



Performance of Braford steers grazing on cultivated pastures and fed or not fed an energy supplement

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ABSTRACT - This experiment evaluated the performance of 84 Braford steers grazing on summer and winter cultivated pastures fed or not fed an energy-protein supplement. Steers were 10 months old and weighed, on average, 165 kg at the beginning of the trial. Steers grazed on cultivated winter pasture, consisting of black oats (*Avena strigosa*) and ryegrass (*Lolium multiflorum* Lam.), and then on cultivated summer pasture, consisting of Napier grass (*Pennisetum purpureum*). The following treatments were applied: SS – supplement was fed during both seasons; SN – supplement was fed only during the winter; NS – supplement was fed only during the summer; and NN – steers were not fed any supplement. Supplementation resulted in higher body weight and better body condition score (SS: 369.2 and 4.52; SN: 335.2 and 4.01; NS: 352.5 and 4.49; SS: 322.5 and 3.83). *Longissimus dorsi* area was larger in supplemented steers, which also presented thicker backfat when compared with those not fed any supplement (3.67 and 2.29 mm, respectively).

Key Words: black oats, body condition, body weight, Napier grass, weight gain

Introduction

In beef cattle production systems, reducing market age allows for profiting from the better feed efficiency of young animals. According to Restle et al. (1999b), feed efficiency worsens as steers age, consequently increasing production costs. The production system is more biologically efficient and beef quality is better when steer market age is reduced (Costa et al., 2002).

However, it is only possible to market younger steers when health and nutritional management is efficient. The low nutritional levels to which steers are subjected are the main cause of older ages in the market. Improvements in production systems, such as grazing on cultivated pastures (Müller & Primo, 1986) and feeding silage in feedlots (Restle et al., 1999b) reduce steer market age.

It must be considered, nevertheless, that some technologies, such as the establishment of new cultivated pasture areas, are sometimes unaffordable. Therefore, the use of cultivated pastures to take advantage of the weight gain or gain per area potential of steers needs to be maximized, and an excellent alternative is energy-protein supplementation (Restle et al., 1999a).

The present experiment evaluated the performance and carcass traits of Braford steers grazing on summer and winter cultivated pastures and fed or not fed an energy-protein supplement.

Material and Methods

The experiment was carried out on Itú farm, located in Itaqui, state of Rio Grande do Sul, Brazil, 29° 12' south latitude and 55° 36' west longitude. The relief is hilly, with deep, naturally acid soils presenting intermediate superficial texture. The soil is classified as a dystrophic red latosol (EMBRAPA, 1999) and the climate is subtropical, according to the Köppen classification (Moreno, 1961).

In this trial, 84 Braford steers weaned at 60-70 days of age were randomly chosen from the commercial herd of the farm at an average age of ten months and 165 kg initial average weight.

The trial was carried out during two seasons: winter and subsequent summer. All steers grazed on cultivated winter pasture and then on cultivated summer pasture, and the difference among treatments was the supply or absence of supply of an energy supplement, consisting of soybean hulls, at 7.0 g/kg. The following treatments were applied: SS – the supplement was fed during both seasons; SN – the supplement was fed only during the winter; NS – the supplement was fed only during the summer; and NN – steers were not fed the supplement.

Animals were weaned in the second half of December. They were kept on Napier grass (*Pennisetum purpureum*) pastures and fed a ration (10 g/kg) containing 180 g crude

protein/kg dry matter and 750 g total digestible nutrients (TDN)/kg dry matter until May.

Two six-hectare paddocks were used for the management of the winter and summer pastures. Paddocks were divided with an electric fence and were grazed every other week to eliminate the effect of paddock. Both paddocks allowed access to a supplement trough. Winter/spring pasture consisted of a mixture of black oats (*Avena strigosa*) and ryegrass (*Lolium multiflorum* Lam.), and summer pasture consisted of Napier grass (*Pennisetum purpureum*).

Pastures were managed at stocking densities that provided *ad libitum* pasture allowance and that also ensured pasture maintenance. Whenever necessary, extra steers were used to control pasture development in order to allow proper forage availability management.

Winter pasture was planted by no-tillage on April 15, with densities of 80 kg black oats/ha and 40 kg ryegrass/ha. Ryegrass was sod-seeded at 620 g/kg and subsequently over-seeded at 380 g/kg. For both black oats and ryegrass, the distance between rows was 17 cm. Napier grass pasture was planted on October 10 also using no-tillage, at a density of 40 kg seeds/ha and 35 cm between rows. Both fertilizer placement and top-dressing were performed according to the results of the soil analyses conducted by an accredited laboratory. A commercial formulation with 10-20-20 NPK was applied at 200 kg/ha. Urea was applied by top-dressing twice at 75 kg/ha/application.

Steers grazed for four periods of 21 days each both in the summer and winter pastures. Between grazing periods, steers remained for 40 days on a *Brachiaria brizanta* cv. Marandú pasture, and were not fed any supplement.

The energy-protein supplement consisted of soybean hulls and contained 160 g crude protein/kg dry matter and 670 g TDN/kg dry matter. It was fed once daily immediately after noon in troughs with sufficient space to prevent the expression of dominant behavior at 7 g/kg body weight, on average.

Steers were weighed at the beginning and end of the experimental period and every 21 days to adjust stocking

rate and supplement intake. When steers were weighed, they were also scored for body condition in a 1-5 scale, where 1 = thin, 3 = average, and 5 = fat (Lowman et al., 1973).

Available forage mass (Table 1) was estimated using the comparative method (Haydock & Shaw, 1975). Forage samples were analyzed for crude protein (CP) and neutral detergent fiber (NDF), according to the techniques described by the AOAC (1984) at the Animal Nutrition Laboratory of the School of Agriculture of Universidade Federal do Rio Grande do Sul.

During the entire experimental period, mineral salt was offered *ad libitum*. Steers were vaccinated according to the calendar of the Department of Agriculture of the state of Rio Grande do Sul. External and internal parasites were controlled using specific products as needed.

At the end of the experimental period, muscle development was evaluated by measuring rib eye area (REA) and backfat thickness (BFT) of the *longissimus dorsi* muscle and at the dorsal portion of the *biceps femoris* muscles using an ultrasound equipment. Ultrasound images were acquired and processed (digitalized) using an Aloka SSD 500V scanner (Eletro Medicina Berger, Ltda.), equipped with an UST 5049 linear transducer of 3.5MHz frequency and 17.2 cm length. *Longissimus dorsi* REA and BFT were measured between the 12th and 13th ribs with the aid of an acoustic guide. On the *biceps femoris*, REA and BFT were measured by placing the transducer on the area with the aid of an acoustic guide. Images were stored in the hard disk of a portable computer and processed using the software Animal Ultrasound Service (AUSKey4W, 1994). Only one image per animal was stored for each trait measured by ultrasound.

In the beginning of the summer, after the winter period, animals were evenly redistributed: half of the steers fed the supplement during the winter continued to receive the supplement, while the other half was no longer supplemented. Also, half of the steers that were not fed the supplement during winter was offered the supplement, and the other half was not supplemented for the entire experiment.

Table 1 - Forage mass, crude protein and neutral detergent fiber percentages of the pastures used during the experimental period

	Period	Forage mass (kg/ha dry matter)	Crude protein (g/kg dry matter)	Neutral detergent fiber (g/kg dry matter)
Black oats + ryegrass	August	1354	196	614
Black oats + ryegrass	September	1463	173	576
Black oats + ryegrass	October	1710	124	541
<i>Brachiaria brizanta</i>	November	2450	65.2	684
Napier grass	December	1790	184	664
Napier grass	January	1960	163	593
Napier grass	February	2210	143	504

A completely randomized experimental design was applied, using initial weight as covariate. Data were submitted to analysis of variance, using the least square method. The following model was applied:

$$Y_{ijkl} = \mu + T_i + IW_j + E_{ij}$$

where: Y_{ijkl} = dependent variable; μ = observed mean; T_i = effect of supplementation sequence of the i -th order, with $I = 1$ (supplementation during winter and summer), 2 (supplementation during winter and not during the summer), 3 (no supplementation during winter and supplementation during the summer and 4 (no supplementation); IW_j = effect of the covariate initial weight; and E_{ij} = random error assuming normal distribution with mean equal to zero and variance σ^2 .

When F was significant ($P < 0.05$), means were compared by the test of Tukey at 0.05 significance level. Also, supplemented steers were contrasted with non-supplemented steers within each grazing period. Data were analyzed according to the least square method using the GLM procedures of statistical package SAS (Statistical Analysis System, version 9.2).

Results and Discussion

Qualitative pasture values (Table 1) were consistent with those reported in other studies carried out in the state of Rio Grande do Sul (Roso et al., 2000; Freitas et al., 2005; Pilau & Lobato, 2006), and the small differences possibly result from minor climate and soil fertility variations.

Forage mass gradually increased as pastures matured, presenting 1354 and 1710 kg/ha dry matter and 1790 and 2210 kg/ha dry matter during the first and last assessments conducted in the summer and winter, respectively. The average values of 1509 and 1987 kg dry matter/ha complied with the recommended requirements for steer weight gain (Mott, 1984).

Supplementation promoted higher weight gain regardless of season (Table 2). Supplemented steers gained 20.0, 60.5 and 36.2% body weight during winter, summer, and total experimental period, respectively, relative to non-supplemented steers.

This was due to the higher energy levels supplied. In the beginning of their growth cycle, cultivated pastures usually present protein and moisture surplus, resulting in a relative energy deficit. Also, at later stages, pasture nutrient digestibility is reduced, with consequent nutritional deficit (Freitas et al., 2005). Feed supplements, such as grains and their by-products, supply protein and energy, allowing for the correction of that nutritional imbalance, promoting better animal performance (Restle et al., 1999a).

Winter pastures present high protein content and, according to Freitas et al. (2005), cattle grazing on winter pastures respond to energy supplementation because it promotes better nutritional balance. However, those authors warn us that cattle may replace good-quality pasture intake by supplement intake during the winter.

The higher weight gain of the supplemented steers suggests an additive effect of supplementation on performance. The neutral detergent fiber values obtained showed that pastures presented adequate digestibility, although pasture samples were cut very close to the soil. Nevertheless, it must be considered that the material cattle consume is more digestible due to selective intake (Pilau & Lobato, 2006). The resulting better efficiency and higher weight gain are due to a metabolizable energy intake that exceeds maintenance requirements (Poppi & McLennan, 1995).

When grazing cattle are fed supplements, their behavior changes, with increased rumination, grazing and idle periods (Pilau et al., 2005). Also, cattle tend to move longer during the day, selecting forage to consume higher percentages of leaf blades and plant parts with lower neutral detergent fiber content (Frizzo et al., 2003).

Table 2 - Performance parameter means according to supplementation and season

Period	Supplementation				Standard error of the mean	Probability
	Yes	Yes	No	No		
Winter (black oats+ryegrass)	Yes	Yes	No	No		
Summer (Napier grass)	Yes	No	Yes	No		
Initial weight, winter (kg)	165.4	165.2	163.7	167.3	2.750	0.9287
Final weight, winter (kg)	261.2a	260.0a	245.1b	244.9b	2.317	0.0001
Weight gain, winter (kg)	1.141a	1.129a	0.969b	0.923b	0.028	0.0001
Final weight, summer (kg)	369.2a	335.2c	352.5b	322.5c	4.182	0.0001
Weight gain, summer (kg)	1.016a	0.608b	1.006a	0.654b	0.031	0.0001
Total weight gain (kg)	0.970a	0.899a	0.810b	0.739b	0.020	0.0052
Total weight gain (kg)	203.8a	170.0b	188.8a	155.1b	4.182	0.0001
Initial body condition score ¹	2.83	2.82	2.81	2.81	0.017	0.6599
Final body condition score ¹ , winter	3.44a	3.45a	3.10b	3.07b	0.022	0.0001
Final body condition score ¹ , summer	4.52a	4.02b	4.49a	3.83c	0.046	0.0001

Means in the same row followed by different letters are different ($P < 0.05$) by the test of Tukey.

¹ 1 - very thin; 2 - thin; 3 - average; 4 - fat; 5 - very fat.

Although average pasture residues were relatively high, pasture quality, particularly during the summer, was not adequate because of low rainfall (70 and 14 mm in January and February, respectively), resulting in 0.631 average weight gain in the steers that were not supplemented during the summer. This weight gain can be considered low, and it compromised the performance of steers whose only nutrient source was the pasture.

However, supplementation promoted an additive effect on animal performance. Supplementation of cattle grazing on low-quality and quantity pastures results in better performance (Pilau & Lobato, 2006).

Restle et al. (1999a), in a study with steers grazing on cultivated winter pastures with high average residues that allowed for pasture selection, did not find any performance differences between steers fed an energy supplement at 5 or 10 g/kg body weight. Moore et al. (1999), in a literature review on the energy and protein supplementation of cattle grazing improved or regular natural pastures or cultivated winter and summer pastures, concluded that animals grazing on natural pastures present the best response, provided the quality of the supplement is good. Those authors also mentioned that forage intake was rarely replaced by supplement because cattle grazing on natural pastures almost never reach maximum daily organic matter intake.

In the present study, the steers supplemented during the entire experimental period presented higher average weight gain and final body weight than those supplemented during only one season or not supplemented at all (Table 2; $P > 0.05$).

When supplemented for only one season, the steers fed the supplement during the summer were 5.2% heavier ($P > 0.05$) at the end of the experiment than those supplemented during the winter (352.5 vs. 335.2 kg, respectively). This difference is partially due to the drought that occurred at the end of the summer, which hindered Napier grass growth, accelerating its maturation and consequently reducing its quality. The steers that were fed the supplement received higher nutrient supply, which determined the difference observed in final body weight in relation to those that were not supplemented. Energy-protein supplementation is an alternative during periods when pastures do not present the expected nutritional quality.

Steers grazing on winter pastures and supplemented with 5 or 10 g of ground corn/kg body weight presented similar weight gain to those that grazed exclusively 1.502, 1.532, and 1.598 kg, respectively (Restle et al., 1999a). In high-quality pastures, differences in daily weight gain are not significant whether steers are supplemented or not,

because supplementation is utilized essentially to replace the missing nutrients (Restle et al., 1998; Pilau & Lobato, 2006). However, in cows grazing winter pastures at the end of their growth cycle, supplementation promoted higher weight gain and better body condition (Restle et al., 2001), demonstrating its additive effect.

The effects of supplementation on dry matter intake may be additive, substitutive, both, additive with stimuli or substitutive with reduction (Hogdson, 1990). The effect is additive when nutrient intake from forage is reduced due to low forage quality, short grazing time, etc. This effect increases daily weight gain. On the other hand, when forage quality is good, as in the present experiment, there is a substitutive effect, in which part of forage intake is replaced by supplement intake (Restle et al., 1999a). Supplementation may change forage intake quality and quantity relations according to additive or substitutive effects (Pilau & Lobato, 2006).

Several experiments show that there is no improvement in animal performance with increasing supplementation levels; on the contrary, positive effects when animals fed supplements are compared with those that do not receive supplements (Frizzo et al., 2003; Pilau et al., 2004; Pilau et al., 2005; Freitas et al., 2005). This demonstrates additive effects of supplementation on forage and substitutive effects among supplementation levels. However, other experiments did not report differences between steers supplemented with increasing supplement levels and those exclusively grazing natural pastures, showing that there was only a substitutive effect (Difante et al., 2006).

The effect of substitution of forage by a supplement is important when pasture areas are limiting and the number of animals exceeds the available pasture area. In addition, it is used when stocking rates need to be maintained, despite the variations in forage growth due to weather, trying to maintain dry matter production. When forage allowance is balanced, animals are able to express their full potential for dry matter intake and consequently for weight gain (Restle et al., 2000).

Another aspect of the substitutive effect to be considered in production system is that, despite not increasing individual weight gain, it allows for increasing stocking rate/ha because forage intake is reduced, thereby increasing weight gain/ha (Horn et al., 1995; Frizzo et al., 2003) or the number of finished steers per area (Restle et al., 2000). In the present experiment, it was not possible to measure weight gain per area because the steers remained in the same area, only changing paddocks. Frizzo et al. (2003), working with yearling heifers grazing on black

oats and ryegrass pasture and supplemented at 0, 7, and 14 g/kg body weight, found increasing stocking rates and forage losses inversely proportional to the supplementation levels. However, when stocking rate increased, net profit/ha decreased as the supplementation level increased.

The higher nutritional supply also resulted in higher body condition scores at the end of the experimental periods (Table 2), which is required when marketing steers for slaughter, particularly young steers (Costa et al., 2002).

In the present trial, at the end of the total experimental period, the body condition score of steers that were not supplemented (3.83) did not reach the value required for slaughter (4.0), according to the 1-5 subjective scale of Lowman et al. (1973). High energy supply to young and growing animals through supplementation of concentrates is particularly important when high fat deposition is required, as in the case of finishing steers (Restle et al., 2000).

Body condition score significantly increased ($P<0.05$) when the supplement was fed, as shown by the steers supplemented during the winter and the summer. High energy supply via supplement in association with good quality pasture determined higher fat deposition. Restle et al. (2000), feeding increasing supplementation levels to finishing cows, observed better body condition scores, but not higher weight gains in the supplemented animals.

Muscle development and backfat deposition were influenced ($P<0.05$) by supplementation fed during the winter and the summer (Table 3). The individual comparison of the four treatments showed that the steers supplemented both in the winter and in the summer gained more weight, followed by those supplemented in only one of the season, and lastly, by those that were not fed any supplement. This was reflected on 17.6 and 6.0%, and 60.2 and 74.4% higher muscle development and backfat thickness as measured on the *longissimus dorsi* and *biceps femoris*, respectively. This is a result of the higher dietary energy supply to the supplemented animals, determining different tissue gain composition, with correlations between dietary energy level and muscle development and backfat deposition.

The muscle development observed is consistent with body growth, considering that the steers had not achieved

mature age during the experimental period, and the results also show that it was significantly influenced by feeding level. On the other hand, when supplying increasing supplement levels to mature finishing cows in feedlots or on cultivated pastures, no differences were detected in muscle development, suggesting that dietary energy levels during finishing do not affect this trait (Restle et al., 2001).

Muscle development or fat deposition were not different between steers supplemented in either season, except for fat thickness on the 12th rib, which was greater in the steers supplemented in the period immediately before measurement. The steers supplemented only during the winter may have deposited more fat until the end of the supplementation period, although this was not measured. This extra fat may have been used by metabolism for maintenance and weight gain, as these steers were subjected to worse nutritional conditions during the summer derived from poorer pasture quality and draught periods. When properly fed initially and then subjected to feed restriction situations, young animals tend to use their body reserves to maintain body growth and muscle development (Di Marco, 1998). When evaluating cows at different ages, Restle et al. (2001) observed that young cows presented lower backfat deposition as compared with older cows because of their development stage.

The steers supplemented during both seasons presented higher muscle development and backfat deposition than those supplemented for only one season or those not fed any supplement ($P<0.05$). There was higher influence of supplementation immediately before these traits were measured.

Finishing fat is important because it determines when cattle can be marketed. Supplemented steers presented approximately 3 mm of fat, which is the lower limit for marketing carcasses in more demanding markets (Johnson, 1994), for correct carcass chilling (Vaz et al., 2011), and for adequate meat color (Restle et al., 1999b).

Making steers reach 370 kg at 16-17 months of age under grazing conditions means more area available on the farm before the second winter, allowing for a better distribution of other cattle categories. The supplemented

Table 3 - Muscle development and backfat deposition means measured by ultrasound according to feeding treatments and season

Period	Supplementation				Standard error of the mean	Probability
	Yes	Yes	No	No		
Winter (black oats+ryegrass)	Yes	Yes	No	No		
Summer (Napier grass)	Yes	No	Yes	No		
<i>Longissimus dorsi</i> area (cm ²)	57.5a	54.5a	54.8a	48.9b	0.923	0.0001
Fat thickness at the <i>longissimus dorsi</i> (mm)	3.67a	2.90bc	3.27ab	2.29c	0.200	0.0001
<i>Biceps femoris</i> thickness, cm	7.28	7.07	7.08	6.87	0.132	0.1461
Fat thickness at the <i>biceps femoris</i> (mm)	5.51a	3.95bc	4.73ab	3.16c	0.309	0.0001

Means in the same row followed by different letters are different ($P<0.05$) by the test of Tukey.

steers in the present study presented better muscle development, along with the correct backfat thickness, and thus, adequate market conditions. This demonstrates that it is possible to further intensify production systems to market even younger animals.

The slaughter of young steers of up to 24 months of age adds value to production systems through bonuses paid for carcass quality (Pascoal, 2008), thereby diluting system fixed costs (Vaz et al., 2010). Therefore, in addition to supplementation costs and weight gain, the systemic context of technology should be taken into account, particularly considering the marketing of 15-month-old steers. Production systems should not be analyzed considering only specific aspects of a technology; instead, one should adopt a systemic approach as to its influences on the production system (Vaz et al., 2010).

Conclusions

Supplying steers grazing on winter-spring and summer pastures with an energy-protein supplement (soybean hulls) at 7.0 g/kg body weight increases body weight gain and allows for better muscle development and higher backfat deposition. Higher body weight in 16-month-old steers results in greater backfat deposition and larger *longissimus dorsi* area.

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