Archivos de Zootecnia
Journal website: https://www.uco.es/ucopress/az/index.php/az/
SHORT NOTE

Hind quarter and degree of fatness of cattle fed lipid sources in the diet

Lima, E.S.[1@]; Valente, T.N.P.[2]; Morais, J.P.G.[3]; Roça, R.O.[4] e Deminicis, B.B.[5]

[1] Universidade Municipal de São Caetano do Sul (USCS), Campus Centro, SP, Brasil.
[2] Instituto Federal Goiano (IF Goiano), Campus Posse, GO, Brasil.
[3] Universidade Federal de São Carlos (UFSCAR), Araras, SP, Brasil.
[4]Universidade Estadual Paulista Júlio de Mesquita Filho (UNESP), Botucatu, SP, Brasil.
[5]Universidade Federal de Mato Grosso (UFMT), Sinop, MT, Brasil.

Aditional Keywords
Beef cattle.
Characteristics of Carcass.
Protected fat.
Whole cottonseed.

SUMMARY

The aim of this study was to determine the effect of the inclusion of different lipid sources (whole cottonseed and protected fat in diets containing sugar cane, corn, citrus pulp, cottonseed meal, and urea) on hind quarter (HQ) and degree of fatness (DF) of the meat of Nellore cattle during finishing in feedlot. The treatments evaluated were: feed with 2.50% cottonseed (control diet = called T1 treatment); feed with 11.50% cottonseed (high cottonseed = called T2 treatment); and feed with 3.13% cottonseed added of protected lipid (called T3 treatment), all on a dry matter basis. The forage:concentrate ratio of the diet was 50:50. Thirty nine intact steers with average initial body weight of 494 kg and 36 months of age were confined during 63 days. After this period, the animals were slaughtered and HQ and DF of the carcass were analyzed. The addition of lipid sources tested in this study did not affect the DF. However, for HQ there were differences (P <0.05) between T2 and T1, with higher HQ value in the carcass of animals that received 11.50% cottonseed. It was concluded that the addition of lipid in the diet may affect the carcass characteristics.

Palabras chave adicionais
Bovino de corte.
Características da carcaça.
Lipídio protegido.
Caroço de algodão.

Quarto traseiro e gordura de cobertura de bovinos alimentados com fontes de lipídeo na dieta

RESUMO

O objetivo deste estudo foi determinar o efeito da inclusão de diferentes fontes lipídicas (caroço de algodão e Gordura protegida em dietas contendo cana-de-açúcar, milho, polpa cítrica, farinha de algodão e uréia) no quarto traseiro (QT) e no grau de gordura de cobertura (GC) da carcaça de bovinos Nelore durante a terminação em confinamento. Os tratamentos avaliados foram: dieta com 2,50% de caroço de algodão (dieta controle = tratamento T1); dieta com 11,50% de caroço de algodão (caroço de algodão em maior quantidade = tratamento T2); e dieta com 3,13% de caroço de algodão adicionada a lipídio protegido (chamado tratamento T3), sendo os valores com base na matéria seca da dieta. A relação volumoso: concentrado da dieta foi de 50:50. Trinta e nove bovinos inteiros com peso corporal inicial médio de 494 kg e 36 meses de idade foram confinados durante 63 dias. Após esse período, os animais foram abatidos e o QT e GC da carcaça foram analisados. A adição de fontes lipídicas testadas neste estudo não afetou o GC. No entanto, no QT houve diferenças (P <0,05) entre T2 e T1, com maior valor de QT na carcaça de animais que receberam 11,50% de semente de algodão. Concluiu-se que a adição de lipídios na dieta pode afetar tais características da carcaça.

Information
Cronología del artículo.
Recibido/Received: 12.01.2022
Aceptado/Accepted:11.01.2024
On-line: 15.07.2024
Correspondencia a los autores/Contact e-mail:
erico.lima@online.uscs.edu.br

INTRODUCTION

Feeds cost is an important factor that impacts the successful in feedlot (Maxwell et al. 2015), and currently the carcasses should have greater proportion of muscle and minimum amounts of fat. Fat content should be just enough to prevent dehydration and darkening under refrigeration, and to ensure meat juiciness and taste (Agastin et al. 2014). Adequate carcass yield and fat thickness should be achieved taking economic aspects into consideration. The fat thickness minimum required by the meat industry (3 mm) (Mez-

zomo et al. 2015). When animals do not reach this minimum fat thickness, the meat industry may devalued the carcass and pay less money to the farmer, a fact that was observed in this study.

The use of fatty by-products may be an alternative to decrease the use of starch rich feeds without compromising the energy levels of the diet. Cottonseed (CS) is one of the ingredients that has been widely used in ruminant feeding to achieve this aim (Costa et al. 2013; Lima et al. 2015; Lima et al. 2017). The use of calcium together with fat in the diet (protected lipid - PL) helps to prevent the negative effects of dietary fiber on digestion in diets containing more than 40% forage (Rogério et al. 2003). In this case, the use of protected lipids is an adequate alternative of feedstuffs for use in feedlot.

The objective of this study was to investigate if access to lipid sources, such as CS, or CS added of PL, may improve hind quarter (HQ) and degree of fatness (DF) of the meat of Nellore cattle during finishing in feedlot.

MATERIAL AND METHODS

Experimental site

The study was carried out in a beef cattle Farm located at 22º 04' 00'' south, 47º 09' 03'' west, average altitude of 615 m (BRAZIL). The climate of the region is classified as Cwa by the Köppen classification. Characterized by a hot and humid season from October to March, followed by a cold and dry season from May to September.

Animal management, feeding and treatment

A group of 39 intact male Nellore animals raised in *Brachiaria humidicola (Rendle) Schweickerdt* pastures was used in the study. Mean age of the animals was 36 months, and initial mean live weight was 494 ± 10 kg. Animals were identified and dewormed before the beginning of the trial.

Animals were then randomly assigned to one of three treatments, on a dry matter basis: feed with 2.50% CS (control diet = called T1 treatment), feed with 11.50% CS (high cottonseed = called T2 treatment), and feed with 3.13% CS added of 1.77% PL (CS + PL = called T3 treatment). Animals were confined for 63 days. Diets were formulated according to the CNCPS software 4.0 (CNCPS 2000) for uncastrated finishing cattle to provide weight gains of 1.4 kg/animal/day. (Total diet = Forage:concentrate ratio was 50:50). Sugar cane was used as forage, and concentrate was urea, cracked corn kernels, citrus pulp, cotton meal, CS and/or PL. The PL used in this study was made from commercial soybean oil, which go through saponification with calcium salts for protection of long-chain fatty acids. Results of laboratory analysis for nutritional composition of PL: 95.5% dry matter (DM), 85.2% ether extract (EE), and 14.8% mineral matter (MM). Animals were fed manually every day at 8 am and 4 pm, in a total diet system with about 5% leftovers, which were weighted in the morning for diet adjustment. Nutritional composition of the diets is shown in Table 1.

Samples of the experimental diets, sugar cane, and concentrate were collected every seven days, placed in plastic bags and stored in a freezer (-4 oC) to be analyzed later on. After thawing, composite samples were obtained for a 21 day period. Samples of feed and forage were weighted and oven-dried at 60oC for 72 h. Then, samples were processed in a Wiley® knife mill to pass through 1-mm screen sieves, and stored in plastic bags. Samples were analyzed for DM, crude protein (CP) and MM according to the AOAC (1990), EE (Thiex, Anderson & Gildemeister 2003), neutral detergent fiber assayed with heat stable amylase and expressed exclusive of residual ash (aNDFom-NDF), acid detergent fiber expressed exclusive of residual ash (ADFom-ADF) (Van Soest, Robertson & Lewis 1991), and lignin analyzed by the sulfuric acid method (LIG (sa), AOAC 1990; Gomes et al. 2011) after sequential neutral-acid detergent extraction (Van Soest, Robertson & Lewis 1991). In the aNDFom-NDF analyses, thermostable α-amylase was used without sodium sulfite (Mertens 2002), using Ankom® fiber extractor, according to Valente, Detmann and Sampaio (2015). Non-fiber carbohydrates (NFC) in the ingredients of the diets were determined by the following equation: NFC = 100 - (%aNDFom-NDF + %CP + %EE + %MM), according to Sniffen et al. (1992). Due to the presence of urea in the diets, NFC was calculated as indicated by Hall (2000): NFC = 100 – [(%CP - %CP from urea + %urea) + %aNDFom-NDF + %EE + %MM]. Estimated metabolizable energy (ME) in Mcal/kg of DM was determined according to the NRC recommendations (1996), considering that 1 kg of total digestible nutrients (TDN) contains 4.409 Mcal of digestible energy (DE), with the factor 0.82 used in the conversion from ED to EM. Results of these analysis carried out in the software CQBAL 3.0. (2012) are shown in Tables 2 and 3.

After 63 days of the study, animals were weighted for the last time after a 14 h solid food fasting. Mean final live weight was 577 ± 11 kg. Soon after being weighted, animals were transported to a slaughterhouse, in solid food fasting until the moment they were slaughtered. Animals were slaughtered according to the regular flow of the industry. After slaughter, carcasses were identified and divided into two halves that were kept in a cold chamber for 24 h at 2 ºC.

Degree of fatness

The carcass were classified according to their degree of fatness (DF), Followed by 1 to 5, where 1 = carcass without fat; 2 = carcass with sparse fat; 3 = medium fat carcass; 4 = carcass with uniform fat; And 5 = carcass with excessive fat (Luchiari 2000).

Hind Quarter

Means the posterior portion of the beef side which is separated from the front quarter by a cut after 6th rib.

Statistical procedures and model evaluation

A completely random design with 3 treatments and 13 repetitions was used, according to the $Yij = \mu + Ti + eij$ model, where: Yij is the value observed in the jth experimental unit (animal) that received the ith

Table I. Percent composition of the diets on a dry matter basis (Composición de porcentaje de las dietas).

Ingredients (%)	Treatments		
	T1[1]	T2[2]	T3[3]
Sugar cane	50.00	50.00	50.00
Cracked corn	14.64	13.07	13.12
Citrus pulp	21.61	17.81	20.61
Cottonseed	2.50	11.50	3.13
Cottonseed meal	9.30	5.78	9.42
Urea	0.83	0.83	0.83
Protected fat	-	-	1.77
Mineral mix [4]	0.83	0.83	0.83
Potassium chloride	0.28	0.17	0.28
Ionophores	0.01	0.01	0.01

[1] Treatment with 2.50% CS.
[2] Treatment with 11.50% CS.
[3] Treatment with 3.13% CS added of 1.77% PL.
[4] Composition /kg: P= 60g; Ca= 180g; Mg= 5g; S= 17g; Na= 135g; Cu= 650mg; Mn= 500mg; Zn= 2400mg; I= 48mg; Co= 38mg; Se= 12mg.

Table II. Mean chemical composition of ingredients used in the experimentais diets as percentage dry matter of crude protein (CP), ether extract (EE), non-fiber carbohydrates (NFC), neutral detergent fiber (aNDFom-NDF), acid detergent fiber (ADFom-ADF), lignin (LIG), mineral matter (MM) (Composición química media de los ingredientes utilizados en las dietas experimentales como porcentaje de materia seca de proteína cruda (PC), extracto etéreo (EE), carbohidratos no fibrosos (CNF), fibra detergente neutro (aNDFom-FDN), fibra detergente ácido (ADFom-FDA), lignina (LIG), materia mineral (MM)).

Ingredients	DM (%)	% dry matter						
		CP	EE	NFC	aNDFmo-NDF	ADFmo-ADF	LIG	MM
Sugar cane	30.27	2.82	2.93	29.06	62.43	39.56	6.85	2.76
Cracked corn	87.02	8.73	4.46	71.46	14.42	5.32	2.75	0.93
Citrus pulp	87.94	5.87	3.5	64.78	21.38	16.75	7.52	4.47
Cottonseed	91	19.67	20.83	1.36	54.65	45.44	17.03	3.49
Cottonseed meal	87.24	46.08	1.94	0.12	45.66	28.32	9.91	6.2
Protected lipid	95.47	-	85.21	-	-	-	-	14.79
Urea	99.51	287.84	-	-	-	-	-	-

Note. NFC according to Sniffen et al. (1992).

treatment; μ is the overall mean; Ti is the fixed effect of the ith treatment; eij is the experimental error related to the experimental unit. Data were analyzed by means of the GLM (Generalized Linear Models) of the SAS software (2002), and means were compared using Tukey test at a 5% significance level.

RESULTS AND DISCUSSION

Regarding the HQ analysis, it may be noted that there were differences (P<0.05) between the treatments, for mean HQ was 92.33 kg. T2 treatment did not differ (P>0.05) between T3. The T2 treatment was the highest value found in the study. This value of HQ supplies the minimum DF required by the slaughterhouse (Table 4). It results in a higher remuneration, considering that the bovine quarter is the most valued portion of the carcass due to the location of the most preferred cuts by the final consumer.

In a similar study, Silva (2016) tested an increased diet of protected lipid (Soybean oil fat acid and Calcium Hydroxide) and found no effect of diet on the hind quarter of beef cattle (Table 4). Different result was obtained by Oliveira et al. (2013) in which the use of whole cottonseed and other sources of oilseeds in the diet of zebu steers was evaluated, inclusion of cottonseed did not alter the weight of the rump when compared to the diet without additional lipid source. The lower mean hind weight verified in this study (Table 4) in relation to the study of Oliveira et al. (2013), the response may be related with the animals in the present study started feedlot with a more advanced age and live weight. The fact that the animals are not castrated may have affected the development of the hind quarter of the animals at maturity, is related to the non-castration of the animals and, with the advancement of the age, the whole animals are expected to increase the sexual dimorphism (Zhou et al. 2011).

Table III. Mean chemical composition of experimentais diets, for dry matter (DM), crude protein (CP), ether extract (EE), non-fiber carbohydrates (NFC), neutral detergent fiber (aNDFom-NDF), mineral matter (MM), total digestibility nutrient (TDN) and metabolizable energy (ME) used in different treatment (Composición química media de las dietas experimentales para materia seca (MS), proteína cruda (PC), extracto etéreo (EE), carbohidratos no fibrosos (CNF), fibra detergente neutro (aNDFom-FDN), materia mineral (MM), nutrientes totales digestibles (NTD) y energía metabolizable (EM) utilizados en los diferentes tratamientos).

Items	Diets		
	T1[1]	T2[2]	T3[3]
DM	58.09	58.50	58.26
CP	11.11	10.90	11.11
EE	3.57	5.18	5.11
NFC[4]	38.61	35.03	36.88
aNDFom-NDF	43.56	45.83	43.52
MM	3.15	3.06	3.38
TDN[5]	67.55	68.16	68.99
ME[6]	2.44	2.46	2.49

[1] Treatment with 2.50% CS.
[2] Treatment with 11.50% CS.
[3] Treatment with 3.13% CS added of 1.77% PL.
[4]NFC according to Hall (2000).
[5]Estimated in the feed composition according to the CQBAL 3.0 (2012) and the NRC (2001).
[6]ME = estimated metabolizable energy, in Mcal/kg of DM, according to the NRC (1996).

Table IV. Means, standard error (SE), and probability (P-value) for the variable of the treatments (Medias, error estándar (EE) y probabilidad (valor P) para la variable de los tratamientos).

Items	Diets			Mean	SE	P-value[5]
	T1[1]	T2[2]	T3[3]			
HQ, kg	88.31b	96.69a	91.98ab	92.33	2.33	0.0506
DF[4]	2.46	3.0	2.92	2.79	0.16	0.06

[1] Treatment with 2.50% CS.
[2] Treatment with 11.50% CS.
[3] Treatment with 3.13% CS added of 1.77% PL.
[4] Degree of fatness (DF), Followed by 1 to 5, where 1 = carcass without fat; 2 = carcass with sparse fat; 3 = medium fat carcass; 4 = carcass with uniform fat; And 5 = carcass with excessive fat.
[5]According to Tukey test (P < 0.05).

No differences (P> 0.05) were found for the three treatments for DF, shown in Table 4. Mean DF was 2.79. Lima et al. (2016) found no difference between control diet with whole cottonseed or diet with protected lipid when evaluating the degree of fatness of longissimus thoracis of Nellore cattle in the feedlot, indicating the absence of the effect of oil on this animal tissue. Similarly, the diets elaborated by Silva (2016) showed no difference (control diet and energetic diet with protected lipid) in beef cattle on the thickness of the longissimus thoracis muscle between the 12th and 13th ribs. There is a positive correlation between the muscle l*ongissimus thoracis* and carcass yield.

Barducci et al. (2016) when studying three treatments with isoenergetic diets: (1) without additional lipid source, (2) with lipid source from cottonseed co-products and (3) with lipid source protected from ruminal degradation, reported no difference between diets in relation to the subcutaneous fat of *Longissimus thoracis* for Nellore cattle.

CONCLUSIONS

In the present study, the increase of whole cottonseed in the bovine diet resulted in a higher weight of the hind quarter compared to the control diet, which may contribute to a higher remuneration for meat products, are usually more valued in the market.

The inclusion of protect lipid or whole cottonseed in the diet does not interfere in the degree of fatness of the carcass of cattle in feedlot.

ACKNOWLEGMENTS

The authors would like to thank the owner of Chapéu de Chapéu farm, Mr. Raul Schwinden, for the confinement area for the animals; Mr. Cirlei and José Benedito for providing the animals for the study, and FRIGONOBRE meat plant for providing the area for meat evaluation.

The UNESP/FMVZ/Botucatu for all support of this research. In the study by Silva (2016), in contrast, the animals evaluated were young, and the average hind quarter weights, animals had less weight, compared to the present study.

BIBLIOGRAPHY

Agastin, A, Naves, M, Farant, A, Godard, X, Bocage, B, Alexandre G & Boval, M 2014, 'Effects of feeding system and slaughter age on the

growth and carcass characteristics of tropical-breed steers', Journal of Animal Science, vol. 91, no. 8, pp. 3997-4006.

Association of Official Analytical Chemists (AOAC) 1990, 15rd edn, Edition Official methods of analysis, Arlington.

Barducci, RS, Franzói, MCS, Sarti, LMN, Millen, DD, Putarov, TC, Perdigão, A, Martins, CL & Arrigoni, MDB 2016, 'Perfil de ácidos graxos e características da carne de bovinos Nelore confinados com diferentes fontes lipídicas protegidas', Arquivo Brasileiro de Medicina Veterinária e Zootecnia, vol. 68, no. 1, pp. 233-242.

Cornell Net Carbohydrate and Protein System (CNCPS) 2000, version 4.0, The net carbohydrate and protein system for evaluating herd nutrition and nutrients excretion, Ithaca.

Costa, DPB, Roça RO, Costa QPB, Lanna DPD, Lima ES, & Barros WM 2013, 'Meat characteristics of Nellore steers fed whole cottonseed', Revista Brasileira de Zootecnia, vol. 42, no. 3, pp. 183-192.

Chemical composition feedstuff (CQBAL) 2012, version 3.0, Brazilian Guide Ruminant Nutrition, Viçosa.

Gomes, DI, Detmann, E, Valadares Filho, SC, Fukushima, RS, Souza, MA, Valente, TNP, Paulino, MF & Queiroz, AC 2011, 'Evaluation of lignin contents in tropical forages using different analytical methods and their correlations with degradation of insoluble fiber', Animal Feed Science and Technology, vol. 168, no. 3-4, pp. 206-222.

Hall, MB 2000, Calculation of non-structural carbohydrate content of feeds that contain non-protein nitrogen, University of Florida, Gainesville.

Lima, ES, Morais, JPG, Roça, RO, Costa, QPB, Andrade, EM, Vaz, VP, Valente, TNP & Costa, DPB 2015, 'Meat Characteristics of Nellore Cattle Fed Different Levels of Lipid-Based Diets', Journal of Agricultural Science, vol. 7, no. 7, pp. 174-183.

Lima, ES, Morais, JPG, Roça, RO, Andrade, EN, Valente, TNP, Costa, QPB & Deminicis, BB 2015, 'Effect of different sources of lipids in diet on the qualitative characteristics of Longissimus thoracis muscle of cattle finished in feedlots', African Journal Agricultural Research, vol. 10, no. 29, pp. 2835-2840.

Lima, ES, Morais, JPG, Roça, RO, Valente, TNP, Andrade, EN & Deminicis, BB 2016, 'Performance and carcass characteristics of cattle fed lipid sources in the diet', Canadian. Journal of Animal Science, vol. 96, no. 4, pp. 581-588.

Lima, ES, Valente, TNP, Roça, RO, Cezário, AS, Santos, WBR, Deminicis, BB & Ribeiro, JC 2017, 'Effect of whole cottonseed or protected fat dietary additives on carcass characteristics and meat quality of beef cattle: a review', Journal of Agricultural Science, vol. 9, no.05, pp. 175-189.

Luchiari Filho, A 2000, Beef cattle, São Paulo, Brazil.

Maxwell CL, Bernhard BC, O'Neill, FC, Wilson, BK, Hixon, CG, Haviland CL, Grimes, AN, Calvo-Lorenzo, MS, VanOverbeke, DL, Mafi, GG, Richards CJ, Step, DL, Holland, BP & Krehbiel, CR 2015, 'The effects of technology use in feedlot production systems on feedlot performance and carcass characteristics', Journal of Animal Science, vol. 93, no. 3, pp. 1340-1349.

Mertens, DR 2002, 'Gravimetric determination of amylase-treated neutral detergent fiber in feeds with refluxing in beaker or crucibles: collaborative study', Journal of AOAC International, vol. 85, no. 6, pp. 1217-1240.

Mezzomo, R, Paulino, PVR, Barbosa, MM, da Silva Martins, T, Paulino, MF, Alves, KS, Gomes, DI & dos Santos Monnerat, JPI 2015, 'Performance and carcass characteristics of young cattle fed with soybean meal treated with tannins', Animal Science Journal, vol. 87, no. 6, pp. 775-782.

Müller, L 1980, Norms for Carcass Avaliation and Carcass Concourse of Cattle, Federal University of Santa Maria, Santa Maria, p. 31.

National Research Council (NRC) 1996, 7rd edn, Nutrient requirements of beef cattle, National Academic Press, Washington.

National Research Council (NRC) 2001, 7rd edn, Nutrients requirements of dairy cattle, National Academy of Sciences,Washington.

Oliveira, DM, Ladeira, MM, Chizzotti, ML, Machado Neto, OR, Ramos, EM, Gonçalves, TM, Bassi, MS, Lanna, DP & Ribeiro, JS 2011, 'Fatty acid profile and qualitative characteristics of meat from Zebu steers fed with different oilseeds', Journal of Animal Science, vol. 89, no. 8, pp. 2546–2555.

Oliveira, DM, Ladeira, MM, Chizzotti, ML, Bassi, MS, Machado Neto, OR & Busato, KC 2013, 'Carcass characteristics of zebu steers receiving different oleaginous grains', Acta Scientiarum, Animal Sciences, vol. 35, no. 3, pp. 301-306.

Rogério, MCP, Borges, I, Santiago, GS & Teixeira, DAB 2003, 'Use of cottonseed in ruminant feed', Veterinary Science and zoology file, UNIPAR, vol. 6, no. 1, pp. 85-90.

SAS INSTITUTE (SAS/STAT) 2002, version 9.0, User's Guide for windows environment, Cary.

Silva, MLP 2016, 'Growth performance and meat quality of beef cattle fed different diets on feedlot', PhD thesis, Universidade Estadual Paulista, Jaboticabal, Brazil.

Sniffen, CJ, O'Connor, DJ, Van Soest, PJ, Fox, DG & Russel, JB 1992, 'A net carbohydrate and protein system for evaluating cattle diets: II: carbohydrate and protein availability', Journal Animal Science, vol. 70, no. 11, pp. 3562-3577.

Thiex, NJ, Anderson, S & Gildemeister, B 2003, 'Crude fat, hexanes extraction, in feed, cereal grain, and forage (Randall/Soxtec/submersion method): collaborative study', Journal of the Association of Official Analytical Chemists, vol. 86, no.5, pp. 899-908.

Valente, TNP, Detmann, E & Sampaio, CB 2015, 'Review: Recent advances in evaluation of bags made from different textiles used in situ ruminal degradation', Canadian Journal of Animal Science, vol. 95, no. 4, pp. 493-498.

Van Soest, PJ, Robertson, JB & Lewis, BA 1991, 'Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition', Journal of Dairy Science, vol. 74, no. 10, pp. 3583–3597.

Zhou, Z, Gao, X, Li, J, Chen, J & Xu, S 2011, 'Effect of castration on carcass quality and differential gene expression of longissimus muscle between steer and bull', Molecular Biology Reports, vol. 38, no. 8, pp. 5307-5312.