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Carcass characteristics of zebu steers receiving different oleaginous grains

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ABSTRACT. This research aimed to evaluate carcass traits of Zebu steers fed different oleaginous grains. Thirty one 23 months old zebu steers with 365 $\pm$ 37.5 kg of live weight were used. The diets consisted ofcorn silage and four different concentrates; no additional lipids and three different ground oilseeds sources: soybean, cottonseed and linseed. The diets had concentrate:roughage ratio of 60:40 and were offered *ad libitum*. The experimental period was of 84 days, preceded by a 28 day adaptation period. The experiment was carried out in a randomized block design and the means were compared by Scott-Knott test at 5% level of probability. The CS inclusion of into the diet decreased ($p < 0.05$) carcass yield of the animals. The hindquarter was heavier ($p < 0.05$) with the addition of SB to the diet. The spare ribs had the highest performance ($p < 0.05$) and outside flat was heavier ($p < 0.05$) when the animals were submitted to CS and FS diets. The CS addition to the diet improved carcass characteristics.

Keywords: beef cattle, cottonseed, feedlot, linseed, lipids, soybean.

Características de carcaça de novilhos zebuínos recebendo diferentes grãos de oleaginosas

RESUMO. Este trabalho foi realizado com o objetivo de avaliar as características da carcaça em novilhos Zebuínos alimentados com inclusão de fontes de lipídeos moídas. Utilizaram-se 31 novilhos Zebuínos com idade média inicial de 23 meses e peso vivo inicial de 365 $\pm$ 37,5 kg. As dietas consistiram em silagem de milho e quatro concentrados, sendo um sem lipídeo adicional (SLA) e três com a inclusão de diferentes grãos de oleaginosas moídas: grão de soja (GS), caroço de algodão (CA) e semente de linhaça (SL). As rações apresentaram relação concentrado:volumoso 60:40 e foram fornecidas *ad libitum.* O período experimental teve duração de 84 dias sendo precedido de um período de adaptação de 28 dias. O delineamento utilizado foi em blocos casualizados, sendo as médias dos tratamentos comparadas pelo teste Scott & Knott no nível de 5% de probabilidade. Com a inclusão de CA observou-se diminuição ($p < 0,05$) do rendimento de carcaça dos animais. O traseiro especial foi mais pesado ($p < 0,05$) com a inclusão GS na dieta. O maior rendimento ($p < 0,05$) da ponta de agulha e maior peso ($p < 0,05$) de coxão duro foram verificados com a inclusão de CA e SL na dieta. A inclusão de GS na dieta melhora as características de carcaça.

Palavras-chave: bovinos de corte, algodão, confinamento, linhaça, lipídeos, soja.

Introduction

As the beef cattle industry evolves and consumer market becomes more demanding, greater attention has been given to the final product of the activity. Thus, carcass characteristics become important parameters to evaluate the efficiency and quality of the production system (KAZAMA et al., 2008).

Moreover, for the success of the activity, to reduce feed costs is one of the goals of research, which is always looking for alternative feeds with nutritional quality and lower price. Among the various alternative feed sources, cottonseed and soybean grain stand out for being excellent protein sources and containing other basic and essential nutrients, such as lipids. Linseed also represents a good source of cattle feed, although its benefits have been less evaluated.

Besides improving meat quality, feeding diets with high levels of grain may influence carcass characteristics, such as: carcass weight, hot dressing percentage (HDP), rib eye area (REA) and subcutaneous fat deposition (SITZ et al., 2004). Greater REA and smaller backfat thickness (BFT) are indicative of higher muscle yield, greater proportion of usable meat cuts and lower proportion of body fat in the carcass (SUGUISAWA et al., 2006).

There are studies in the literature that have evaluated the effect of oil on feed intake and performance. Muller et al. (2005), Noci et al. (2007) and Ito et al. (2010) have concluded that lipid sources can be used without causing a drop in performance or affecting carcass characteristics. These authors have evaluated the use of grains, oils and rumen-inert fats. Regarding studies comparing only whole oilseeds, Wada et al. (2008) observed little influence on the quantitative characteristics of the carcass.

However, studies in which authors evaluate the effect of ground grains and different oilseeds on carcass characteristics are scarce. Most researches with ground grains evaluate their effect on digestibility, feed intake and performance (JORDAN et al., 2006; PAULINO et al., 2006; PASSINI et al., 2002).

The aim of this study was to evaluate the carcass quality of zebu steers fed ground: soybean (SB), cottonseed (CS) or linseed (LS).

Material and methods

The experiment was conducted at the Department of Animal Science of the Federal University of Lavras from August to November of 2008.

A total of 31 zebu steers were used, with an average initial age of 23 months and an initial BW of 365 $\pm$ 37.5 kg. The animals were confined in individual covered stalls (area of 2 m^2 $animal^{-1}$) with concrete floors and sand bedding. The animals had individual feeding troughs, but water troughs were shared between 2 stalls.

The experimental period lasted 84 d and was preceded by an adaption period of 28 days, during which the animals received the same experimental diet. At the beginning of the adaption period, the animals were treated for ectoparasites and endoparasites. The animals were weighed at the beginning and end of the experimental period, after a 16h fast.

Diets were composed of corn silage as forage and 4 different concentrates containing different ground oilseeds. Thus, each type of concentrate represented a treatment, as follows: no additional lipids (NAL; control), or with SB, CS or LS (Table 1). The feeds were formulated to be isonitrogenous according to the NRC (2000) and were provided to the animals *ad libitum* at 7:30AM and 3:30PM min.

The oilseeds were ground to pass a 5-mm mesh in order to increase ruminal availability of the lipids. The geometric mean diameters were 823, 446, and 849 µm for the SB, CS, and LS, respectively, which did not allow the passage of whole grains.

Samples of concentrates and silage were collected every 14 days and were proportionally subsampled to form a composite sample which was then predried in a forced-air oven at 65°C for 72h and ground to a mesh size of 1 mm. Chemical analyses were performed according to Silva and Queiroz (2002). Nonfiber carbohydrates were obtained according to Sniffen et al. (1992), and TDN was calculated according to the NRC (2001).

Table 1. Ingredient and chemical composition of experimental diets.

Ingredients	Composition (% DM)			
	No additional lipids	Soybean	Cottonseed	Linseed
Corn silage	40.0	40.0	40.0	40.0
Corn	49.2	43.8	37.2	43.8
Soybean meal	9.0	-	3.0	7.8
Soybean	-	14.4	-	-
Cottonseed	-	-	18.0	-
Linseed	-	-	-	6.6
Mineral premix*	1.8	1.8	1.8	1.8
Nutrients	Chemical composition			
Dry matter[1]	64.2	64.7	64.7	64.4
Crude protein[2]	13.2	13.3	13.3	13.5
Neutral detergent fiber[2]	33.3	32.1	41.2	34.5
Nonfiber carbohydrates[2]	45.0	43.2	34.2	42.3
Ether extract[2]	3.5	6.1	6.7	5.8
Total digestible nutrients[2]	76.0	76.1	75.4	75.2

*Chemical composition por kilogram of product: Ca: 235 g; P 45 g; S 23 g; Na: 80.18 g; Zn: 2.38 mg; Cu: 625 mg; Fe: 1.18 mg; Mn: 312 mg: Co: 32 mg; I: 41.6 mg; Se: 11.25 mg; Vit. A: 70.000 UI; Vit. D3: 5.000 UI; Vit. E: 15 UI; Niacine: 3.33 mg; [1]as-fed basis; [2]dry matter basis.

Slaughtering of animals was conducted in a commercial slaughterhouse, using the technique of cerebral concussion and section of the jugular vein, followed by removal of hides and evisceration.

At the end of the slaughtering line, carcasses were washed, split in two halves, identified and weighted to obtain the hot carcass weight (HCW) and to determine the hot dressing percentage (HDP). The carcasses were then taken to a cold chamber and kept under refrigeration for approximately 48 hours at 4ºC. After this period they were weighed again to obtain the cold carcass weight (CCW). Chilling loss (CL) was obtained taking into account the carcass weight loss and its ratio in relation to HCW.

Backfat thickness was measured between the 12 and 13^{th} ribs at ¾ of the medial border on the left side of the cold carcass on the *Longissimus dorsi*, with the aid of a graduated caliper. The rib eye area, also measured between the 12 and 13^{th} ribs, was outlined in transparency paper and determined by the use of a planimeter.

Each cold carcass was then divided into hindquarter, forequarter and spare ribs to obtain the respective weights and yields relative to cold carcass. Next, boning of these meat cuts was performed to obtain retail cuts.

The experiment was carried out in a completely randomized block design, and steers were blocked by breed. The PROC GLM of SAS (2004) was used and the means were compared the Scott-Knott test at 5% level of probability. There were eight replicates of NAL, CS and LS treatments and seven replicates of SB treatments. Adjustments were made for initial body weight and age covariates.

Results and discussion

The similarity of carcass weight, in kilograms or arrobas, between treatments was due to similar slaughter weight of animals (Table 2).

It appears that Zebu steers, with approximately 475 kg of live weight, an inferior slaughter weight in comparison to those used in several countries, can produce carcass weights above the 16@ required by Brazilian slaughterhouses.

Supplementation with cottonseed reduced HDP, what could be explained by the lower average daily gain (ADG) shown by animals fed this ingredient (0.93 versus 1.07 kg day^{-1} for the remaining averages). The diet with inclusion of cottonseed had the highest NDF content.

According to Menezes et al. (2005a), HDP is important to the production system, regarding to commercialization patterns of Brazil that remunerates the producer according to carcass weight. Thus, according to this study, animals fed CS would provide the producer lower selling price per animal.

The REA was not affected by partial replacement of corn grain by soybean, cottonseed or linseed grain. These values are similar to those observed by Wada et al. (2008) studying the effect of lipid sources in confined Nellore heifers. The similarities of the results of REA and BFT between treatments may be associated with the fact that diets were isoenergetic and isonitrogenous.

In this work, despite the difference in ether extract (EE) levels of the diet with no additional lipids in relation to the other diets, they were provided to *Bos indicus* steers kept in individual stalls, which minimizes animal's energy demands and increases the energy available for subcutaneous fat accumulation. This may explain the elevated BFT observed. Moreover, the elevated BFT could also be influenced by the energy density of the diets, since they were 2.8 Mcal of metabolizable energy kg^{-1} of DM in average. Another factor related to the elevated BFT could be associated to the age group of the Zebu steers used in the experiment, in which some animals were older than 28 months at slaughter. Ribeiro et al. (2009) evaluating carcasses of 14.6 months old intact Zebu males receiving a diet with concentrate level and energy value similar to those in this work, found values of 4.6 mm for BFT.

The BFT in this study was higher than that recommended by national meat packing plants (3-6 mm). According to Geay et al. (2001) subcutaneous fat can directly affect carcass cooling rate, behaving as a thermal insulator and positively contributing to the conversion of muscle into meat. Over 6 mm, prejudice occurs to the producer because of trimming of excess fat located in the peri-renal region during carcass dressing, before carcass weighing, and to the meat packing plants because of higher operating costs involved in this process (COSTA et al., 2002).

Another factor associated to BFT and that should be taken into consideration is the homogeneity in the distribution of carcass fat cover. Medium fat carcasses (3-6 mm) do not usually have good uniformity in the distribution and thus, a portion of the round and the shoulder muscles remains unprotected, and this could compromise the quality of certain cuts.

The BFT interferes directly in CL since carcasses with lower fat deposition have greater drip loss. There was no difference in CL between the diets, but these values are within the recommended literature, ranging from 1 to 2% (CUNHA et al., 2008). Thus, the greater degree of carcass finishing of the animals justifies the CL values found in this study.

Table 2. Means and standard errors of the mean for final body weight (FBW), hot carcass weight (HCW), cold carcass weight (CCW), hot dressing percentage (HDP), backfat thickness (BFT), rib eye area (REA) and Chilling loss (CL) of Zebu animals receiving different oilseeds grains.

	Treatments				SEM	P
	NAL	SB	CS	LS		
FBW (kg)	476.0	480.5	471.9	478.5	8.02	0.89
HCW (kg)	264.0	268.4	256.7	265.2	5.26	0.15
HCW (@)	17.6	17.9	17.1	17.7	0.17	0.23
CCW (kg)	259.3	264.2	252.4	261.0	5.10	0.12
HDP (%)	55.8a	56.1a	54.1b	55.4a	0.48	0.04
REA (cm^2)	70.4	70.5	65.2	68.7	2.73	0.41
BFT (mm)	7.7	7.4	7.5	6.9	0.96	0.93
CL (%)	1.7	1.5	1.6	1.6	0.12	0.66

Means followed by the same letters, in rows, do not differ statistically by Scott and Knott test, at 5% significance level. NAL: no additional lipids; SB: soybean; CS: cottonseed; LS: linseed.

As stated by Silva et al. (2008), less CL leads to higher added value in the carcass commercialized to meat packing plants, because there is less weight loss during cooling, which provides higher retail yield.

Although animals fed SB grain had heavier hindquarter (Table 3), diets had minimal effect on the forequarter to hindquarter ratio. This shows that it's possible to produce high quality carcasses based on diets containing different oilseeds.

Table 3. Means and standard errors of the mean for hindquarter, forequarter and spare ribs weights and yields of Zebu animals receiving different oilseeds grains.

	Treatments				SEM	P
	NAL	SB	CS	LS		
Hindquarter (kg)	123.17b	128.05a	119.11b	123.74b	2.62	0.03
Hindquarter (%)	47.48	48.46	47.18	47.40	0.36	0.09
Forequarter (kg)	98.23	97.59	95.07	96.79	1.81	0.21
Forequarter (%)	37.91	37.01	37.67	37.06	0.62	0.16
Spare ribs (kg)	37.87	38.59	38.27	40.45	1.13	0.43
Spare ribs (%)	14.61b	14.53b	15.16a	15.53a	0.37	0.04

Means followed by the same letters, in rows, do not differ statistically by Scott & Knott test, at 5% significance level. NAL: no additional lipids; SB: soybean; CS: cottonseed; LS: linseed.

It was expected that hindquarter from the animals in this work would represent at least 48%, since they were slaughtered over 17@. However that was not the case, except for steers fed the SB diets. The presence of hump in Zebu cattle could be the reason. Menezes et al. (2005b) reported that the higher forequarter yield presented by Nellore is due to the presence of the hump.

The hindquarter weight is an important feature for the entire beef chain. Therefore, it would be economically desirable to have a greater hindquarter yield, since that is where most of the prime cuts are found, and these are the cuts that achieve greater business value.

Costa et al. (2002) evaluating hindquarter yield based on the age of the animals, observed that with increasing age there was a tendency in obtaining heavier hindquarters. In agreement with the author, this trend may be related to increased fat deposition in this region, especially when working with castrated animals.

According to Luchiari Filho (2000), in an ideal carcass, hindquarter should be over 48%, forequarter up to 39% and spare ribs up to 13%. No difference was observed for forequarter yield and the values were within the standards required. Although the spare ribs yield was higher for animals fed CS and LS, the values were out of the standards recommended by the author.

Only meat cuts from the left half carcass were considered for the evaluation of retail cuts (kg) (Table 4), while retail yields were based on weight of meat cuts in relation to cold carcass weight (Table 5). Steers fed SB grain had greater outside flat yields and weights, and lower thin skirt yields, while steers fed LS had greater outside flat yields and weights, with no differences found on the other meat cuts evaluated.

Table 4. Means and standard errors of the mean for weight (kg) of major retail cuts of Zebu animals receiving different oilseeds grains.

	Treatments				SEM	P
	NAL	SB	CS	LS		
Whole rump	14.61	15.20	14.30	14.84	0.65	0.33
Strip loin	6.97	7.30	6.81	7.25	0.45	0.15
Rump cap	1.24	1.34	1.29	1.32	0.10	0.50
Tenderloin	1.58	1.55	1.45	1.57	0.13	0.44
Rump heart	3.49	3.62	3.39	3.50	0.21	0.19
Tri-tip	1.21	1.38	1.26	1.27	0.12	0.20
Outside flat	5.37b	5.81a	5.26b	5.68a	0.33	0.03
Top inside	8.98	9.47	8.93	9.55	0.50	0.13
Knuckle	4.81	5.07	4.64	4.73	0.34	0.17
Eye round	2.32	2.35	2.25	2.37	0.15	0.41
Chuck	14.28	13.91	14.05	14.22	0.79	0.91
Hump	1.62	1.66	1.44	1.43	0.22	0.27
Ribs	8.20	8.71	8.23	9.10	0.65	0.17
Thin skirt	2.61	2.40	2.64	2.80	0.25	0.37

Means followed by the same letters, in rows, do not differ statistically by Scott and Knott test, at 5% significance level. NAL: no additional lipids; SB: soybean; CS: cottonseed; LS: linseed.

Table 5. Means and standard errors of the mean (%) for major retail cuts of Zebu animals receiving different oilseeds grains.

	Treatments				SEM	P
	NAL	SB	CS	LS		
Whole rump	11.21	10.58	10.37	10.53	0.25	0.26
Strip loin	5.36	5.54	5.39	5.55	0.10	0.56
Rump cap	0.96	0.10	0.10	0.10	0.03	0.47
Tenderloin	1.21	1.17	1.16	1.20	0.04	0.76
Rump heart	2.68	2.74	2.69	2.69	0.06	0.89
Tri-tip	0.94	1.04	1.00	0.97	0.03	0.16
Outside flat	4.11b	4.39a	4.17b	4.35a	0.08	0.04
Top inside	6.92	7.16	7.08	7.32	0.12	0.12
Knuckle	3.69	3.83	3.68	3.63	0.09	0.47
Eye round	1.76	1.78	1.79	1.82	0.05	0.87
Chuck	11.00	10.52	11.15	10.90	0.24	0.35
Hump	1.24	1.26	1.14	1.11	0.08	0.47
Ribs	6.35	6.61	6.52	6.95	0.19	0.16
Thin skirt	2.00a	1.81b	2.10a	2.15a	0.08	0.05

Means followed by the same letters, in rows, do not differ statistically by Scott and Knott test, at 5% significance level. NAL: no additional lipids; SB: soybean; CS: cottonseed; LS: linseed.

In consonance with Bonilha et al. (2007), carcass cut weights are directly related to carcass weight. As there was a trend for greater carcass weight for animals receiving SB and LS diets, the greater outside flat yields and weights may be related to this factor. This could also explain why steers fed SB had heavier hindquarter weights. The lower thin skirt yields could be related to the lower spare ribs yields.

The weights and yields of most retail cuts assessed in this study were not significantly different among treatments. This is of great relevance as it shows that is possible to obtain meat cuts from Zebu cattle that would provide a similar yield, even when different diets are used.

The whole rump, where main retail cuts are found (strip loin, rump cap, tenderloin, rump heart and tri-tip) represents 10 to 11% of total carcass weight. This demonstrates why meat packing plants search for heavier animals, which would improve manufacturing yield by the production of meat cuts of higher commercial value.

The REA was highly correlated to HCW, hindquarter, hindquarter gun cuts and whole rump (Table 6). Therefore, the greater the muscularity displayed by the animals, the greater the carcass cuts yields. This explains why animals of large breeds have higher carcass cuts yields in proportion to animals of smaller breeds. The hot dressing percentage and spare ribs weight had lower correlation to AOL. A smaller amount of retail cuts are found in the spare ribs region compared to another regions, which could explain the low correlation. It was also verified that BFT was not correlated to REA. The forequarter cuts showed higher correlation to REA.

Table 6. Correlation between REA and hot carcass weight, carcass yield, backfat thickness and weight of main carcass cuts of Zebu animals receiving different oilseeds grains.

Correlation	Value	p
REA *vs* hot carcass weight	0.56	< 0.01
REA *vs* hot dressing percentage	0.38	0.03
REA *vs* backfat thickness	0.19	0.30
REA *vs* hindquarter cuts weight	0.58	< 0.01
REA *vs* hindquarter gun cuts weight	0.56	< 0.01
REA *vs* whole rump cuts weight	0.56	< 0.01
REA *vs* forequarter cuts weight	0.65	< 0.01
REA *vs* spare ribs cuts weight	0.40	0.03

Conclusion

The lipid sources used in finishing feedlot Zebu steers had little influence on the carcass quality. The major changes occur on hot dressing percentage and hindquarter weight, in which cottonseed supplementation impaired these characteristics.

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