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Production and quality of beef from young bulls fed diets supplemented with peanut cake

B.R. Correia [a,*], G.G.P. Carvalho [b], R.L. Oliveira [b], A.J.V. Pires [c], O.L. Ribeiro [b], R.R. Silva [c], A.G. Leão [d], J.I. Simionato [e], B.M.A. Carvalho [f]

[a] Postgraduate Studies in Animal Science, State University of Southwest Bahia, Brazil
[b] Federal University of Bahia, Brazil
[c] State University of Southeast Bahia, Brazil
[d] Federal University of Mato Grosso, Brazil
[e] Federal Technological University of Paraná, Brazil
[f] Federal University of Minas Gerais, Brazil

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ABSTRACT

Peanut cake is a biodiesel byproduct that has been tested as an alternative feed additive for use in cattle production. This study aimed to assess the importance of dietary peanut cake inclusion for young bull growth rate, beef production, and beef quality. In total, 32 Nellore young bulls individually housed in stalls with a mean initial body weight of 390 ± 43.5 kg were distributed in a completely randomized design for the experiment. The animals were fed Tifton 85 hay and one of four concentrate mixtures with 0, 33, 66 or 100% peanut cake instead of soybean meal. There was a linear reduction ($P < 0.05$) in the slaughter weight and hot carcass weight and a quadratic effect ($P < 0.05$) on the beef texture. No alterations occurred in the physicochemical characteristics of the longissimus thoracis; however, changes were observed ($P < 0.05$) in the longissimus thoracis fatty acid profile. The replacement of soybean meal with peanut cake at levels up to 100% in the diet of feedlot-finished young bulls promotes a beneficial increase in the levels of PUFAs and the following nutraceutical compounds: conjugated linoleic acid (CLA) and Ω3 and Ω6 fatty acids.

1. Introduction

Brazil has the world's largest commercial cattle herd with approximately 200 million heads (MAPA, 2014) and a production of approximately 9.3 million tons of carcasses per year (USDA, 2014). Since 2004, Brazil has consolidated itself as the largest beef exporter, selling its products to more than 180 countries (MAPA, 2014). However, the use of new technologies is essential to increase beef production and improve its quality to meet the internal and external demands and, thus, consolidate existing markets and access new markets.

The concept of beef quality is relative because, in addition to the chemical composition, other parameters including the appearance, juiciness, texture and color are important for product acceptance by consumers (Domingues et al., 2015; Baba, Kallas, Costa-Font, Gil, & Realini, 2016). Beef quality, in turn, may be affected by animal nutrition, and several byproducts of biodiesel production may be used as viable alternatives in animal feed (Gonzaga Neto et al., 2015; Oliveira, Palmieri, et al., 2015; Oliveira, Faria, et al., 2015).

Peanut (*Arachis hypogaea*) has become a key economic alternative crop among oilseeds cultivated for biodiesel production. The byproduct of the extraction of peanut seed oil has a high nutritional value, particularly regarding protein levels (41 to 45%) and lipids (8 to 9%) (Silva, Medeiros, et al., 2015; Gonzaga Neto et al., 2015), with a chemical composition comparable to that of soybean meal (Silva, Oliveira, et al., 2015), a traditional and costly ingredient in animal feed.

This study evaluated the carcass traits, physicochemical characteristics and fatty acid profile of beef from feedlot-finished young bulls fed diets supplemented with peanut cake.

2. Materials and methods

2.1. Location, animals and diets

This study was performed in strict accordance with the recommendations in the Guide for the National Council for Animal Experiments Control (CONCEA). The protocol was approved by the Committee on the Ethics of Animal Experiments of the Federal University of Bahia, Bahia State, Brazil (Permit Number: 03-2012). The animals were slaughtered by captive bolt, as per the requirement for the welfare of

* Corresponding author at: Federal University of Recôncavo Bahia, Department of Animal Science, 44380000, Cruz das Almas City, BA, Brazil.
E-mail address: brauliorochacorreia@hotmail.com (B.R. Correia).

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the animals in the Industrial Inspection and Sanitary Regulation of Animal Products, and all efforts were taken to minimize suffering.

The experiment was conducted in the period from November 2010 to March 2011 at the Experimental Farm of the School of Veterinary Medicine and Animal Science, Federal University of Bahia, located in the city of São Gonçalo dos Campos, Bahia State, Brazil.

Thirty-two entire Nellore young bulls were used, eight per experimental diet, with an initial mean body weight of 390 ± 43.5 kg and mean age of 15 months. The animals were individually housed in 2.0 × 4.0 m stalls that were partially covered and equipped with feeders and drinkers. Measurements of animal weights were performed at baseline and every 28 days during the trial.

The diets, consisting of peanut cake, soybean meal, ground corn, mineral premix, urea and ammonium sulfate at a 9:1 ratio (urea S/A) and Tifton 85 hay (Table 1), were formulated to be isonitrogenous (15% crude protein, CP) and isocaloric (65% total digestible nutrients, TDNs), with a 40:60 roughage: concentrate ratio in the form of a mixed total diet, according to the guidelines from the National Research Council (NRC, 2000) for daily gains of 1.2 kg (Table 2).

The experimental diets contained four amounts of peanut cake (0, 33, 66 and 100%) as a replacement for the soybean meal in the concentrate, with ground corn and Tifton 85 hay as roughage (Table 2).

The animals were fed twice daily at 8:00 am and 4:00 pm, according to the dry matter (DM) intake on the previous day, to maintain the percentage of daily leftovers at 10% of the feed supply and avoid limiting the intake. Samples of the concentrate ingredients, roughage and leftovers were collected and stored at −20 °C for subsequent analyses.

2.2. Analyses of nutrients and diet

The samples of food and leftovers were predried at 55 °C for 72 h; ground in a Wiley mill (Tecnal, Piracicaba City, São Paulo State, Brazil) with a 1 mm sieve; stored in air-tight, plastic containers (ASS, Ribeirão Preto City, São Paulo State, Brazil); and sealed properly until laboratory analysis was performed for the DM levels, ash, CP and ether extract (EE) (Methods 967.03, 942.05, 920.29 and 981.10, respectively; AOAC, 1990). To determine the neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents, the methodology of Van Soest, Robertson, and Lewis (1991) was used, with the modifications that were proposed in the Ankom device manual (Ankom Technology Corporation, Macedon, New York, USA). The correction of NDF and ADF for the nitrogen compounds and the estimation of the neutral (NDIN) and acid (ADIN) detergent insoluble nitrogen compounds were performed according to Licitra, Hernandez, and Van Soest (1996). The non-fiber carbohydrates (NFCs) were obtained according to Mertens (2002). The TDNs were calculated using the formula estimates of digestibility for each analytical fraction given by the NRC (2001). The ingredient percentages and chemical composition are shown in Table 2.

Table 1
Chemical composition of the ingredients used in the experimental diets.

Item	Ingredients			
	Ground corn	Soybean meal	Peanut cake	Tifton 85 hay
Dry matter[a]	94.43	95.76	96.46	85.70
Mineral matter[b]	1.36	7.05	5.26	7.30
Crude protein[b]	7.10	44.91	44.52	6.96
Ether extract[b]	2.65	2.06	14.71	1.31
Neutral detergent fiber[b,d]	11.84	25.91	17.60	80.35
Acid detergent fiber[b]	4.39	20.01	15.55	55.09
Lignin[b]	0.08	0.22	6.85	9.90
Hemicellulose[b]	5.46	9.29	11.31	27.80
Non-fiber carbohydrates[b]	77.04	20.07	17.91	4.08
Neutral detergent insoluble nitrogen[b]	1.71	5.00	2.68	0.76
Acid detergent insoluble nitrogen[b]	2.85	2.72	1.99	0.41
Estimated TDNs [c]	86.50	72.25	78.22	53.65

[a] Values as a percentage of the natural matter.
[b] Values as a percentage of the dry matter.
[c] Total digestible nutrients, estimated using the equations given by the NRC (2001).
[d] Corrected for ash and protein.

Table 2
Composition of experimental diets.

Ingredients (%)	Peanut cake (%)			
	0	33	66	100
Peanut cake	0.00	4.08	8.16	12.23
Soybean meal	12.16	8.10	4.05	0.00
Ground corn	44.88	44.91	44.94	44.91
Mineral premix[a]	1.52	1.48	1.43	1.43
Urea S/A[b]	1.43	1.43	1.43	1.43
Tifton 85 hay	40.00	40.00	40.00	40.00
Chemical composition				
Dry matter[c]	91.27	91.29	91.32	91.35
Mineral matter[d]	4.39	4.32	4.25	4.18
Crude protein[d]	15.70	15.56	15.42	15.42
Ether extract[d]	1.96	2.48	3.00	3.51
Total carbohydrates[d]	77.94	77.64	77.33	76.89
Neutral detergent fiber[e]	40.61	40.28	39.95	39.61
Acid detergent fiber[d]	26.44	26.26	26.09	25.91
Non-fiber carbohydrates[d]	38.65	38.59	38.52	38.42
Estimated TDNs[f]	69.07	69.35	69.64	69.88

[a] Levels of active elements (per kg): calcium 240.00 g; phosphorus 174.00 g; copper 1250.00 mg; cobalt 100.00 mg; iron 1795.00 mg; iodine 90.00 mg; manganese 2000.00 mg; selenium 15.00 mg; zinc 5270.00 mg; and fluorine 1740.00 mg.
[b] Urea and ammonium sulfate at a 9:1 ratio.
[c] Values as a percentage of the natural matter.
[d] Values as a percentage of the dry matter.
[e] Corrected for ash and protein.
[f] Total digestible nutrients, estimated using the equations given by the NRC (2001).

2.3. Carcass traits, beef quality and fatty acid profile

At the end of confinement, the animals were weighed after a 14 h period of fasting from solids and were slaughtered the same day in a commercial slaughterhouse by mechanical stunning followed by bleeding, skinning and evisceration. The carcasses were identified and weighed to assess the hot carcass weight (HCW) and hot carcass yield (HCY) following slaughter. Subsequently, they were refrigerated for 24 h at 2 °C. The right side of the carcass was used to assess the following quantitative carcass traits: carcass length (CL), leg length (LL), cushion thickness (CT), rib eye area (REA) and subcutaneous fat thickness (SFT).

The carcass length was measured using a measuring tape to determine the distance from the anterior edge of the pubic bone to the medial, cranial edge of the first rib. An aluminum caliper compass was used to determine the leg length, measuring the distance between the anterior edge of the pubic bone and the medial point of the bones of the tarsal joint. The cushion thickness was assessed using an aluminum caliper compass to measure the distance between the lateral and medial sides of the upper portion of the cushion using a measuring tape.

The section between the 10th and 13th ribs on the right half carcass was removed according to the methodology described by Hankins and Howe (1946) and adapted by Muller (1987). The subcutaneous fat thickness was measured using a precision caliper at three equidistant points in the cut region between the 12th and 13th ribs. The rib eye area was also assessed at that point, in cm^2, using a standard planimeter. Subsequently, all the portions removed from the right half carcasses were frozen for analysis. The evaluations of beef color and texture were performed in the section removed from the right half carcass, according to the 1 to 5 scale proposed by Muller (1987). The texture was scored with grade values from 5 (very fine) to 1 (very coarse), and the color was scored with grade values from 5 (bright red) to 1 (dark).

The sections removed from the half carcasses for the laboratory analyses were thawed at room temperature and each dissected using a scalpel and knife to obtain the longissimus thoracis muscle, from