sabanera in the two experiments, the two cultivars were the prevailing species in each of the treatments. Thus, the response of the animals is consequence of the cultivar intake.

Nutritional quality of the cultivars. In experiment 1, the cultivar Agrosavia Sabanera showed lower ADF ($P < 0,05$), higher *in situ* dry matter degradability ($p < 0,05$), and contributed higher content of ethereal extract (EE) with regards to Tanzania. Meanwhile, in experiment 2, there were no differences in the quality of the cultivars. However, Agrosavia Sabanera contributed with 2,1

Table 1. Dry matter offer and floristic composition in cultivars Agrosavia Sabanera and Tanzania.

Variable	Experiment							
	Gyr x Holstein cows				Costeño con Cuernos cows			
	Agrosavia Sabanera	Tanzania	MSE ±	P - value	Agrosavia Sabanera	Tanzania	MSE ±	P - value
Offer, t DM/ha								
Leaves	3,5[a]	2,7 b	0,007	0,005	2,1	1,7	0,05	0,07
Stems	2,8[a]	1,7 b	0,020	0,010	1,0	1,1	0,10	0,50
Total	6,3[a]	4,4 b	0,022	0,007	3,1	2,8	0,05	0,09
Leaf:stem ratio	1,2[b]	1,6 a	0,010	0,010	2,1	1,5	0,32	0,29
Floristic composition, %								
Grass	80,2	95,0	2,2	0,09	74,4 b	87,9	1,0	0,04
Sedges	19,8	5,0	2,0	0,09	26,6 a	12,1	0,9	0,04

MSE: Standard error of the treatment mean

percentage units more to the crude protein content compared with Tanzania (table 2).

In this study, the analyzed components in the nutritional value of the cultivars, with the exception of crude protein, were similar to the ones reported by Mojica-Rodríguez *et al.* (2019a) in Tanzania, at 28 days of regrowth, in the Agustín Codazzi municipality. The crude protein content (11,7 to 13,9 %) in the two evaluated cultivars in this work was acceptable, and proves the importance of doing an adequate management regarding their utilization at an appropriate regrowth and fertilization age for feeding cattle. The values reported here are similar to those referred by Patiño-Pardo *et al.* (2018) and Cornejo-Cedeño *et al.* (2019), who indicated in the cultivar Tanzania (25 days of regrowth) approximate content of crude protein between 12,0 and 13,0 %, respectively. They are also similar to the 15,4 % reported by Atencio-Solano *et al.* (2018) in Agrosavia Sabanera (21 days of regrowth).

Milk production. In experiment 1, there was a trend ($p = 0,07$) to increase milk production in the cows fed with the cultivar Agrosavia Sabanera, which represented improvement by 8,9 % in this variable. Meanwhile, in experiment 2, milk production per milking cow was similar in the cows that consumed the two cultivars (table 3). For the GH as well as the CCC, fed Agrosavia Sabanera and Tanzania (table 3), there was no statistical difference in total fat-corrected milk production per cow.

Based on the results of this study, the milk production per milking cow increased by 65,9 and 4,5 % with the cultivar Agrosavia Sabanera; while with Tanzania it increased by 52,3 %. However, no increase was proven in GH and CCC cows, respectively. The values are higher than the ones obtained with Colosuana pasture (4,4 kg/cow/day) in Zebu x Holstein animals, in the micro-region Cesar Valley, in the dry Caribbean (Mojica-Rodríguez *et al*., 2013).

Milk composition. In experiment 1, the content of total solids and fat was higher ($p < 0,05$), in the cows (Gyr x Holstein cows) fed with Agrosavia Sabanera compared with Tanzania. In experiment 2, there was no effect of the cultivar on the concen-

Table 2. Nutritional quality of *M. maximus,* cvs. Agrosavia Sabanera and Tanzania (%).

Variable	Experiment							
	Gyr x Holstein cows				Costeño con Cuernos cows			
	Agrosavia Sabanera	Tanzania	MSE ±	P - value	Agrosavia Sabanera	Tanzania	MSE ±	P - value
Crude protein	13,9	13,6	2,90	0,90	13,8	11,7	1,86	0,89
NDF	68,5	67,5	0,63	0,19	66,2	69,7	3,99	0,38
ADF	35,1	42,5	1,59	0,02	43,4	38,4	2,88	0,17
SE	2,8	2,2	1,19	0,06	2,3	1,8	0,47	0,33
ISDMD	67,4	60,6	0,73	0,007	64,8	62,5	1,38	0,11

NDF: neutral detergent fiber, ADF: acid detergent fiber, EE: ethereal extract, ISDMD: *in situ* dry matter digestibility, MSE: standard error of the mean.

Tabla 3. Milk production of Gyr x Holstein and Costeño con Cuernoscows grazing *M. maximus,* cvs. Agrosavia Sabanera and Tanzania (kg/cow/day).

Variable	Experiment							
	Gyr x Holstein cows				Costeño con Cuernos cows			
	Agrosavia Sabanera	Tanzania	MSE ±	P - value	Agrosavia Sabanera	Tanzania	MSE ±	P - value
Milk production per milking cow	7,3	6,7	0,3	0,07	4,6	4,4	0,2	0,32
Total milk¥	9,4	9,0	0,6	0,39	7,0	6,5	0,3	0,08
Total FCM	9,2	8,2	0,8	0,18	6,6	6,3	0,4	0,39

¥Includes the milk consumed by the calf.
FCM: 4 % fat-corrected milk, MSE: standard error of the mean.

tration and daily production of the evaluated milk components (table 4).

In this study, the concentration of total solids increased by 3,2 % (12,6 *vs.* 12,2%) and 13,1 % (13,8 *vs.* 12,2 %) with Agrosavia Sabanera in GH and CCC cows, respectively. With Tanzania there was no modification (12,2 *vs.* 12,2 %), but it did increase by 12,3 % (13,7 *vs* 12,2%) in GH and CCC, respectively, if the effect of each one of these cultivars is compared with that of Colosuana pasture on the concentration of this component in milk of crossbred cows in the dry Caribbean (Mojica-Rodríguez *et al*., 2013). The content of total solids in the CCC cows shows the capacity of this breed group to produce good quality milk, which has been approached in other studies (Ossa *et al*., 2011) and on which different kinds of audience agree about creole breeds (Vilaboa-Arroniz *et al*., 2013), and besides it is shown in other creole breeds, such as back-eyed white creole cattle (Onofre *et al*., 2018).

The highest offer of leaves with lower ADF content and higher dry matter degradability of the cultivar Agrosavia Sabanera with regards to the Tanzania pasture, possibly led to the existence of higher nutrient absorption. This explains the positive effects of such cultivars on the milk production and content of total solids found in the GH cows. The dry matter intake has been identified as a factor that influences positively milk production and composition in cattle, which is associated to higher utilization of digestible energy (Flórez-Gómez *et al.,* 2017; González, 2018).

The fiber and fat content of forage influences positively the fat content of cattle milk (Mojica-Rodríguez *et al*., 2019b). The cultivars in the two experiments showed similar NDF contents, but Agrosavia Sabanera contributed higher fat quantity in experiment 1, which explains the higher quantity of fat in the milk of GH cows.

Conclusions

The GH and CCC cows showed similar individual milk production with the cultivars Tanzania and Agrosavia Sabanera. Nevertheless, the utilization of the latter increased the content of total solids in the milk of Gyr x Holstein cows. This information corroborates that the cultivar Agrosavia Sabanera is a new alternative as grazing grass in dual-purpose production grasses in the Colombian dry Caribbean.

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Authors' contribution

- José Edwin Mojica-Rodríguez. Designed the study, carried out the analysis and manuscript writing.
- Esteban Burbano-Erazo. Carried out the analysis and manuscript writing.

Conflict of interests

The authors declare that there are no conflicts of interests between them.

Table 4. Milk composition of cows grazing *M. maximus* cvs Agrosavia Sabanera and Tanzania.

Variable	Experiment							
	Gyr x Holstein cows				Costeño con Cuernos cows			
	Agrosavia Sabanera	Tanzania	MSE ±	P - value	Agrosavia Sabanera	Tanzania	MSE ±	P - value
Total solids								
Concentration, %	12,6 a	12,2 b	0,20	0,04	13,8	13,7	0,24	0,71
Production, kg/day	1,2	1,1	0,08	0,22	1,0	0,9	0,04	0,11
Protein								
Concentration, %	3,3	3,3	0,01	0,79	3,5	3,5	0,06	0,22
Production, kg/day	0,3	0,3	0,01	0,34	0,2	0,2	0,01	0,06
Fat								
Concentration, %	3,9	3,4	0,23	0,06	3,7	3,9	0,32	0,44
Production, kg/day	0,4	0,3	0,04	0,14	0,3	0,2	0,02	0,70

MSE: standard error of the mean

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