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Development and reproductive performance of beef heifers supplemented with brown rice meal and/or protected fat on temperate grasslands

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ABSTRACT - The response of energy supplementation was evaluated on the development and reproductive performance of beef heifers on temperate grasslands. Twenty-eight Charolais × Nellore heifers, with initial average age of 18 months and initial live weight of 274.9 kg were utilized. The animals were maintained on oat + ryegrass pasture and distributed in the following treatments: no supplementation (NS): heifers kept exclusively on pasture; MEG: supplementation with protected fat Megalac®; BRM: supplementation with brown rice meal; BRM+MEG: supplementation with BRM + protected fat. The average final weight of the heifers was of 403.4 kg and corresponded to 89.5% of the adult weight. The body condition of heifers increased linearly with daily increase of 0.012 points, correlating positively with the final weight. There was interaction between treatment and period for average daily weight gain. The highest daily weight gain, 1.395 kg, occurred in the first period when the animals were supplemented with BRM+MEG. In the last period, the NS animals presented the lowest daily weight gain, 0.888 kg. Supplementation with brown rice meal and/or protected fat does not interfere in the intake of pasture by heifers or increase the total intake of dry matter, not changing, therefore, the average daily weight gain at the end of the period of grazing. The daily weight gain does not change during supplementation. The use of temperate pasture with and without supplementation promotes the proper development of the structure and reproductive tract of heifers, benefiting the animal performance indexes in the first mating at 25-27 months of age.

Key Words: body condition, daily weight gain, intake, reproductive tract

Introduction

Rearing replacement heifers is certainly one of the most important stages within the reproductive system aimed at breeding, where improving the reproduction of young females, through the additional inclusion of food in the process of growth is important for increasing the productivity of this system (Barcellos et al., 2003). According to ANUALPEC (2010), in the last 10 years, the productivity of the Brazilian breeding system was almost stagnant, still with a low birth rate, near 60%.

Much of the low animal productivity of most Brazilian properties happens due to the deficiency in pasture management and lack of forage and property planning (Lupatini, 2000). In this context, the incorporation of temperate grasslands exactly during the period of greatest forage need has crucial role for beef cattle. According to Semmelmann et al. (2001), the main objective of a replacement rearing system is to develop heifers that have reached puberty and cycle regularly before the beginning of the first mating season. Di Marco et al. (2006) highlight that a nutrient management that enables the females to reach their minimum weight of mating with a certain advance is necessary, since it is important to obtain higher pregnancy rate in heifers, in addition to the good development until the mating has a long-term effect on their reproductive performance.

The use of supplements rich in fat such as brown rice meal and protected fat may improve the use of temperate grasslands, because, according to Pascoal et al. (2000), these pastures present high crude protein content, and the energy level is the limiting factor for the animal performance. However, the types of lipids used in the diet can influence the fermentation and the ruminal digestibility of the fibre, through the suppression of cellulolytic and methanogenic bacteria, and saturated lipids behave in a less harmful way to the microbial flora (Duarte et al., 2005). Besides the possible benefit of energy supplementation, the intake of extra lipids, 44 g/kg in the diet, may be beneficial to the reproductive development, resulting in an increase in the percentage of pubertal heifers at the beginning of the breeding season (Lammoglia et al., 2000).

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Thus, the response of the supplementation with brown rice meal and/or protected fat was evaluated on the development and reproductive performance of beef heifers on temperate grassland.

Material and Methods

The experiment was carried out in the Beef Cattle Laboratory in the Department of Animal Science of Universidade Federal de Santa Maria. This area is located in the Central Depression of Rio Grande do Sul, at 95 m of altitude, latitude 29º 43' South and longitude 53º 42' West. The soil of the experimental area is owned by the São Pedro mapping unit and classified as a paleudalf soil (Embrapa, 1999). The climate of the region is Cfa (subtropical humid), according to the Köppen classification.

The experimental area used corresponded to 16.3 ha, of which 11.7 ha were divided into 12 paddocks with variable area where the animal tests were managed, and 4.6 ha where the animal regulators remained. The implementation of the pasture occurred on April 1st, 2009 with the broadcast sowing of 31.2 kg/ha of ryegrass seeds (*Lolium multiflorum* Lam.) based on 100% of cultural value, and on April 2nd, 3rd and 4th, 2009 with sowing of 77.4 kg/ha of oat seeds (*Avena strigosa* Schreb.) based on 100% of cultural value in a row. In the based fertilizer, 141 kg/ha of NPK fertilizer formula 5-20-20 were used. The cover fertilization was accomplished in four stages: June 4th, 2009 - 47 kg/ha of urea; June 16th, 2009 - 124 kg/ha of NPK fertilizer formula 5-20-20; July 11th, 2009 - 77 kg/ha of urea; and August 22nd, 2009 - 38.5 kg/ha of urea.

The pasture establishment was of 70 days, when the heifers joined the pasture; the last 15 days before the trial period were used for adaptation to the supplement and to the management. The experimental period lasted 112 days, from July 5th, 2009 to October 24th, 2009, divided into four periods of 28 days.

Twenty-eight Charolais × Nellore heifers, with initial age of 18 months and average live weight of 274.9±4.97 kg were distributed in the following treatments: no supplementation (NS): heifers maintained exclusively on oat + ryegrass; Megalac® (MEG): heifers maintained on oat + ryegrass pasture receiving 3% of protected fat under the estimate of the total intake of dry matter fixed at 30 g/kg live weight; brown rice meal (BRM): heifers maintained on oat + ryegrass pasture receiving brown rice meal at a level of 8 g/kg of live weight; and brown rice meal + Megalac® (BRM+MEG): heifers maintained on oat + ryegrass pasture receiving brown rice meal at a level of 8 g/kg of live weight and 3% of protected fat under the estimation of total dry matter, fixed at 30 g/kg live weight. Each treatment consisted of three area replications, with a variable number of animals within them; two paddocks with two heifers each, and a paddock with three heifers.

The weight of the animals was measured before the beginning and end of each period of the experiment, previously fasted for 12 hours of solids and liquids. During the weighing, the body condition of heifers was assessed, assigning scores from 1 to 5, in which 1 = very thin and 5 = very fat, following the method described by Lowman et al. (1973). The pelvic area was measured rectally, with the aid of the Rice pelvimeter before the start and the end of the trial period, determining the width or horizontal measure, which corresponds to the distance between the right and left ileus, at the height of the psoas tuber, and the height or vertical measure, which corresponded to the distance between the symphysis of the pubis and the base of the sacral vertebrae body. The horizontal and vertical measurements were calibrated in centimetres and then multiplied to obtain the estimate of the pelvic area in cm^2. The reproductive tract score, assessed at the beginning and end of the experimental period, was determined according to the methodology described by Anderson et al. (1991), with heifers sorted according to the scores: infant (1 or 2), pre-pubertal (3) and pubertal (4 or 5).

The hip height and perimeter of the chest were evaluated at the beginning and at the end of the experimental period with the aid of a measuring tape and graduated ruler with the immobilization of the animal in torso restraint, staying with the dorsal line straight.

Before the start of the breeding season, comprised between November 15th, 2009 and February 28th, 2010, the bulls for breeding were selected through andrologic examination, utilizing a bull:cow ratio of 1:20. The determination of gestational age was performed after 45 days of the end of the breeding period, through ultrasound, then it was determined by the difference between the day of the examination and the beginning of the breeding season, the probable day of conception.

The grazing method adopted was continuous with variable stocking rate, using the "Put and take" technique (Mott & Lucas, 1952), from the use of a pre-determined forage mass of 1200 kg DM/ha, utilizing regulator animals to maintain the forage availability desired. Forage mass was determined by the double sampling technique (Wilm et al., 1944). Of each cut made in the repetition, a sample was taken for the composition of the composite sample for determination of dry matter (DM). For the calculation of the estimate of dry matter (DM) intake per treatment and period, the final forage mass of the period and the forage losses occurring during the period were subtracted from the total dry matter/ha production in the period. Dividing the estimated intake of DM/ha by the ability of animal support in the period, the DM in g/kg of body weight for each period was obtained. The rate of substitution and addition were calculated from the following formulas: replacement = [(forage DM intake of non-supplemented heifers – forage DM intake of the supplemented animals)/DM intake of the supplement]; addition = [(Total DM intake of supplemented animals – forage DM intake of non-supplemented animals)/ DM intake of the supplement] * 100.

For sampling of forage consumed by heifers, grazing simulations were performed in each experimental period according to the method of Euclides et al. (1992). The samples were pre-dried in an oven with forced air circulation at 55 °C for 72 hours until they reached constant weight, then they were ground in a Willey-type mill of 1 mm mesh sieve.

The dry matter content was determined by drying in oven at 105 °C until constant weight. The total nitrogen content was determined by the Kjeldahl method (AOAC, 1995). The ether extract content was determined after treating the samples with ether in a reflux system at 180 °C for 2 hours. The content of neutral detergent fibre is in accordance with Van Soest et al. (1991) (AOAC, 1995). Total digestible nutrients were calculated from the chemical composition of the food using the equation of Weiss et al. (1992).

The experimental design was completely randomized, with three replicates per area, in a 4 × 4 factorial arrangement (four treatments × four periods). The variables were tested concerning normality by the Shapiro-Wilk test, in which all presented normal distribution. The total weight gain, heart girth, hip height, pelvic area and weight/height ratio, which consisted of only two measures, at the beginning and end of the experiment, were subjected to analysis of variance and F test at 5% of significance using PROC GLM. The pelvic area was initially used as a covariate. For pregnancy rate, the chi-square test was utilized. Other data were subjected to analysis of variance and F test at 5% significance level using the PROC MIXED, and the information criterion for choosing the best covariance structure was the AIC, and when differences between the means were detected, they were compared by Student's t test.

The mathematical model adopted in the analysis of variance was:

$$Y_{ijk} = \mu + T_i + R_k (T_i) + P_j + (TP)_{ij} + e_{ijk}$$

in which: Y_{ijk} represents the dependent variables; μ, the mean of all the observations; T_i, the effect of the i-th dietary treatment; R_k (T_i), the effect of the k-th repetition within the ith treatment (error a); P_j, the effect of the j-th period; $(TP)_{ij}$, the interaction between the i-th treatment and the j-th period; and e_{ijk}, the total experimental error (error b).

Regression test, lack of fit test (Lack-of-fit), and correlation test at 5% significance level were performed. Data analyzes were performed using the statistical package SAS (Statistical Analysis System, version 8.01).

Results and Discussion

The ingestion of supplements for treatments Megalac®, brown rice meal and brown rice meal + Megalac®, showed means of 0.115; 2.430 e 2.594 kg/day, respectively. The Megalac® supplement intake for the treatment which received only the product was inferior to the treatment which was mixed with the brown rice meal, a fact that was associated with their low palatability when provided as the sole source of supplementation, which stops occurring when mixed with another product accepted by cattle.

The contribution of crude protein (CP) of the pasture (Table 1) was above the requirements for maintenance and gain for beef heifers over the year, 126 g/kg of dry matter (DM), according to the NRC (1996), which would enable the use of only energy supplementation up to 11.2 g/kg of live weight (LW) with no protein deficit. Regarding the content of total digestible nutrients (TDN) (Table 1), the oat + ryegrass and brown rice meal showed similar levels of energy, 722.0 and 720.3 g/kg DM, respectively; the highest participation of TDN per unit of product was with the Megalac® supplement with 1635 g/kg DM.

There was significant interaction between treatments and periods for the weight of the animals (Figure 1). The evolution of the weight was constant for all treatments; however, it can be seen that the heifers that received MEG and BRM+MEG gained more weight at the end of the experiment, when the forage quality began to decrease due to the advancement of the reproductive stage and consequently in function of increased lignification of forage intake. The extra input of energy via Megalac® probably benefited this increased weight gain at the end of the experimental period,

Table 1 - Average contents of chemical analysis of forage from the grazing simulation, brown rice meal and Megalac®

Variable, g/kg DM	Forage	Brown rice meal	Megalac®
Dry matter	184.40	909.60	950.00
Organic matter (DM)	887.30	862.40	950.00
Crude protein	201.10	108.70	-
Ether extract	51.40	137.90	845.00
Neutral detergent fiber[1]	407.30	395.00	-
Total digestible nutrients	722.00	720.30	1.635.00

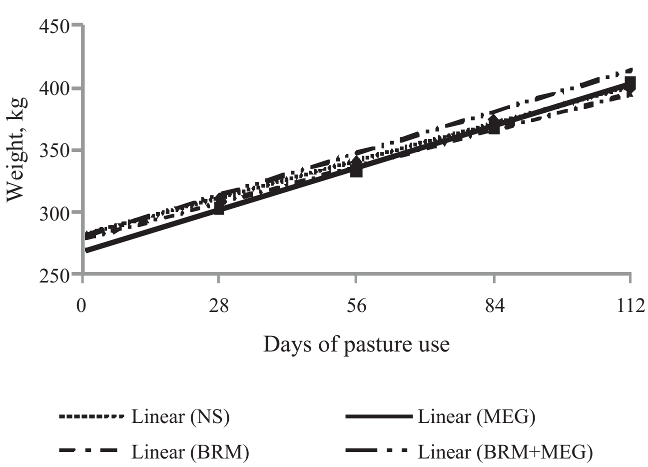
[1] Corrected for ash.

because when using BRM or just grazing, the performance observed was lower.

The average weight of heifers at the beginning of the experiment of 274.90±4.97 kg accounted for 61.09% of the mature weight of Charolais × Nellore cows, 450 kg. According to Barcellos et al. (2003), the heifer is ready for mating when achieving at least 60-65% of the body weight of an adult cow; however, for British × Zebu crosses, this percentage may be slightly higher. Thus, with the autumn-winter period, when the stagnation of the growth of native grass has already initiated by May, and the quality deteriorates considerably by June, the maintenance of heifers exclusively on pasture seeking to mate would lead to loss of weight and body condition, which would compromise the reproductive indexes.

In this study, the average final weight reached by the heifers was of 403.4±5.83 kg and corresponded to 89.5% of the adult weight, in which the rearing of females on oat + ryegrass pasture with or without supplementation enabled the heifer to achieve the adequate weight for mating. For Barcellos et al. (2006), the weight of the heifer is the variable of greatest impact on reproductive performance during its first mating.

The body condition of heifers increased linearly (Figure 2) with each additional day of 0.012 points, correlating positively with the final weight (r = 0.79, P<0.0001).



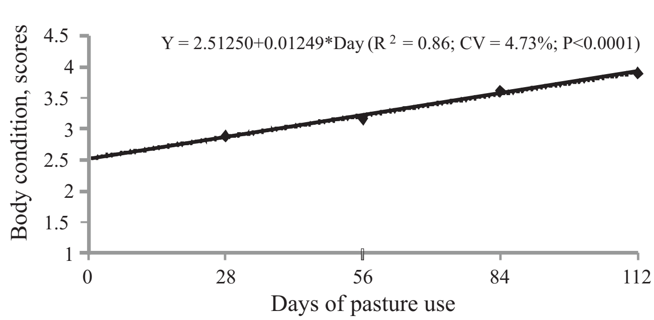
CV - coefficient of variation.
NS - no supplementation = 281.6+1.06724*Day (R^2 = 0.48; CV = 10.15%; P<0.0001).
MEG - Megalac® = 268.28571+1.20485*Day (R^2 = 0.83; CV = 5.00%; P<0.0001).
BRM - brown rice meal = 278.71429+1.04235*Day (R^2 = 0.44; CV = 10.84%; P<0.0001).
BRM+MEG - brown rice meal+ Megalac® = 280.07143+1.19847*Day (R^2 = 0.74; CV = 6.35%; P<0.0001).

Figure 1 - Evolution of the live weight of heifers supplemented with different concentrates, over the period of use of oat + ryegrass pasture.

Body condition becomes an important tool to assist the producer in the search for better reproductive rates especially for heifers that will enter the first mating season, because according to Rice (1991), it is one of the nutritional status indicators that is most directly associated with the pregnancy rate. Cows with higher body condition score at the start of the breeding season are those that phenotypically present higher body weight, lower value for days to calving, and higher success rate at calving than cows with lower body condition score (Mercadante et al., 2006). In this study, both the quality of pasture and supplements offered were decisive for the heifers to present high weight and high body condition score at the end of the experimental period (3.91 points).

There was interaction (P<0.05) between treatment and period for average daily weight gain (Table 2). The occurrence of interaction between treatment and period in temperate grassland is reported by other authors (Roso & Restle, 2000; Rocha et al., 2004; Pilau et al., 2004).

The highest daily weight gain, 1.395 kg, occurred in the first period when the animals were supplemented with BRM+MEG. One could infer that the daily weight gain during this period was the result of a likely compensatory gain; however, daily weight gain was very close to that observed in the third period, that is, the diet supplied allowed the heifers to express high daily weight gain during different periods. In the last period, the animals with no supplementation presented lower daily weight gain, 0.888 kg. This lower result is probably related to the body condition presented by heifers, averaging 3.79 points, i.e., during this period, heifers had a higher fat deposition, and as they did not have extra energy intake via supplements, as in the other treatments, the daily weight gain was lower due to lower energy density of the dietary intake. Santos et al. (2005), working with beef heifers in temperate grasslands also observed greater daily weight gain: 1.425 kg in the



CV - coefficient of variation.

Figure 2 - Estimate of body condition of heifers during the grazing periods.

initial period (July to August) when the animals were supplemented (9 g/kg BW) with soybean hulls, and daily weight gain of 0.580 kg for calves grazing only on pasture in the last period (September-October). The joint analysis of the data shows that the daily weight gain does not remain homogeneous during the use of the pasture, with occurrence of periods of higher or lower daily weight gain.

During the period of pasture use, weight gain in kg/ha showed quadratic behaviour: Y = 165.16996-3.11581*Day +0.02622*Day^2 (R^2 = 0.55, P<0.0001) (Table 3). The inflection observed in the trend line for the weight gain in kg/ha occurred between August 2nd and August 30th, 2009, concurrently with the least ability of animal support and daily weight gain observed by the grazing in that period (Table 2). At the end of pasture use, with the highest accumulation rate observed in this period, it was possible to increase the ability of animal support, and the maintenance of daily weight gain close to or higher than the other periods enabled possible treatments to have higher weight gain (kg/ha/period) in the final grazing cycle. The data from Rocha et al. (2003) corroborate this result, in which the greatest weight gain in kg/ha occurred in the same period of this experiment, at the end of September to mid-October, but with higher values when supplement was used (231.5 kg/ha), but close when the animals were raised on pasture (163.5 kg/ha). According to Rocha et al. (2003), the data on live weight gain/ha quantify the potential for animal production of different alternatives of pasture utilization, and also enable the verification of the economic return of each strategy utilized.

In relation to the total weight gain (kg/ha; Table 3), there was no difference (P>0.05) between treatments, with gains ranging from 345.27 kg (MEG) to 473.25 kg (BRM+MEG). These values are in accordance with data found in the literature with variations of 298.3 kg/ha without supplementation on oat + ryegrass pasture (Roso, 2007) to 1039.3 kg/ha with increasing supplementation over the period of temperate grasslands (Freitas et al., 2005). Another factor that tends to make the overall gain in kg/ha vary is the number of days of pasture use, which was 112 days in the present study. In favourable weather, Roso & Restle (2000) managed beef heifers for 182 days, and even with a reduction in daily weight gain in the last period, the total weight gain/ha reached 726.3 kilograms, that is, even with the reduction in daily weight gain in the last days of grazing, the increase of grazing periods tends to increase the total weight gain (kg/ha).

The dry matter intake of pasture (Table 4) was not affected (P>0.05) by the supplement provision, so that the total dry matter intake also did not change.

Table 2 - Means and regression equations for daily weight gain of heifers receiving different supplements on oat + ryegrass pasture

Treatment	Daily weight gain, kg/day/period				Mean	Standard error
	July 5th -August 1st	August 2nd -August 29th	August 30th - September 26th	September 27th - October 24th		
No supplementation[1]	1.247	1.074	1.196	0.888	1.101	0.05
Megalac®[2]	1.056	1.048	1.281	1.260	1.161	0.05
Brown rice meal[3]	1.083	1.270	0.911	1.171	1.089	0.05
Brown rice meal + Megalac®[4]	1.395	1.069	1.309	1.181	1.238	0.05
Mean	1.242	1.025	1.239	1.083	1.147	-
Standard error	0.04	0.04	0.04	0.04	-	-

P>0.05 for means of the treatments and periods. CV - coefficient of variation.
[1] Y = 2.44337-0.06962*Day+0.00112*Day^2-0.00000552*Day^3 (R^2 = 0.40; CV = 16.60%; P = 0.0273).
[2] Y = 0.95026+0.00302*Day (R^2 = 0.24; CV = 14.95%; P = 0.0079).
[3] Y = 3.29847-0.1147*Day+0.00173*Day^2-0.00000796*Day^3 (R^2 = 0.32; CV = 20.36%; P = 0.01).
[4] Y = 3.22194-0.10313*Day+0.00155*Day^2-0.00000709*Day^3 (R^2 = 0.25; CV = 18.77%; P = 0.0258).

Table 3 - Weight gain (kg/ha/period) and total weight gain (kg/ha) of heifers over the period of pasture use

Treatment	Daily weight gain, kg/day/period				Total weight gain/ha[1]	Standard error
	July 5th -August 1st	August 2nd -August 29th	August 30th - September 26th	September 27th - October 24th		
No supplementation	91.47	71.55	112.07	146.50	421.59	17.02
Megalac®	87.81	67.79	82.07	107.60	345.27	17.02
Brown rice meal	102.45	59.87	84.21	147.76	394.29	17.02
Brown rice meal + Megalac®	117.93	75.25	107.20	172.86	473.25	17.02
Mean[2]	99.92	68.62	96.39	143.68	-	-
Standard error	7.58	7.58	7.58	7.58	-	-

[1] P>0.05.
[2] Y = 165.16996-3.11581*Day+0.02622*Day^2 (R^2 = 0.55; CV = 25.09%; P<0.0001).

Even with a reduction in DM intake of pasture for treatments BRM and BRM+MEG, the provision of the supplement complemented the dry matter intake by heifers. These variables could explain the lack of variation in average daily weight gain, mainly because the TDN content of oat + ryegrass pasture and of the brown rice meal are similar (Table 1). Thus the replacement of the forage by the concentrate had no effect on the increase in average daily weight gain, with additive effect of the concentrates (Table 4).

The dry matter intake of pasture for all treatments of this study is above the level recommended by the NRC (1996), 26.3 g/kg BW. However, the literature has similar, as well as higher data on pasture intake values than those obtained in this experiment. Bremm et al. (2005) found mean value of 38 g/kg BW of pasture dry matter intake for animals without supplementation, and when they received wheat bran corresponding to 10 g/kg BW, the forage intake decreased to 28 g/kg BW, but during the experimental period, these authors observed extreme intake between August 18th and September 14th, 2002, which corresponded to 59 and 53 g/kg for animals not supplemented and supplemented with 5 g/kg BW, respectively. Pötter (2008), grouping several studies in one analysis, found forage intake of 40 g/kg BW for animals exclusively on pasture and 34 g/kg BW for animals supplemented with 9 g/kg BW. The dry matter intake, by the technique used, may be overestimated by errors in estimating initial and final forage production, trampling, insect activity and intake by non-experimental animals (Minson, 1990, apud Pötter, 2008).

The diets did not influence (P>0.05) the circumference of the chest and hip height of heifers at the end of the experiment (Table 5). The final chest circumference showed a high correlation (r = 0.73; P<0.05) with the final weight of heifers, so that, under grazing conditions that do not limit intake, the increase in thoracic perimeter tends to promote greater capacity for DM intake and consequently a better performance from animals, best explained by the correlation between final chest circumference and average daily weight gain, r = 0.42 (P<0.05).

In this experiment, the diets offered had 407.3 g/kg DM of NDF in the maximum, therefore not limiting intake, about which, according to Van Soest (1994) values of 550.0-600.0 g/kg DM of NDF in the diet offered correlate negatively with feed intake. When the hip height was correlated with the final weight, the observed value was of 0.45 (P<0.05), the same found by Thompson et al. (1983) for the same characteristics. The results also agree with Montanholi et al. (2008), in which the assessment of correlations between chest circumference and hip height shows that the perimeter of the chest is a linear measure more appropriate to estimate the live weight than the hip height, because, according to Barker et al. (1988), the size of the skeleton is less susceptible to variations from the medium than the weight, in addition to their earlier maturation.

In the present study, there was correlation (r = 0.65; P = 0.0002) for weight/height and chest circumference and correlation (r = 0.90; P<0.0001) for the weight/height ratio and final weight of the heifers, values below those from Thompson et al. (1983), who found r = 0.85 and r = 0.96, respectively. The weight/height ratio did not differ (P>0.05) between treatments, presenting very close values, showing that body development was similar between heifers. The weight/height ratio can be considered a better estimator of body structure of the animal than its live weight, since it gathers data on body weight, which depends on body composition, with the height, expressing a qualification of the animal size (Barcellos et al., 2003). Thus the average daily weight gain of 1.147 kg for 112 days had an increase of 18 cm in chest circumference and 6 cm in height, so that the weight/height ratio increased from 2.14 to 2.99, demonstrating the structural growth that heifers had prior to mating.

Because the heifers of the present experiment were crossbred Charolais × Nellore, that is, their racial composition leads to animals that tend to have later puberty, especially when compared with animals of European blood, it becomes essential that by the moment of mating, animals have already reached puberty and be on a regular

Table 4 - Estimates of pasture dry matter intake and total dry matter (pasture + supplement) intake, replacement rate and addition rate

Variables	Type of supplements				Standard deviation
	No supplementation	Megalac®	Brown rice meal	Brown rice meal+ Megalac®	
Pasture dry matter (DM) intake, g/kg LW	39.2	40.7	37.7	34.3	0.28
Total DM intake (pasture + supplementation), g/ kg LW	39.2	41.0	45.0	41.7	0.33
Replacement rate, kg	-	0	0.321	0.369	6.43
Addition rate, %	-	100.00	67.87	63.04	6.43

P>0.05.
LW - live weight

cycle. Hall et al. (1995), testing two types of animals with different growth rates, fast and medium, observed difference for the weights at puberty: 390.1 versus 361.7 kg for animals of medium and rapid growth, respectively; however, the age at puberty was similar for both (401.9 vs. 398.5), and the weight/height ratio was the same, 3.1 kg/cm. Fox et al. (1988), in turn, consider the weight/height ratio of 2.77 kg/cm as one of the suitable factors for the onset of puberty in heifers of the intermediate frame. The manifestation of puberty in ½ Charolais ½ Nellore and ½ Nellore ½ Charolais heifers managed on pasture cultivated in two subsequent winter periods occurred when the weight of 346 kg was reached at 20 months (Restle et al., 1999). In the present study, the moment of puberty onset was not verified; however, the animals showed the same weight as reported by Restle et al. (1999), approximately at 60 days of grazing at the same age mentioned by the respective authors.

At the end of the trial, the examination of the reproductive tract pointed to all treatments of score above 3 (Table 5), which, according to Anderson et al. (1991), determines pubertal heifers that can already conceive. The non-occurrence of variation between treatments in reproductive tract score can be explained by the high daily weight gain of more than 1.080 kg, i.e., in favourable environmental conditions for animal performance, the inclusion of concentrate in the diet did not alter the evolution of the reproductive tract. The response obtained in this experiment is consistent with the results of Montanholi et al. (2004) with heifers mating at 18 months, who found that when the average daily gain was higher than 0.700 kg, the reproductive tract score did not change. Even reaching the weight considered suitable for breeding at 18/20 months, 65% of the adult weight, Polled Hereford heifers with average daily gain of 0.137 kg showed less development of the reproductive tract, reproductive tract score of 1.9 in relation to heifers with average daily gain of 0.616 kg, which showed reproductive tract score of 3.5, which resulted in a significant percentage of pregnant heifers, 25 *vs.* 75%, respectively (Souza, 2009).

The development of the reproductive tract presented by heifers in the period before mating was crucial for the high pregnancy rate achieved (Table 5), where all treatments had 100% of pregnancy, with the exception of heifers supplemented only with MEG, which presented 85.71% of pregnancy, without statistical difference between treatments. It is pertinent to note that when an ultrasound was performed to verify pregnancy, it was found that a calf from the MEG treatment had not yet manifested puberty, which contributed to lower pregnancy rate, although it is an exception that is not related to daily supplementation but to specific factors of the animal, since in the treatment BRM + MEG, no variation was observed.

On average, the pregnancy rate of 96.30% is consistent with that reported by Silva et al. (2005), 86.7% in Hereford heifers at 24 months of age and with weight of 350.6 kg at the beginning of the mating. There was the possibility of improvement in the pregnancy rate of heifers in function of the provided supplements, which had high levels of lipids that could have positive effects on the reproduction of heifers, regardless of the input energy, since it has been demonstrated that the use of lipid supplements positively affects important reproductive functions in several tissues, including the hypothalamus, anterior pituitary, ovary and uterus, according to Funston (2004). However, this effect became null due to the non-occurrence of variations in the body, structural and reproductive tract growth of heifers.

Table 5 - Means and standard error of initial and final chest circumference (CC), hip height (HH), gains of CC (GCC) and HH (GHH), weight/height ratio (W/H ratio), pelvic area (PA), reproductive tract score (RTS) and pregnancy

Variables	Type of supplement				Mean	Standard error
	No supplementation	Megalac®	Brown rice meal	Brown rice meal+ Megalac®		
Initial CC, m	1.54	1.55	1.55	1.56	1.55	0.02
Final CC, m	1.74	1.72	1.72	1.74	1.73	0.02
GCC, m	0.21	0.17	0.17	0.18	0.18	0.02
Initial HH, m	1.28	1.28	1.26	1.31	1.28	0.01
Final HH, m	1.33	1.35	1.34	1.33	1.34	0.01
GHH, m	0.05	0.07	0.07	0.04	0.06	0.01
Initial W/H ratio, kg/cm	2.15	2.14	2.16	2.11	2.14	0.07
Final W/H ratio, kg/cm	2.96	2.99	2.95	3.07	2.99	0.09
Initial PA, cm^2	119.14b	159.54a	139.07ab	135.39ab	138.29	8.34
Final PA, cm^2	203.79	194.87	199.34	204.25	200.56	9.47
Initial RTS	3.00	3.00	2.86	3.00	2.96	0.28
Final RTS	3.21	3.29	3.50	3.50	3.37	0.25
Pregnancy (%)	100.00	85.71	100.00	100.00	96.30	-

Means followed by different letters in the row differ (P<0.05) by the t test.

The pregnancy rate observed in this experiment is extremely satisfactory and should be considered as the objective of production systems aiming at the productive efficiency of the dams. The high rate of pregnancy, especially for heifers that will conceive for the first time, should not be the sole purpose during the breeding period; one should seek the conception of the heifers in the initial stage of mating aiming at calving as soon as possible so that the primiparous can recover the body state in time to conceive again in the next mating season.

In this regard, the daily weight gain shown by heifers associated with the structural development and evolution of the reproductive tract was crucial for 88% of heifers conceiving within the first 30 days. This variable is important for the next breeding season, since healthy cows with appropriate nutritional management tend to show estrus from 40 to 50 days postpartum, that is, they will tend to have their cycle regularly in the next breeding season (Rovira, 1996). Another important factor refers to the conception in the initial period of the first mating of heifers, taking effect on the production system, because they will give birth earlier in the birth season of the following year, weaning heavier calves and in greater numbers throughout their productive life (Lesmeister et al., 1973).

Conclusions

Supplementation with brown rice meal and/or protected fat does not interfere in the intake of pasture for heifers or increase the total intake of dry matter, so the average final daily weight gain is not changed. The use of temperate pasture with or without supplementation promotes proper development of the structure and reproductive tract of heifers, improving the animal performance indexes in the first mating at 25/27 months of age.

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