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# Non-carcass components of finished feedlot steers fed with slow-release or agricultural urea in substitution of soybean meal

# Componentes não integrantes da carcaça de novilhos terminados em confinamento recebendo ureia protegida ou agrícola em substituição ao farelo de soja

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## Abstract

The effect of termination of steers in a feedlot using the total substitution of soybean meal by slow-release or agriculture urea on the non-carcass components was evaluated. Twenty-seven purebred and Charolais × Nellore castrated crossbred steers (mean age 20 months, mean initial weight 293 kg) were allocated to received concentrates containing slow degradation urea, soybean meal, or agricultural urea. The experimental design was in randomized blocks (breed predominance), with three treatments and nine replicates, with the animal being the experimental unit. Diets did not lead to significant differences in empty body weight (EBW). The similarity between treatments was also verified in relation to EBW/slaughter weight, with mean values of 0.87 for treatments containing urea and 0.88 for soybean meal treatment. The gastrointestinal contents, both in absolute weight and in relation to EBW, were similar between the rations evaluated, with mean values of 54.33 kg and 13.52%, respectively. Steers fed with slow-release urea had a 32.8% higher weight of omasum relative to 100 kg of EBW ($P<0.05$) compared to the animals fed with soybean meal.

**Key words**: Concentrate. Gastrointestinal contents. Fats. Omasum. Blood.

## Resumo

O objetivo do presente estudo foi avaliar o efeito da terminação de novilhos em confinamento, utilizando a substituição total do farelo de soja por ureia protegida ou agrícola sobre os componentes não integrantes da carcaça. Foram utilizados 27 bovinos machos castrados, puros e cruzas Charolês x Nelore, com idade e peso médio inicial de 20 meses e 293 kg respectivamente, distribuídos em três tratamentos: Ureia Protegida – concentrado contendo ureia de degradação lenta; Farelo de Soja – concentrado contendo

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farelo de soja; Ureia Agrícola – concentrado contendo ureia agrícola. O delineamento experimental utilizado foi de blocos ao acaso (predominância racial), com três tratamentos e nove repetições, sendo o animal a unidade experimental. As dietas não proporcionaram diferenças significativas no peso de corpo vazio (PCV). Semelhança entre os tratamentos também foi verificada na relação peso de corpo vazio/peso de abate, apresentando valores médios de 0,87 para os tratamentos que continham ureias e 0,88 para o tratamento farelo de soja. O conteúdo gastrintestinal tanto em peso absoluto quanto em relação ao peso de corpo vazio apresentou similaridade entre as rações avaliadas, com valores médios de 54,33 kg e 13,52%, respectivamente. Os novilhos que receberam ureia protegida apresentaram maior peso de omaso relativo a 100 kg de PCV (P<0,05) em relação aos animais alimentados com farelo de soja, com superioridade de 32,8%.

**Palavras-chave**: Concentrado. Conteúdo gastrintestinal. Gorduras. Omaso. Sangue.

## Introduction

The use of foods that can substitute for more expensive food is becoming increasingly important in beef cattle breeding, especially when the animals are finished in an intensive system. The search for higher productivity and resources that reduce production costs has been the main concern of the agricultural sector, as a consequence of increased competitiveness and the fall in profit margins.

The termination of steers in the feedlot setting requires diets that allow the maximum weight gain so that they meet the conditions of slaughter in the shortest time. Some feedlot food ration ingredients, such as corn and soybean meal, are expensive.

In order to reduce production costs, some companies have developed products to control the release of non-protein nitrogen in the rumen and improve the production of microbial protein, with the goal of replacing soybean meal. Among these products, slow-release urea is an alternative of protein in feed for animals in confinement. The reduced use of urea allows the inclusion of other ingredients and more flexibility in the formulation of rations (MANELLA, 2010).

The substitution of soybean meal for another source of non-protein nitrogen has been evaluated based on animal performance and carcass quality (MANELLA, 2010; MASCARDI, 2009). However, non-carcass components have not been studied. This omission is important, as these components are an important source of revenue for the slaughterhouses, which sell them both domestically and abroad. In recent years, 14% of exports have been guts and giblets from non-carcass components (ABIEC, 2015). The non-carcass components can be between 29.28% and 37.16% of the slaughter weight (SW) (MENEZES et al., 2007), and are a source of income for industry. In addition, from the producer's point of view, the non-carcass internal organs, which include the head, hide, blood, paws, and visceral fat, are important because they tend to vary according to breed and diet, and directly influence carcass yield (MACITTELI et al., 2005).

The objective of this study was to evaluate the effect on non-carcass components in feedlot-terminated steers of the complete substitution of soybean meal with slow-release or agricultural urea.

## Material and Methods

The experiment was carried out from August to December 2014 at the Laboratório de Bovinocultura de Corte (LBC), belonging to the Department of Animal Science of the Federal University of Santa Maria, located in the municipality of Santa Maria, Rio Grande do Sul.

Twenty-seven castrated, purebred and Charolais-Nelore crossbred steers with a mean age of 20 months and initial mean live weight of 293 kg were used in the experiment. All the animals used in the study were from the experimental herd of the LBC.

The animals were confined in covered and paved 12 $m^2$ boxes. Each box has a trough. Drinking fountains were shared between two boxes. The water was supplied *ad libitum* with level regulated by a float valve faucet. Before the experimental period, the steers were adapted to the experimental conditions for 20 days. In addition to the adaptation, the control of endoparasites was also carried out with the application of an albendazole sulfoxide-based product (10% concentration).

The rations were calculated as previously detailed (NRC, 2000), with an estimated intake of dry matter (DM) of 2.65 kg 100 kg$^{-1}$ live weight (LW) and an average daily weight gain of 1.5 kg per animal with an isonitrogenated ration (Table 1). The steers were distributed according to the predominance of genetics and balanced by LW to concentrates containing slow-release urea, soybean meal, or agricultural urea.

**Table 1.** Participation of ingredients and chemical composition of the experimental rations.

| Ingredients | Treatments | | |
|---|---|---|---|
| | Slow-release urea | Soybean meal | Agricultural urea |
| [1]Corn silage, % | 35.00 | 35.00 | 35.00 |
| [2]Corn, % | 45.37 | 35.94 | 45.35 |
| [2]Oat grain, % | 16.25 | 16.25 | 16.25 |
| [2]Soybean meal, % | -- | 11.05 | -- |
| [2]Urea, % | 1.75 | -- | 1.72 |
| [2]Calcitic limestone, % | 0.97 | 1.10 | 0.97 |
| [2]Salt, % | 0.65 | 0.65 | 0.65 |
| | Chemical composition | | |
| [1]Dry matter, % | 64.82 | 66.41 | 64.80 |
| [1]Crude protein, % | 14.35 | 14.88 | 14.70 |
| [1]Ether extract, % | 3.37 | 3.20 | 3.37 |
| [1]Mineral matter, % | 2.42 | 3.02 | 2.42 |
| [1]Neutral detergent fiber, % | 25.88 | 26.60 | 25.87 |
| [1]Total digestible nutrient, % | 77.24 | 77.34 | 77.22 |
| [1]Digestible energy, % | 3.39 | 3.40 | 3.39 |

[1]Participation in composition of total ration; [2]Participation in concentrated fraction.

The ration was supplied in two meals, with half in the morning at 08h00 and the rest in the afternoon at 14h00. The slow-release and agricultural urea rations were weighed separately and added to the troughs and then mixed thoroughly with the other ingredients. The voluntary intake of the ration was recorded daily by weighing the quantity of food offered and the leftover food from the previous day to calculate the consumption of dry matter. The food leftovers were pre-established to be between 5% and 8% higher than the daily consumption of the previous day. The rations offered in the slow-release urea, soybean meal, and agricultural urea treatment provided an average daily gain of 1.560; 1.716, and 1.536 kg; dry matter intake of 2.37; 2.08, and 2.36%, and feed conversion of 6.12; 5.00, and 6.49 respectively.

When the steers reached a weight of 450 kg as a predetermined average for slaughter, the animals were slaughtered in a commercial slaughterhouse, following the normal flow of the establishment. The animals were slaughtered in two lots. In the first lot, 15 animals were sent, comprising five animals of each treatment with the balanced genetic groups remaining 91 days in the feedlot. After 11 days, the remaining 12 animals were sent to the second slaughter, comprising four of each treatment with 102 days of confinement. Before the slaughter, the animals were weighed following a 14-hour fast for solids and liquids.

During the slaughter, all parts of the body of the animal were separated and weighed individually on digital scales. The body parts consisted of peripheral components, which include the head (including ears and horns), paws, and hide (including tail); internal organs (heart, kidneys, lungs, liver, and spleen). digestive tract (rumen, reticulum, omasum, abomasum, large intestine, and small intestine; weighed when empty), fats (heart, inguinal, kidney, trim, ruminal, and intestinal fat), and blood. The sum of these sets plus the warm carcass weight comprised the empty body weight of the animal (EBW). The weight of the gastrointestinal contents (GICs) was obtained by the difference between the slaughter weight (SW) and the EBW.

After slaughter, the carcasses were washed, identified, weighed, and placed in a cold chamber for 24 hours. At the end of the refrigeration they were re-weighed. These weights allowed the determination of the weights of warm and cold carcasses after calculating the warm and cold carcass yields, and the chilling weight loss.

A randomized block experimental design (racial predominance) was used, with three treatments and nine replications, with the animal as the experimental unit. The variables were tested for normality by the Shapiro-Wilk test. The data were submitted to analysis of variance by F test with 5% significance, using the PROC GLM. For the variables that showed a difference, the averages were compared by the Student's t-test with 5% significance, using the Statistical Analysis System, version 9.4 (SAS Institute, Cary, NC, USA). The mathematical model adopted in the analysis of variance was

$$Y_{ij} = \mu + \beta i + T_j + \varepsilon_{ij}$$

where $Y_{ij}$ = dependent variables, $\mu$ = means of all observations, $\beta i$ = effect of the i$^{th}$ block corresponding to the genetic predominance of the animal, $T_j$ = effect of the j$^{th}$ treatment, and $\varepsilon_{ij}$ = residual random error. Pearson's correlation test was also performed using the PROC CORR procedure.

## Results and Discussion

The rations did not lead to significant differences (P>0.05) in EBW (Table 2), which was related to the similarity in the slaughter weights previously stipulated at the beginning of the experimental period. The correlation in the slaughter weight and empty body weight was 0.98 (P<0.0001), which was very close to that reported by Menezes et al. (2007) who observed a correlation of 0.93 for the same variables in steers from Charolais-Nellore rotation crossing finished in feedlot. The similarity between the treatments was also verified in EBW/SW, with mean values of 0.87 for the treatments containing urea and 0.88 for the treatment containing soybean meal. The results of this study corroborate the data of Owens (1995) who reported a variation of 85% to 90% of LW in the relationship between the SW and EBW.

**Table 2.** Slaughter weight (SW), empty body weight (EBW), relationship between EBW/SW, gastrointestinal content (GIC) in absolute weight and relative to 100 kg of EBW (%EBW), and yield of hot and cold carcass in relation to EBW (RCQPCV and RCFPCV) of steers fed with slow-release or agricultural urea in substitution to soybean meal.

| Variables | Treatments | | | SEM | P-value |
|---|---|---|---|---|---|
| | Slow-release urea | Soybean Meal | Agricultural urea | | |
| Slaughter weight, kg | 450.26 | 462.54 | 455.04 | 23.24 | 0.6269 |
| Empty body weight, kg | 394.12 | 410.81 | 399.89 | 21.21 | 0.6357 |
| EBW/SW | 0.87 | 0.88 | 0.87 | 0.004 | 0.5907 |
| GIC, kg | 56.13 | 51.72 | 55.14 | 2.64 | 0.5039 |
| GIC, %EBW | 14.19 | 12.64 | 13.75 | 0.50 | 0.6570 |
| RCQPCV, % | 65.26 | 65.89 | 65.51 | 0.59 | 0.5346 |
| RCFPCV, % | 63.94 | 64.57 | 64.16 | 0.58 | 0.5386 |

SEM = standard error of the mean.

The absolute weight of GICs and weight in relation to EBW was similar between the diets tested, with mean values of 54.33 kg and 13.52%, respectively. These results may be related to the similarity in the quantity of concentrate supplied to animals. According to Ferreira et al. (2000), the content of the digestive tract decreases linearly with the increase in concentration level in the diet, since diets with lower levels of concentrate displayed higher levels of fiber and lower digestibility, increasing the retention time in the rumen. In the present study, lower values were observed than those reported by Menezes (2011), who observed 17.15% EBW in GICs in animals finished in the feedlot with roughage:concentrate ratio of 60: 40.

No differences were observed in the yields of hot and cold carcass in relation to the EBW among the treatments evaluated. This was expected due to the similarity in the pre-established SW and GICs. The use of slow-release and agricultural urea as substitutes for soybean meal protein content in the rations did not lead to any change (P>0.05) in the peripheral components expressed in absolute values and in relation to the EBW (Table 3). The similarity of these constituents must be related to similar body weight and balance in the genetic pattern of animals distributed in different treatments.

**Table 3.** Absolute weights and relative to 100 kg of empty body weight (%EBW) of external tissues from steers fed with slow-release or agricultural urea in substitution to soybean meal.

| Variables | Treatments | | | SEM | P-value |
|---|---|---|---|---|---|
| | Slow-release urea | Soybean meal | Agricultural urea | | |
| Head, kg | 15.00 | 14.65 | 14.80 | 0.56 | 0.7190 |
| Head, % EBW | 3.79 | 3.57 | 3.70 | 0.05 | 0.2964 |
| Paws, kg | 9.52 | 9.27 | 9.55 | 0.43 | 0.4764 |
| Paws, %EBW | 2.41 | 2.26 | 2.40 | 0.11 | 0.8592 |
| Hide, kg | 35.45 | 36.39 | 35.34 | 1.77 | 0.6701 |
| Hide, %EBW | 9.08 | 8.88 | 8.86 | 0.06 | 0.1720 |
| Total weight external tissues, kg | 59.99 | 60.32 | 59.70 | 2.57 | 0.6210 |
| Total weight external tissues, %EBW | 15.30 | 14.72 | 14.97 | 0.17 | 0.3023 |

SEM = standard error of the mean.

The results indicate that the supply of urea can maintain a balanced development of animals and peripheral carcass components, allowing the marketing of the sub-products by the slaughter industry. According to Pacheco et al. (2005), one of the products derived from cattle slaughter is hidden and is highly valued by slaughterhouses, which can be marketed before or after salting.

In the present study, the steers that were fed with slow-release urea showed a 32.38% higher omasum weight per 100 kg EBW (P<0.05) in relation to the animals fed with soybean meal (Table 4) and intermediate behavior for the steers fed with agricultural urea. Jones et al. (1985) reported a greater omasum size in animals fed diets based on forage (50% corn silage and 50% hay), compared with animals fed with a higher content of concentrate (30% corn silage and 70% corn grain), unlike this study in which the roughage:concentrate ratio was the same in all treatments. Experiments with slow release urea showed that the ruminal hydrolysis of this product was intermittent and favored the synchronization between fiber degradation and the release of nitrogen by fibrolytic bacteria (BENEDETI et al., 2014; RIBEIRO et al., 2011).

The remainder of the components of the digestive tract did not show any difference. The mean values of rumen-reticulum in absolute weight and percent EBW were 6.55 kg and 1.62%, respectively, similar to those found by Cattelam et al. (2011), which were 6.04 kg and 1.80% for animals of the same breed predominance in confinement. Similarity in the development of the abomasum should be related to the equality in the roughage:concentrate ratio between the diets, since this component participates actively in the digestive process (FERREL et al., 1976). According to Gesualdi Junior et al. (2001), the weight of the abomasum increases with the increase of concentrate in the diet. Even in steers fed with rations in the same roughage:concentrate ratio, the abomasum weight may vary due to the type of selection made by the animals (PACHECO et al., 2005), which may explain the similarity in abomasum weights in this study. According to Ribeiro et al. (2001), the musculature and the volume of the abomasum increase in proportion to the weight gains of the body, regardless of diet.

**Table 4.** Absolute weights and relative to 100 kg of empty body weight (%EBW) of the tissues of the digestive tract and of the gastrointestinal content of steers fed with slow-release or agricultural urea in substitution to soybean meal.

| Variables | Treatments | | | SEM | P-value |
|---|---|---|---|---|---|
| | Slow-release urea | Soybean meal | Agricultural urea | | |
| Rumen, reticulum, kg | 6.50 | 6.43 | 6.73 | 0.31 | 0.6655 |
| Rumen, reticulum, % EBW | 1.64 | 1.56 | 1.66 | 0.03 | 0.9481 |
| Omasum, kg | 5.56 | 4.38 | 4.78 | 0.73 | 0.3778 |
| Omasum, % EBW | 1.39a | 1.05b | 1.18ab | 0.12 | 0.0092 |
| Abomasum, kg | 1.26 | 1.40 | 1.32 | 0.20 | 0.5665 |
| Abomasum, % EBW | 0.31 | 0.33 | 0.32 | 0.03 | 0.5300 |
| Intestines, kg | 8.59 | 8.96 | 8.73 | 0.38 | 0.3788 |
| Intestines, % EBW | 2.16 | 2.18 | 2.16 | 0.10 | 0.9309 |
| Total weight of the digestive tract, kg | 21.93 | 21.18 | 21.58 | 1.52 | 0.4775 |
| Total weight of the digestive tract, % EBW | 5.53 | 5.15 | 5.35 | 0.18 | 0.3899 |

Means followed by lower case letters in the same line differ from one another by the t test (P <0.05), by PROC GLM.
SEM = standard error of the mean.

The total value of the digestive tract presented absolute and relative mean values of 21.56 kg and 5.34%, respectively. Pacheco (2006) emphasized in a review of some studies that animals with lower weights of the digestive tract presented higher carcass yields. Although there was no significant difference (P>0.05) in this variable, the author reported a negative correlation of -0.40 (P<0.0353) between the total weight of the digestive tract and cold carcass yield.

No abnormal metabolism was observed in steers in the present study because they kept their fuel consumption and performance within the expected when called before the trial period. Similarly, there were no differences (P>0.05) in absolute weights and relative weights of internal organs (Table 5).

The organs developed normally with the growth of the animal. Thus, the similarity in the weights of the internal organs was associated with the previously stipulated slaughter weight of the steers. According to Ferrel et al. (1976), the size of the internal organs is related to the higher consumption of nutrients by the animal, especially energy and protein, since they participate actively in the metabolism of these nutrients. Owens et al. (1993) noted that due to variations in food consumption, energy requirements and metabolic rates, the liver is the most altered organ. A similarity in the development of the internal organs of cattle fed with different protein sources was reported by Macitelli et al. (2005). Even though there was no difference, the liver weight in this study was within the normal range of other studies that used animals of the same age and genetic predominance.

**Table 5.** Absolute weights and relative to 100 kg of empty body weight (%EBW) of vital organs and blood of steers fed with slow-release or agricultural urea in substitution to soybean meal.

| Variables | Treatments | | | SEM | P-value |
|---|---|---|---|---|---|
| | Slow-release urea | Soybean meal | Agricultural urea | | |
| Heart, kg | 1.20 | 1.28 | 1.39 | 0.05 | 0.2779 |
| Heart, % EBW | 0.30 | 0.30 | 0.33 | 0.01 | 0.2210 |
| Lungs, kg | 5.60 | 5.80 | 6.04 | 0.34 | 0.7270 |
| Lungs, % EBW | 1.40 | 1.40 | 1.50 | 0.01 | 0.4310 |
| Liver, kg | 5.47 | 5.38 | 5.38 | 0.38 | 0.4392 |
| Liver, % EBW | 1.37 | 1.30 | 1.32 | 0.05 | 0.4899 |
| Kidneys, kg | 0.79 | 0.81 | 0.81 | 0.04 | 0.4253 |
| Kidneys, % EBW | 0.19 | 0.19 | 0.19 | 0.01 | 0.7980 |
| Spleen, kg | 1.44 | 1.37 | 1.38 | 0.07 | 0.6408 |
| Spleen, % EBW | 0.36 | 0.32 | 0.33 | 0.003 | 0.2023 |
| Total weight of vital organs, kg | 14.52 | 14.66 | 15.02 | 0.83 | 0.5894 |
| Total weight of vital organs, % EBW | 3.66 | 3.56 | 3.72 | 0.07 | 0.9108 |
| Blood, kg | 17.13 | 17.45 | 17.42 | 1.12 | 0.4292 |
| Blood, % EBW | 4.35 | 4.24 | 4.31 | 0.24 | 0.4930 |

SEM = standard error of the mean.

The experimental rations did not influence blood volume of animals, accompanying the similarity in the internal organs (P>0.05; Table 5), and there was a correlation between the blood weight and the weight of the heart (r= 0.84; P<0.0001), a result close to that found by Menezes (2011), who observed a correlation of 0.74 between the same variables. According to Pacheco et al. (2005), the larger the organs, the greater the amount of blood needed to support the metabolic demand of the animals. In addition, other studies have demonstrated that the variation in blood weight accompanies the variation in weight of vital organs and empty digestive tract (RIBEIRO et al., 2001), which would be needed to accompany the changes in metabolic rate in animals, which was not observed in this study.

The amount of fat deposited in the body of animals determines their feed efficiency. In comparison to muscle, this tissue requires a greater quantity of nutrients for their deposition (KUSS, 2007). According to Owens et al. (1993), the internal fat is the first to deposit. With respect to adipose tissue deposition (Table 6), none of the variables showed a significant difference (P>0.05), which was likely related to the similar development stage of the steers. Restle et al. (2005) observed that the increase in the slaughter weight of steers resulted in an increase in the absolute weights of fat in different deposition sites evaluated. Tedeschi et al. (2002) evaluated slow-release urea in diets of steers in the finishing phases and also did not find differences in kidney, pelvic and heart fat compared to a diet containing urea. According to Leme (2000), renal, pelvic and inguinal fat expressed in absolute or relative weight are the best indicators of body fat deposition, because the fat thickness of the carcass is often reduced with the removal of the hide.

**Table 6.** Absolute weights and relative to 100 kg of empty body weight (%EBW) of different fat tissues from steers fed with slow-release or agricultural urea in substitution to soybean meal.

| Variables | Treatments | | | SEM | P-value |
|---|---|---|---|---|---|
| | Slow-release urea | Soybean meal | Agricultural urea | | |
| Heart, kg | 0.22 | 0.23 | 0.22 | 0.04 | 0.7406 |
| Heart, %EBW | 0.05 | 0.05 | 0.04 | 0.007 | 0.7537 |
| Inguinal, kg | 2.37 | 2.60 | 2.33 | 0.44 | 0.5666 |
| inguinal, %EBW | 0.60 | 0.62 | 0.57 | 0.08 | 0.5158 |
| Kidneys, kg | 4.73 | 5.55 | 5.17 | 1.00 | 0.5984 |
| Kidneys, %EBW | 1.18 | 1.32 | 1.27 | 0.18 | 0.5607 |
| Rumen, kg | 4.77 | 5.37 | 4.89 | 0.75 | 0.4502 |
| Rumen, %EBW | 1.17 | 1.27 | 1.19 | 0.14 | 0.3918 |
| Abomasum, kg | 2.78 | 3.38 | 2.89 | 0.40 | 0.3324 |
| Abomasum, %EBW | 0.70 | 0.81 | 0.71 | 0.06 | 0.2679 |
| Intestines, kg | 7.03 | 7.46 | 7.51 | 0.532 | 0.4910 |
| Intestines, %EBW | 1.76 | 1.81 | 1.83 | 0.065 | 0.3666 |
| Dressing, kg | 0.81 | 1.19 | 1.21 | 0.18 | 0.8658 |
| Dressing, %EBW | 0.20 | 0.29 | 0.29 | 0.05 | 0.9276 |
| Total fat, kg | 22.75 | 25.81 | 24.25 | 2.98 | 0.4736 |
| Total fat, %EBW | 5.72 | 6.22 | 5.96 | 0.45 | 0.3845 |

SEM = standard error of the mean.

## Conclusions

Steers fed with slow-release urea displayed a larger omasum, expressed in relation to EBW, compared to steers fed with soybean meal as a protein source. The substitution of soybean meal for different urea used in the present study did not modify the characteristics of the non-carcass components of the carcass.

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