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Effect of supplementation during breeding on the performance of heifers mated at 13/15 months of age

Efeito da suplementação durante a recria no desempenho de novilhas acasaladas aos 13/15 meses de idade

José Fernando Piva Lobato[1]*; Marcos Bernardino Alves[2]; Lidiane Raquel Eloy[2]; Luciana Pötter[3]; Bruna Fernandes Machado[4]; Sheila Cristina Bosco Stivanin[2]; Viviane da Silva Hampel[2]; Maria Eduarda Cocco Dallanóra[4]; Ricardo Zambarda Vaz[5]

Highlights

Energy supplements during breeding determine early puberty.
Sexual precocity requires weight and body condition scores.
The body condition score at weaning can predict pregnancy at 13/15 months of age.
Greater development during breeding determines reproductive success.

Abstract

The aim of this study was to evaluate the performance of beef heifers at 13/15 months of age from weaning to the end of the reproductive season, submitted to three feeding systems during the winter months following weaning: a pasture of black oats (*Avena strigosa* Schreb.) and ryegrass (*Lolium multiflorum* Lam.) (RYE), a pasture of black oats and ryegrass supplemented with wheat bran (WB) at 1% of body weight, and a pasture of black oats and ryegrass with wheat bran (WB) at 1% of body weight and 200 ml/head/day crude glycerine (WBG). Supplementation had no effect on the pregnancy rate of pubescent heifers prior to the reproductive season, but resulted in more pubescent heifers and higher rates of conception during the first 21 days after mating. Pregnant heifers, regardless of treatment,

[1] Prof. Titular, PhD, Department of Animal Science, Universidade Federal do Rio Grande do Sul, UFRGS, Porto Alegre, RS, Brazil. E-mail: jose.lobato@ufrgs.br
[2] Researchers Dr[as], Department of Animal Science, UFRGS, Porto Alegre, RS, Brazil. E-mail: marcos.alves@siabrasil.com.br; lidianeloy@hotmail.com; sheila_bosco@hotmail.com; vivihampel@hotmail.com
[3] Prof[a] Dr[a], Department of Animal Science, Universidade Federal de Santa Maria, UFSM, Santa Maria, RS, Brazil. E-mail: potter.luciana@gmail.com
[4] Researchers Mscas, Department of Animal Science, UFSM, Santa Maria, RS, Brazil. E-mail: brunafmachado17@gmail.com; dudinhacocco@yahoo.com.br
[5] Prof. Dr., Department of Animal Science, UFSM, Campus Palmeira das Missões, RS, Brazil. E-mail: rzvaz@terra.com.br
* Author for correspondence

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show better phenotypic characteristics for conformation, precocity, musculature and size at weaning, a higher average daily gain and body condition score at the start and end of the feeding systems, and at the start of the reproductive season, which allows younger heifers to be placed in gestation feeding systems at 13/15 months of age. Herds where pregnancy has stabilised at two years of age require selection for greater sexual precocity and pregnancy at 13/15 months of age, for which weaning weight is a good predictor.
Key words: Average daily gain. Body weight. Conception. Crude glycerine. Feeding systems. Pregnancy rate.

Resumo

O objetivo do estudo foi avaliar o desempenho de novilhas de corte do desmame ao fim do período reprodutivo aos 13/15 meses de idade submetidas a três sistemas alimentares nos meses de inverno após o desmame: pastagem de aveia preta (*Avena strigosa* Schreb.) e azevém (*Lolium multiflorum* Lam.); pastagem de aveia preta e azevém mais suplementação com 1% do peso corporal com farelo de trigo (FT); e pastagem de aveia preta e azevém mais suplementação de 1% de peso corporal com farelo de trigo e 200 ml/cabeça/dia de glicerina bruta (FTG). As suplementações não afetaram a taxa de prenhez das novilhas púberes anteriormente ao período reprodutivo, mas determinaram mais novilhas púberes e maior concepção nos primeiros 21 dias do acasalamento. Novilhas prenhes, independentes dos tratamentos, possuem melhores características fenotípicas de conformação, precocidade, musculatura e tamanho já ao desmame, maior ganho diário médio e condição corporal ao início e fim dos sistemas alimentares e início da temporada reprodutiva, o que permite uma seleção prévia, a idades menores, das bezerras a serem postas em sistemas alimentares para prenhez aos 13/15 meses de idade. Rebanhos com prenhez estabilizada aos dois anos de idade necessitam de seleção para maior precocidade sexual e prenhez aos 13/15 meses de idade, podendo o peso ao desmame ser um bom preditor.
Palavras-chave: Concepção. Ganho diário médio. Glicerina bruta. Peso corporal. Sistemas alimentares. Taxa de prenhez.

Introduction

Livestock farming in Brazil has evolved over the last fifty years, an evolution achieved through the generation and introduction of technology into production systems, reducing the age of slaughter in males and of the first mating in heifers (Associação Brasileira das Indústrias Exportadoras de Carne [ABIEC], 2023). Although livestock farming has evolved, in the south of Brazil there is still a need for improved indicators. A significant number of unselected or under-developed females are still found in herds, making early pregnancy impossible and contributing to the poor reproductive rate that is incompatible with developed livestock production (Vaz & Lobato, 2024).

Full-cycle herds with reproductive rates of 78%-80% can reach an exploitation rate of 28%-29% when heifers and steers are sent for reproduction or slaughter, respectively, at two years of age (Pötter et al., 2010). Pregnancy at two years of age is already achieved by numerous breeding

systems, which, in order to evolve and increase productivity, need to bring the age of first mating forward to 13/15 months (Beretta et al., 2001). Pregnancy in heifers of 13/15 months of age is the result of a combination of genetics for greater weight gain, level of nutrition, animal handling and health control (Vaz et al., 2012). Higher weaning weights followed by adequate supplies of forage are necessary to ensure a better body condition score and constant weight gain in heifers (Landarin et al., 2016). However, in subtropical climates management tools necessary to achieve development goals, where supplementation can support a more-constant weight gain, ensuring the necessary body development (Martini et al., 2023) to obtain adequate reproductive rates and exploit the limits of early puberty.

There is a variety of literature relating to the use of supplements derived from grains or their by-products to accelerate puberty in grazing cattle (Landarin et al., 2016; Martini et al., 2023). The increase in biodiesel production generates crude glycerine as a sub-product, from which ruminants can synthesise glycerol for use as a precursor of glycogen (Chung et al., 2007). Glycerine can therefore be included in diets as an energy ingredient. However, few studies have been carried out in beef cattle, tending to be in dairy cattle in vitro and in confinement (Peripolli et al., 2014; Botini et al., 2015).

Assuming that crude glycerine is one alternative for enhancing supplements in grazing animals, studies are needed to quantify the benefits, and find alternatives for increasing the pregnancy rate of heifers of 13/15 months. The aim of the present study was to evaluate the use of supplements and crude glycerine on the performance of beef heifers kept on pasture, with a view to mating at 13/15 months of age.

Material and Methods

The study was conducted at Granja Itu, in the district of Itaqui, Rio Grande do Sul, located in the physiographic region of the western frontier, at 29º07′ S and 55º36 W. According to the Köppen classification, the climate in the region is humid subtropical (Alvares et al., 2013). The soil is classified as dystrophic arenic (Empresa Brasileira de Pesquisa Agropecuária [EMBRAPA], 2018). The study was approved by the Ethics Committee for Animal Experimentation of the Federal University of Pelotas (approval number CEEA 8250-2015) and was developed considering domestic guidelines for the care and use of animals.

The study included 120 Braford heifers with an average weaning weight of 170.0±3.8 kg (03/2021). From weaning to the start of the feeding systems (03/2021 to 05/2021), the heifers grazed for 90 days on previously deferred Tifton 85 (*Cynodon* spp) with an average forage mass availability of 2500 kg DM/ha, ending the period prior to the feeding systems with 227.8 ± 4.71 kg. From June to October 2021, the heifers were submitted to the following feeding systems: a pasture of black oats (*Avena strigosa* Schreb.) and ryegrass (*Lolium multiflorum* Lam.), a pasture of black oats and ryegrass supplemented with wheat bran at 1% of body weight, a pasture of black oats and ryegrass supplemented with wheat bran at 1% of body weight with an additional 200 ml/head/day of crude glycerine.

The experimental area consisted of three paddocks, each of 11 hectares, which were planted on the same day in April with black oat and ryegrass seeds at a rate of 80 and 30 kg/ha, respectively. When planting, 200 kg/ha 16-16-16 fertiliser was applied, with two applications of 60 kg/ha urea (45-00-00).

Grazing was continuous with a variable number of animals to maintain forage mass between 1,500 and 2,000 kg DM/ha. The forage mass (kg/ha DM) was determined every 28 days by visual estimation with double sampling. At the same time, the canopy height (cm) was measured at the same points used to estimate the forage mass. Using the technique of simulated grazing (Lista et al., 2007), forage samples were taken to determine the forage consumed by the heifers. The forage samples were used to determine the levels of dry matter, organic matter, mineral matter, crude protein (Association of Official Analytical Chemist [AOAC], 1995) and neutral detergent fibre (Senger et al., 2008). The rate of forage accumulation (RFA, kg DM ha/day) was determined using three exclusion cages per experimental unit. The stocking rate was determined as the sum of the average weight of the test animals, plus the average weight of the control animals multiplied by the number of days they remained in the paddock and divided by the total number of days in the period.

The heifers were weighed at the start and end of the feeding systems and the start and end of the reproductive season. The heifers were weighed every 28 days between the first and last weighing of each period (to adjust the stocking rate). Each weighing was carried out after a 12-hour fast from liquids and solids. The average daily gain was obtained from the difference between the final and initial weight in each experimental period, divided by the number of days in the period. The body condition score was also assessed when weighing, with values ranging from 1.0 to 5.0, where 1 = very thin and 5 = obese (Lowman et al., 1976). The reproductive-tract score was determined by palpation, with the heifers classified as pubescent with a score of 4 or 5, prepubescent with a score of 3, and infantile with a score of 1 or 2 (Gutierrez et al., 2014). At the same palpation, the characteristics of the ovaries were assessed for the presence or absence of a corpus luteum.

Following the period of supplementation on winter-spring pasture, the heifers classified as pubescent and prepubescent were grazed on an area of Tifton 85 where they were exposed to reproduction for a period of 82 days (October to December). Breeding was by natural mating employing three bulls with an average age of three years (3% breeder percentage), each of which underwent an andrological examination. The reproductive season was divided into four oestrous cycles of 21 days to estimate the conception period. The pregnancy rate was determined by ultrasonography 60 days after the end of the breeding season. To estimate the date of conception, 292 days, equal to the gestation period of Braford cows, were subtracted from the calving date (Sawyer et al., 1991).

The pelvic area (cm2) was determined 60 days after the reproductive season, using a rectal pelvimeter to measure the distances between the ileum (in the medial part of the bone) and the pubis and sacrum. At the start of the feeding systems, the heifers underwent phenotypic evaluation for conformation, precocity, musculature and size (CPMS), with scores ranging from 1 to 5, where 1 is inferior and 5 is superior (Programa de Melhoramento de Bovinos de Carne, 2022).

A completely randomised experimental design was used to analyse the effect of the different supplements. To compare the feeding systems, the variables that showed normality were submitted to analysis of variance using the *Mixed* procedure of the SAS statistical software (2011), v 9.4, as per the mathematical model:

$$Yij = \mu + P_i + SUPL_j + P*SUPL_{ij} + eij;$$

where: Y_{ij} = value of the dependent variable of the k-th heifer, μ = overall mean; i-th P (1, 2, 3 ...) = period of supplementation; j-th SUPL effect of using supplements, where 1 = no supplements, 2 = wheat bran supplement, 3 = wheat bran + crude glycerine supplement; $P*SUPL_{ij}$ effect of the period x supplement interaction; e_{ij} = effect of the random error associated with each observation Y_{ij}. Continuous response variables with a normal distribution were analysed considering an unequal number of replications, and evaluated by t-test. The pregnancy rate was analysed by chi-square test, also at a level of 5%.

Results and Discussion

The heifers in the different feeding systems grazed black oat and ryegrass paddocks with an average forage mass of 1.680 kg DM/ha, canopy height of 17 cm, and rate of forage accumulation of 40 kg DM/ha/day. The quality of the forage offered to the heifers in the three feeding systems, measured by simulated grazing, showed a respective average content of 19.7%, 57.8%, 73.8% and 69.3% for crude protein (CP), neutral detergent fibre (NDF), in-vitro organic matter digestibility (IVOMD) and total digestible nutrients (TDN) (Table 1).

Post-weaning development is important in production systems where pregnancy occurs at 13/15 months of age, and should not restrict animal development. For proper development, the qualitative characteristics of the pasture should meet the requirements of the animals. The average qualitative values for the black oat and ryegrass pasture were higher for crude protein and lower for TDN than those recommended by the National Research Council [NRC] (2016) as the daily nutritional requirements for the proper development of heifers with a view to mating at 13/15 months of age, which are 15.1% and 77.0%, respectively. It is expected that forage plants in temperate climates present high levels of crude protein, as they have an excess of degradable protein during the initial growth stage; this is not the case with the energy content of the pastures (Pereira et al., 2021).

Table 1
Percentage of dry matter (DM), crude protein (CP), in-vitro organic matter digestibility (IVOMD) and total digestible nutrients (TDN) in black oat and ryegrass pasture determined by simulated grazing in feeding systems solely on pasture or with supplements

Variable	Feeding Systems/Periods			Mean
	Pasture only			
	June	July	August	
DM	87.7	87.1	89.9	88.2
CP	23.4	18.5	16.8	19.5
IVOMD	77.0	73.4	70.1	74.8
TDN	70.2	69.5	68.4	69.3
	Pasture + supplement[1]			
	June	July	August	
DM	87.9	88.1	88.7	88.2
CP	21.4	20.1	16.4	19.3
IVOMD	77.6	73.8	69.3	73.5
TDN	71.3	69.2	68.0	69.5
	Pasture + supplement[2]			
	June	July	August	
DM	88.4	88.8	90.0	89.0
CP	23.8	20.3	16.1	20.0
IVOMD	76.9	73.1	69.8	73.2
TDN	69.9	68.9	68.2	69.1

1 – Supplemented at 1% of body weight with wheat bran; 2 – Supplemented at 1% of body weight with wheat bran + 200 grams of crude glycerine.

At the start of the feeding systems on winter-spring pasture, supplemented heifers had a higher average daily gain (ADG) than those fed exclusively on pasture (P=0.0206), with gains 19% and 13% higher, respectively, for heifers supplemented with wheat bran and with wheat bran and crude glycerine, albeit with a similar body condition score (BCS) (Table 2). During the second period, heifers grazing exclusively on pasture had a higher ADG than those supplemented with wheat bran and crude glycerine (P=0.0281), and did not differ from heifers supplemented with wheat bran only, again with a similar BCS. During the third grazing period, supplemented heifers again obtained a higher ADG compared to those fed exclusively on pasture (P=0.0001), with a respective advantage of 68.95% and 63.56% for heifers supplemented with wheat bran or with wheat bran and crude glycerine.

The varied performance of the heifers in the present study is due to the nutritional value of the pasture, which decreases as the phenological cycle of the annual species progresses (Martini et al., 2023), as found in

the present study. However, the performance of the heifers was not impaired by the use of supplements. As such, a different supplementation frequency might be used in production systems on winter-spring pastures to maintain the nutritional level of the diet in line with acceptable performance (Frizzo et al., 2003; Rosa et al., 2010). Under more-intensive livestock systems in regions with consistent variations in climate and consequent effects on the supply of forage, producers need to have supplementary feed available to ensure consistent weight gain and body development in grazing animals (Martini et al., 2023) that are subject to constant climate adversity and, as a result, nutritional variation (Vaz et al., 2013).

Table 2
Mean and standard error for the evolution of average body weight, average daily gain and body condition score in heifers submitted to different feeding systems prior to mating at 13/15 months of age

Variable	Feeding Systems/Periods			Mean
	Pasture only[1]	Pasture + WB[2]	Pasture + WB e CG[3]	
Body weight, kg				
Start SA (junho)	226.5±4.77	229.1±4.77	228.0±4.71	0.9147
July	254.1±5.03	263.2±5.03	259.5±4.97	0.8712
August	280.1±5.37	288.1±5.37	281.9±5.31	0.9798
September	298.5±5.53	319.1±4.95	311.9±4.79	0.1364
Average daily gain, kg				
June	0.920±0.06b	1.136±0.06a	1.049±0.06a	0.0206
July	0.868±0.04a	0.831±0.04ab	0.746±0.04b	0.0281
August	0.612±0.04b	1.034±0.04a	1.001±0.04a	0.0001
Body condition score, points				69.5
Initial (June)	3.79±0.02	3.83±0.02	3.82±0.02	0.2015
July	3.87±0.02	3.91±0.02	3.90±0.02	0.5136
August	3.90±0.03b	3.97±0.03a	4.00±0.04a	0.0419
September	3.90±0.03b	3.97±0.03a	3.99±0.03a	0.0247
TDN	69.9	68.9	68.2	69.1

**Probability; 1 Oat and Ryegrass Pasture, 2 Oat and Ryegrass Pasture + Wheat bran; 3 Oat and Ryegrass Pasture + Wheat Bran + Crude Glycerine.

The greater weight gain in animals supplemented during the initial period of the feeding systems is due to the increased nutrient intake afforded by the supplements. Although the oat and ryegrass pasture is an excellent source of forage and affords the animals satisfactory gains, grain supplementation can help increase animal performance. By-products containing high concentrations of digestible fibre, such as wheat bran, have fewer negative associative effects on fibre digestion than supplements rich in starch (Pötter et al., 2010; Martini et al., 2023). The greater gains in supplemented heifers at the start of the pasture production cycle are due to the low dry matter content of the pastures at that time, where the supplements allow the heifers to ingest more nutrients (Frizzo et al., 2003; Gonzalez et al., 2016).

By the end of the feeding systems, the supplemented heifers again achieved a higher average daily gain than those fed exclusively on pasture. This greater weight gain is due to the conditions of the forage, where a reduction in the quality of the pasture at the end of the phenological cycle, including an increase in the level of dry matter and a reduction in IVOMD, was met by supplementation (Gonzalez et al., 2016; Martini et al., 2023). Thus, the initial idea of using supplements to achieve greater gains is validated, allowing pasture consumption to be replaced by supplement intake for similar rates of forage accumulation (Pötter et al., 2010; Martini et al., 2023). In the present study, the use of supplements allowed an average stocking rate of 1024.7 kg/ha body weight, while for animals fed exclusively on pasture, the average stocking rate was 917.0 kg/ha.

In the last two evaluations within each feeding system, the BCS of the supplemented heifers was higher than that of the heifers fed exclusively on pasture (P=0.0419 and P=0.0247, respectively). By the end of the feeding systems, the better body condition score of the supplemented heifers was due to the greater energy provided by the supplements. The associative effects produced by the use of supplements are the result of the interaction between the quality of the pasture, the supplement, and the potential for weight gain of the individuals exposed to these systems (Martini et al., 2023). As mentioned above, the weight gain of an individual is often not increased by supplementation, as the animal has a predetermined potential for weight gain. Supplementation can, however, change the composition of the weight gain, where instead of a numerical increase, the gains include a higher proportion of fat. It should be noted that a minimum concentration of body fat is necessary for reproduction in beef cattle, especially for determining puberty and pregnancy at an earlier age, as in the present study (Terry et al., 2021).

By the end of the feeding systems in early September, at 14 months of age the average body weight for each batch of cows was 60.91%, 65.12% and 63.65% of the adult body weight, considering a weight of 490 kg for the adult cows on the farm with a body condition score between 4.0 and 5.0. Of these percentages for heifer body weight, those of heifers fed exclusively on pasture were in line with the 60% of adult weight recommended for Bos taurus heifers, but below the 65% recommended for Bos indicus (NRC, 2016). Supplemented heifers showed an average percentage adult weight that was between

those recommended for Bos taurus and Bos indicus (NRC, 2016). The body weight recommendations for heifers in relation to the adult weight of cows are important for proper development after the first mating, ensuring the heifers grow into cows that are capable of sufficient production. Early pregnancy such as in the present study, under non-ideal developmental conditions, impair the development of the heifers and their future as breeding stock for the herd (Terry et al., 2021).

Heifers that received supplements showed no difference in the percentage of pubescent animals by the end of the feeding systems (Table 3; P>0.05); there was, however, a higher percentage of pubescent animals than in those fed exclusively on pasture (P<0.05), where 76.75% were considered pubescent, with a reproductive-tract score of 4 or 5 (Gutierrez et al., 2014). This percentage is very important in production systems, since pubescent heifers of 14 months of age at the start of the reproductive season have a higher pregnancy rate than non-pubescent heifers. Holm et al. (2009) found that 75 per cent of females considered pubescent (a score of 4 or 5) became pregnant within the first 50 days of the mating season, whereas non-pubescent heifers before the start of the reproductive season had pregnancy rates of 31%, 40% and 53%, for a score of 1, 2 and 3, respectively.

Table 3
Reproductive performance of heifers submitted to different pre-mating feeding systems

Feeding System	Pubescent, (N)%	Pregnancy, (N)%
Pasture of black oats and ryegrass	(24)60.00[b]	(19)79.17[a]
Pasture + WB supplement	(32)80.00[a]	(26)81.25[a]
Pasture + WBCG supplement	(29)72.50[a]	(22)75.86[a]

[a,b] in a column differ (P<0.05) by the Chi-square test. WB - wheat bran; WBCG - wheat bran + crude glycerine.

When evaluating different levels of supplementation during breeding on oat and ryegrass pasture with the aim of mating Charolais and Nellore heifers and their crossbreed calves at 13/15 months of age, Frizzo et al. (2003) found that supplementation was a determining factor in accelerating puberty. Before the start of the reproductive season, 70.0% of the supplemented heifers, regardless of the level of supplementation, were on heat, while only 9.0% of heifers fed exclusively on pasture were on heat (Frizzo et al., 2003). Early puberty is important for the reproduction of heifers mated at 13/15 months of age, since fertility during oestrus increases until the third oestrus after the pubertal oestrus, requiring females to reach puberty approximately 60 days before the start of the reproductive season (Fonseca et al., 2020). Corroborating these reports, Sartori et al. (2024), working with hormonal induction, found they could anticipate the first ovulation, but were unable to guarantee regular oestrous cycles.

There was no difference in the pregnancy rate of the pubescent animals between feeding systems, whether supplements were used or not (P>0.05). This was expected, since it had been decided to expose only pubescent heifers to reproduction following the end of the feeding systems.

During the first reproductive season at 13/15 months of age, the feeding systems presented differences in the rate of conception (Table 4), which for supplemented heifers was higher during the first 21 days of reproduction compared to heifers fed only on pasture (P<0.05). During the second oestrous cycle between days 21 and 42 of the mating season, the rate of conception was reversed, being higher for heifers fed exclusively on pasture than heifers that received supplements (P<0.05); there was no difference between feeding systems during the third oestrous cycle from day 42 to 63 (P>0.05). No conceptions were noted during the fourth period, from day 63 to 84. In the present study, the supplemented feeding systems made early pregnancy possible during the mating season. The 93% increase in conception during the first 21 days in heifers that received supplements was due to the increase in energy consumption from the supplement. According to Ferreira et al. (2024), the higher energy intake increases fat deposition and results in the oestrous cycles of the heifer being brought forward. Supplementation can therefore have a positive effect on conception, mainly due to the higher energy intake of the animals.

Table 4
Distribution of conception by oestrous cycle of heifers submitted to different pre-mating feeding systems

Feeding System	Conception, (N)%		
	21 days	42 days	63 days
Pasture of black oats and ryegrass	(5)26.3[b]	(10)52.6[a]	(4)21.1[a]
Pasture + WB supplement	(13)50.0[a]	(10)38.5[b]	(3)11.5[a]
Pasture + WBCG supplement	(13)59.1[a]	(5)22.7[b]	(4)18.2[a]

[a,b] in a column differ (P<0.05) by the Chi-square test. WB - wheat bran; WBCG - wheat bran + crude glycerine.

The higher rate of conception during the second period of the oestrous cycle of heifers fed exclusively on pasture can be explained in the present study by the fact that only heifers considered pubescent at the start of the reproductive season were exposed to reproduction. The lower rate of conception during the third period, and the lack of pregnancy during the fourth and final period in the three feeding systems shows the length of the reproductive season. Heifers, therefore, need to reach puberty earlier, meaning that the herd requires further selection for sexual precocity, and showing that the livestock industry is still evolving. When evaluating weight gain pre-

and post-weaning, and mating Charolais and Nellore heifers and their crossbreeds at 13/15 months, Vaz et al. (2012) found that greater pre- and post-weaning development determined that more heifers were on heat during the first third of the reproductive season. It should be noted that heifers that conceive at the start of the reproductive season and consequently calve at the start of the calving season have the highest pregnancy rate when primiparous (Sartori et al., 2024), allowing for a greater number of days from calving to the end of the second reproductive season (Reis et al., 2023; Vaz et al., 2023).

Heifers under the different feeding systems had an average pregnancy rate of 78.65%, with no difference between the systems. This similarity in pregnancy rates between the different feeding systems was expected, since, as mentioned above, only heifers considered fit to become pregnant based on the reproductive-tract score prior to mating were exposed to reproduction. The average body weight of 318 kg together with a body condition score of 3.9 at the start of the reproductive season are below what was expected, since this body weight corresponds to 64.49% of the adult weight of the females in the herd. Low pregnancy rates are not consistent with greater economic or biological efficiency, nor with successful mating at 13/15 months of age. Herds should therefore be selected for early puberty, since puberty is inherent to the genetics of the breed or herd, where heifers have a genetically predetermined minimum age at puberty (Brunes et al., 2024). In evolving herds, where reproductive performance is suboptimal, it is necessary to select for greater fertility sufficient for a positive response, based on high heritability.

The results of the present study underline the importance of greater development and of conception at the start of the first reproductive season when mating heifers at 13/15 months of age, since after calving, in addition to the requirements of maintenance, lactation and subsequent reproduction, as occurs in adult cows, primiparous cows are still growing (Freetly et al., 2011).

A retrospective evaluation of the development of the heifers showed that at weaning, and regardless of the feeding system, those that would later become pregnant had better phenotypic scores for conformation, precocity, muscularity and size (CPMS), and higher body weights at weaning and at the start of the feeding systems (Table 5). Visual scores for these characteristics are an important tool for use in selection in order to identify animals of better zootechnical type and greater sexual precocity, affording a greater chance of a good productive response (Vaz et al., 2012).

Table 4
Mean and standard error for the unified conformation, precocity, musculature and size score (CPMS), weights and body condition scores during development from weaning to the end of the first reproductive season at 13/15 months of age in pregnant and non-pregnant heifers

Variable	Pregnant	Non pregnant	P**
CPMS at weaning	3.48±0.07	2.91±0.07	0.0010
Body weight, kg			
Weaning	174.7±0.24	146.5±0.24	0.0002
Start of the feeding systems	242.9±0.25	214.3±0.25	0.0006
Start of the reproductive season	320.4±0.27	309.7±0.27	0.0758
End of the reproductive season	339.5±0.21	325.2±0.26	0.0530
Body condition score, points			
Start of the feeding systems	3.85±0.01	3.78±0.01	0.0509
Start of the reproductive season	4.01±0.02	3.90±0.01	0.0795
End of the reproductive season	4.00±002	3.93±0.01	0.0032
Average daily gain, kg			
From weaning to the start of the feeding systems	0.568±0.023	0.565±0.022	0.9387
During the feeding systems	0.861±0.019	0.795±0.016	0.0487
During the reproductive season	0.227±0.010	0.185±0.009	0.0321

**Probability; CPMS - conformation, precocity, musculature and size in calves assessed at weaning.

Heifers that conceived were heavier, with a better BCS at the end of the reproductive season, and achieved greater average daily gains throughout the feeding systems during breeding and during the reproductive season at 13/15 months of age. The results of the present study show the importance of weight, body condition score and average daily weight gain for whether heifers become pregnant or not, regardless of the use of different feeding systems. Similar results were found by Vaz et al. (2012), who reported that heifers that did not conceive had less weight at weaning until the end of the mating season. These results show that females with less weight at weaning require different handling, to offer better conditions for body development and a greater probability of pregnancy (Eloy et al., 2022). The fact that there are differences in the weight gain of pregnant or failed beef heifers highlights the importance of continuous development during early mating, where both puberty and mating are delayed by poor nutrition (Sartori et al., 2024).

Knowledge and the study of animal growth are important, allowing the producer to identify the most productive animals at a younger age with some degree of certainty, and to make important decisions as early as weaning on whether to invest in the mating of heifers at 13/15 months of age.

Conclusions

The use of crude glycerine as an additional source to wheat bran in energy supplementation has no effect on the development and reproductive performance of heifers at 13/15 months of age.

With no limitations on the supply of forage during the growth of heifers mated at 13/15 months of age, the use of supplements determines earlier puberty, but has no effect on the pregnancy rate of pubescent heifers. It does, however, determine earlier conception during the reproductive season.

Pregnant heifers have better phenotypic characteristics in terms of conformation, precocity, musculature and size at weaning, and perform better during the growth phase and reproductive season at 13/15 months of age.

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