DOI: 10.5433/1679-0359.2016v37n4Supl1p2343

Qualitative feed restriction for late finishing pigs on meat quality and fatty acid profile[1]

Restrição alimentar qualitativa para suínos em fase de terminação sobre a qualidade da carne e perfil de ácidos graxos

Apauliana Daniela Lima da Silva[2*]; José Aparecido Moreira[3]; Rafael Leandro Ramos de Oliveira[2]; Lorena Cunha Mota[4]; Elisanie Neiva Magalhães Teixeira[3]; Janete Gouveia de Souza[3]; Emerson Moreira de Aguiar[3]; Rômulo Genuíno Pessoa de Oliveira[5]

Abstract

The aim of this study was to evaluate the effects of including cashew bagasse bran (CBB) as a food ingredient in qualitative feed restriction programs on the carcass traits and meat quality of barrows and gilts. Twenty–four crossbred pigs (12 barrows and 12 gilts) were used, with an average initial body weight of 57.93 ± 3.67 kg/LW. The experimental design was a randomized block 3x2 factorial arrangement with three levels (0%, 15% and 30% CBB), two sexes (barrows and gilts) and four repetitions. The treatments were composed of the basal diet (BD) formulated with corn, soybean meal and a commercial base mix for finishing pigs, to which different levels of CBB were added. At the end of the trial period, the animals were slaughtered for the evaluation of the meat quality and carcass traits. The inclusion of CBB in the diets did not affect the carcass traits of the gilts but affected the carcass traits of the barrow positively, increasing theyield of meat in the chilled carcass and reducing the thickness of subcutaneous fat. In the *longissimus dorsi* muscle and in the adipose tissue of the pigs, the myristic (C14:0), palmitoleic (C16:1), oleic (C18:1), linoleic (C18:2), linolenic (C18:3) and arachidonic (C20:4) fatty acids were evaluated, and no effect was observed (P>0.05) from the levels of CBB in the diets. In the comparisons between the sexes, a greater concentration of C20:4 fatty acid was observed in the carcass of the gilts. In this context, CBB was considered for use as a feed ingredient in programs of qualitative feed restriction for finishing pigs.
Key words: Alternative food. Fat. Nutrition. Pig farming.

Resumo

Objetivou-se com este estudo avaliar os efeitos do farelo do bagaço de caju (CBB) como ingrediente de rações em programas de restrição alimentar sobre as características da carcaça e da qualidade da carne de suínos machos castrados e fêmeas. Foram utilizados vinte e quatro suínos mestiços (12 machos

[1] Parte da Dissertação de Mestrado do primeiro autor.
[2] Mestres em Produção Animal, Unidade Acadêmica Especializada em Ciências Agrárias, Universidade Federal do Rio Grande do Norte, UFRN, Macaíba, RN, Brasil. E-mail: apauliana@yahoo.com.br; rafael.lro@hotmail.com
[3] Profs. Drs., Unidade Acadêmicas Especializada em Ciências Agrárias, UFRN, Macaíba, RN, Brasil. E-mail: aparecidoufrn@gmail.com; elisanieteixeira@yahoo.com.br; jnobre5@hotmail.com; emersonaguiar@ufrnet.br
[4] Discente do Curso de Doutorado do Programa de Pós-Graduação em Zootecnia, Universidade Federal de Goiás, UFG, Nova Veneza, GO, Brasil. E-mail: lorenacmota@gmail.com
[5] Zootecnista, Unidade Acadêmicas Especializada em Ciências Agrárias, UFRN, Macaíba, RN, Brasil. E-mail: r.pessoa.genuino@hotmail.com
[*] Author for correspondence

Recebido para publicação 07/07/15 Aprovado em 19/11/15

castrados e 12 fêmeas) com peso médio inicial de 57,93 ± 3,67 kg/PV. O delineamento experimental foi o de blocos casualizados em um esquema fatorial 3x2, sendo três níveis (0%, 15% e 30% de CBB), dois sexos e quatro repetições. Os tratamentos foram compostos por uma dieta basal (DB) formulada com milho, farelo de soja e núcleo comercial para suínos em terminação, contendo diferentes níveis de CBB. No final do período experimental os animais foram abatidos para a avaliação da carcaça e da qualidade de carne. A inclusão de CBB nas dietas não afetou a qualidade das carcaças das fêmeas, mas interferiu positivamente nas carcaças dos machos castrados, aumentando o rendimento de carne na carcaça resfriada e reduzindo a espessura de toucinho. Foram identificados no músculo *Longissimus dorsi* e no tecido adiposo das fêmeas e machos castrados os ácidos graxos Mirístico, C14:0; Palmitoléico, C16:1; Oléico, C18:1; Linoléico, C18:2; Linolênico C18:3 e Aracdônico C20:4, mas, não foram afetados (P>0,05) pelos níveis de CBB nas dietas. Quando se comparou os resultados entre sexo, observou-se maior concentração do ácido graxo araquidônico na carcaça das fêmeas. Neste contexto, o CBB apresentou-se como ingrediente a ser utilizado em programas de restrição alimentar qualitativa para suínos na fase de terminação.

Palavras-chave: Alimento alternativo. Gordura. Nutrição. Suinocultura.

Introduction

Brazilian pig farming occupies a prominent position among the largest producers and exporters of pig meat in the world; however, one barrier for pig breeders is the fluctuation in grain supply during the year, which results in an increased cost of production. In the Northeast region, this grain supply scenario is even worse due to the low productivity of corn and soybeans and the high prices paid by the pig producer to purchase these grains from other regions of Brazil.

In pig farming, the nutrition provided is responsible for most of the cost of production. Thus, studies seek to facilitate the use of alternative foods to replace the traditional ones, such as corn and soybean, which during given times of the year can experience increased values. In this regard, cashew bagasse, a byproduct of the cashew juice industry, is an ingredient usually wasted in the Northeast but contains high fiber content and can be used in pig diets (FARIAS et al., 2008).

The nutrition of pigs with the addition of dietary fiber may represent an alternative nutritional management, especially when it aims to improve the animal carcass parameters set for the current consumer market, which shows a preference for substrates with lower fat content.

In this context, the deposition of unwanted fat can be avoided or reduced by means of qualitative feeding restriction, which aims to reduce the consumption of digestible energy and provide improvement in the quality of the pigs’ carcasses (MOREIRA et al., 2007). Thus, the pigs exhaust their intake capacity without exceeding the required consumption of energy, which happens in a diet formulated with corn and soybean. Therefore, qualitative feeding restriction can promote a reduction in the digestible energy intake, resulting in a reduction of carcass fat, and this technique is exclusively adopted in the finishing phase. For the qualitative feeding restriction to be efficient and provide benefits to pig production, a fiber-rich ingredient, as well one that reduces the amount of energy and presents high-regional availability and low cost, is essential.

Controlling the amount of fat deposited in the pig’s carcass is one way to get better prices for the animals produced on a farm. However, the biggest problem is not directly related to the flesh but to the type of fat (monounsaturated, polyunsaturated or saturated) that is present in the diet. The main saturated fatty acids of meat are palmitic, stearic and myristic. Oleic acid is the most abundant monounsaturated, followed by palmitoleic. The linoleic, linolenic and arachidonic acids are the major polyunsaturated fatty acids.

The quality of the meat and carcass depends on intrinsic factors, such as genetics, nutrition management, age and sex, and extrinsic factors, such as the departure of the pig from the property to the entrance of the carcass into cold storage, among others (ALBUQUERQUE et al., 2009). The sex affects the carcass quality and the meat and fat ratio, with males having a higher protein deposition rate than females, which in turn have a higher rate than the castrated males (TRINDADE NETO et al., 2005), making it necessary to compare the data between the sexes.

In this context, the aim was to evaluate the effect of the inclusion of different levels of cashew bagasse bran as an ingredient in food-restriction programs on carcass characteristics, meat quality, and fatty acid profiles in the *longissimus dorsi* muscle and adipose tissue of castrated male pigs and female pigs.

Materials and Methods

The experiment protocol (004/2011) was approved by UFRN's Ethics Committee on Animal Use (CEUA) and developed in the experimental sector of pigs of the Academic Unit Specialized in Agricultural Sciences - UFRN Campus, located in the municipality of Macaíba. The municipality of Macaíba is located in the East Potiguar mesoregion and in the microregion of Macaíba, with the coordinates: 05°51'28,8"South latitude and 35°21'14,4" West longitude.

Twenty-four crossbred pigs were used, twelve castrated males and twelve females, with initial weights of 57.93±3.67 kg, housed in an experimental shed with concrete floor, containing trough or chute-type feeders and pacifier-type water dispensers. Thermometers indicating maximum and minimum temperatures were used, and those were placed inside the shed in a bay at the height of the animals for daily recording throughout the experimental period. Maximum and minimum temperatures, relative humidity and ITU (temperature and humidity index) of the experimental period were 32.4 and 24°C, 84% and 80, respectively.

The animals were distributed in a randomized block design in a 3x2 factorial scheme with three levels of cashew bagasse bran (CBB), both sexes and four repetitions, and the animal represented the experimental unit, which totaled 24 installments. The animals were fed with a basal diet (BD) formulated with corn, soybean and commercial base mix for finishing pigs, with different levels of inclusion of CBB, constituting the following treatments:1) basal diet with 0% CBB, 2) basal diet with 15% CBB, and 3) basal diet with 30%CBB.

The cashew bagasse was obtained by removing the pseudo-fruit juice, followed by drying of the residue in the sun for three days with subsequent grinding. A collection of a representative sample of the total residue for determining the chemical and nutritional composition of cashew bagasse was performed. Analysis of the cashew bagasse composition (BC) was performed in the animal nutrition laboratory at UFRN following the methodology proposed by Silva and Queiroz (2002).

The chemical composition of the cashew bagasse was as follows: dry matter 88.96%, mineral matter 4.64%, organic matter 95.36%, raw protein 15.98%, ethereal extract 2.42%, raw energy 5622.3 kcal, digestible energy 1680 kcal/ED, FDN 68.15%, FDA 41.15%, cellulose 24.30%, hemicellulose 23.56% and lignin 24.19%.

The diets were formulated to meet the nutrient requirements for pigs in the finishing phase according to Rostagno et al. (2005). However, the diet was formulated to maintain the qualitative dietary restriction with decreasing energy according to the increase in CBB levels. The percentage composition and the calculated values of the experimental diets are shown in Table 1.

The animals received water and food *ad libitum*, and the animals and feed were weighed every 14 days. When the animals reached an average of

95±7.42 kg/PV, they underwent fasting for 12 hours and then were transported to the city's meat processing unit in São Paulo do Potengi (RN), where they were slaughtered.

Table 1. Composition of experimental diets for pigs in finishing phases.

Ingredients (%)	Levels of cashew bagasse brans (%)		
	0	15	30
Corn	74.85	62.86	50.87
Soybean bran	22.14	19.14	16.13
Cashew Bagasse	0.00	15.00	30.00
Commercial core[1]	2.50	2.50	2.50
Soy oil	0.50	0.50	0.50
Calculated composition	100	100	100
Digestible Energy kcal/kg	3.400	3.134	2.866
Raw protein	16.50	16.50	16.50
Digestible Lysine	0.69	0.64	0.59
Digestible Methionine	0.25	0.24	0.24
Digestible Tryptophan	0.16	0.14	0.12
Calcium	0.69	0.69	0.69
Total Phosphorus	0.31	0.31	0.31
Available Phosphorus	0.14	0.14	0.14
Sodium	0.17	0.17	0.17
FDA	4.28	9.81	15.34
FDN.	11.68	20.11	28.53

* Assurance levels per kg of product: calcium (min) 240 g; calcium (max) 245 g; phosphorus (min) 25 g; sodium (min) 55 g; iron (min) 3,200 mg; copper (min) 5,000 mg; manganese (min) 1,280 mg; zinc (min) 2,400 mg; iodine (min) 25.50 mg; Cobalt (min) 12.80 mg; Selenium (min) 9.60 mg; Vitamin a (min) 180 IU; Vitamin d3 (min) 32,000 IU; vitamin e (min) 720 IU; Vitamin k3 (min) 36 mg; Vitamin b1 (min) 27 mg; Vitamin b2 (min) 108 mg; Niacin (min) 638 mg; patotenic acid (min) 362 mg; Vitamin b6 (min) 36 mg; folic acid (min) 18 mg; biotin (min) 1.80 mg; Vitamin b12 (min) 580 mg; colistin 200 mg; Phytase u/g.

Bleeding was conducted immediately after the electrical stunning, and the animals were shaved and eviscerated. The carcasses were sawn in half leaving the tails along with the left halves of the carcasses; the carcass halves were set after being weighed in the cold chamber, where they remained for 24 hours at a temperature of 2±1°C following the recommendations of the Brazilian Method of Carcass Classification (BRIDI; SILVA, 2009).

After cooling, the half carcasses were evaluated using the following procedures and with the aid of a caliper: carcass length (CC) was measured from the cranial edge of the pubic symphysis to the edge of the ventral skull of the atlas, and back fat thickness (BT) was measured at the height of the first rib (BT1), the last rib (BT2), and the last lumbar (BT3) (BRIDI; SILVA, 2009).

The calculations for meat yield and the amount of meat in the carcass were carried out according to Bridi and Silva (2009).

The pH value was determined with the aid of a portable pH meter and an insertion electrode 45 minutes and 24 hours after slaughter.

The color of the muscle was determined using a color panel on a scale of 1-6, where 3 was considered normal and values below that indicated a tendency to PSE meat (pale, soft and exudative), and values above meant DFD meat (dark, firm and dry) (BRIDI; SILVA, 2009).

The profile of the fatty acids of the *longissimus dorsi* muscle and of the adipose tissue was performed according to the method of Bligh and Dyer (1959).

A mixture containing 10 g of crushed wet sample of the muscle or 6 g of minced wet sample of fat, 25 ml of chloroform and 50 mL of methanol was homogenized on a shaker table for 20 minutes and then left resting in the freezer for 16 h at -19ºC.

After 16 hours, the mixture was filtered on filter paper and transferred to a 250 mL separation hopper, and then 25 ml of chloroform and 25 ml of 2% sodium sulfate solution were added while the mixture was being vigorously stirred and then was allowed to rest for 2 h.

A two-phase system was formed, and the lower phase, containing purified lipids diluted in chloroform, was filtered through filter paper containing anhydrous sodium sulfate and was collected in a previously weighed volumetric flask. The samples were stored in an amber vial and frozen at -20° C until the time of esterification, and subsequently, the solvent was evaporated entirely using nitrogen gas.

The oils extracted from the *longissimus dorsi* muscle and subcutaneous fat were esterified and methylated according to the methodology of Hartman and Lago (1973).

The determination of fatty acids was obtained by gas chromatography (Thermo Scientific - GC/FID – FOCUS) with a flame ionization detector (FID) and Supelco SPTM capillary column-2560 (100 m × 0.25 mm × 0.2 μm). The temperatures of the detector and the injector were 270 and 230ºC, respectively. The programming of the column heating proceeded as follows: 40°C for 3 minutes, then increasing to180°C at a rate of 10°C/min and then held for 5 min; increasing from 180°C to 220°C at a rate of 10°C/min and then held for 3 min; and, finally, increasing from 220°C to 240°C at a rate of 20°C/min and then held for 25 min. The injection volume was a 1 μl split ratio of 1:10. The carrier gas used was nitrogen. The identification and quantification of the peaks were made by comparison of retention times and peak area of the samples with the patterns of fatty acid methyl esters (Supelco 37 FAMEs components Mix, ref.47885-U).

The parameters studied were submitted to analysis of variance and "t" test in accordance with the procedures of the SAS Institute (2002).

Results and Discussion

The parameters of slaughter weight, yield of meat in the chilled carcass, yield of the hot carcass, amount of meat in the carcass, back fat thickness and shank yield of the females were not influenced (P>0.05) by cashew bagasse bran levels in the diet. The same was shown to occur with the castrated males in relation to slaughter weight, amount of meat in the carcass and shank yield (Table 2). Gomes et al. (2007), when studying the different levels of FDN (neutral detergent fiber) in the feed of pigs in the final finishing stage, also observed no effect on the hot carcass yield, lean meat yield, loin eye area and back fat thickness.

The castrated males fed diets containing 30% CBB had better meat yield in the chilled carcass (RCCR) (P<0.05) compared with treatments without the CBB. When comparing the results of sex, higher values were observed for the females (P<0.05).

In determining the RCCR variable, the ratio between the amount of meat and fat in the carcass is considered, so females had higher protein deposition rate and lower fat deposition rate in the carcass than the castrated males (TRINDADE NETO et al., 2005). This result is favorable because it is promising and justifies the use of higher fiber percentages in the diet through the addition of CBB, even though this diet produces less carcass, when the objective is to obtain a thinner shell and often results in subsidies for the cold storage centers.

Table 2. Carcass characteristics and meat quality of pigs fed with cashew bagasse bran.

Parameters	Bran levels of cashew bagasse (%)			Average	[1]CV
	0%	15%	30%		
Slaughter weight (males) (kg)	96.35	99.70	96.10	97.38	8.28
Slaughter weight (females) (kg)	96.40	96.00	93.45	95.28	
Meat yield in chilled carcass (male) (%)	55.45[b]	54.76[b]	58.99[a]	56.40[b]	4.91
Meat yield in chilled carcass (female) (%)	57.62	59.80	60.23	59.18[a]	
Hot carcass yield (males) (%)	76.02[a]	75.37[a]	73.03[b]	74.80	4.34
Hot carcass yield (males) (%)	75.14	72.11	73.01	72.45	
Quantity of meat on the carcass (males) (kg)	38.62	39.44	39.01	39.04	8.52
Quantity of meat on the carcass (males) (kg)	38.62	39.44	39.01	39.04	
Back fat thickness (males) (mm)	25.90[a]	19.62[b]	17.92[b]	21.15	19.48
Back fat thickness (female) (mm)	22.45	22.10	17.52	21.42	
Shank yield (males) (%)	30.95	31.21	31.63	31.26	2.28
Shank yield (females) (%)	31.39	31.31	31.89	31.72	
Final pH (males)	6.00	6.10	6.10	6.08	4.99
PH end (female)	5.87	5.92	5.85	5.85	
Color (males)	2.50	2.50	2.75	2.50	21.19
Color (females)	3.00[a]	2.00[b]	2.25[b]	2.33	

Averages followed by different capital letters vertically (sexual condition) and lowercase letters horizontally (cashew bagasse levels) differ (P<0.05) by the "t" test. CV = Coefficient of Variation.

The hot carcass yields observed in the males and females were 74.80% and 72.45%, respectively. Similar results were found by Rosa et al. (2001), who showed a carcass yield of 74.57% in a study of animals in the growth phase. This result was positive because at the proportion of CBB levels provided in the diets, the same hot carcass yield was obtained and showed better quality considering that there were reductions in the back fat thickness.

In this experiment, castrated male animals who consumed higher levels of CBB had lower back fat thickness. Probably, these levels are attributable to the lower concentration of the digestible energy delivered: 3,134 and 2,866 kcal/kg in diets formulated with 15 and 30% of CBB, respectively.

Females have less capacity to deposit fat in the carcass; thus, the energy deficit in the diets containing CBB was not enough to significantly affect this category. Costa et al. (2005) evaluated the use of sunflower cake, an ingredient with energetic character and intermediate protein level but with high level of raw fiber, in diets of growing and finishing pigs. They observed a higher fat deposition rate in the castrated males, which may be explained by the ability of these animals to maintain their carcasses and to the addition of lipids to the diet whereby energy was adjusted through the addition of oil.

Regarding the variables of hot carcass yield, amount of meat, back fat thickness, shank yield, pH and color, no interaction was observed between the sexes. Although the fiber provides dilution in the energy level of the diet, the use of fibrous ingredients can have an adverse effect on the digestibility of the diets, mainly due to the composition of the fiber. However, there are points that need to be better studied to determine the most suitable types of fiber, the required level, and the effects on the final product.

Latorre et al. (2004), when studying the effects of sex and slaughter weight on carcass characteristics and quality of pigs in the finishing phase, observed the presence of a large amount of fat in the carcasses of the castrated males compared with the females. However, carcass yield was lower in the male than in the female pigs. According to these authors, the sex can lead to differences in the deposition of fat and lean tissue in the carcass and the physicochemical properties of the meat.

The use of CBB in the diets affected the back fat thickness (BT) of the castrated males, providing lower values when compared with the control treatment. This decrease in BT can be attributed to a deficit of digestible energy in diets supplemented with the CBB. The decrease in BT is one of the main targets set by the meat industry, especially when the reduction of such parameter is accompanied by an increase in the percentage of lean meat and increased loin eye area.

The decrease in back fat thickness and the increase in muscle mass production result in improved carcass quality, although sometimes this improvement may also be associated with the lowest body weight gain of pigs fed fibrous diets (GOMES et al., 2008). However, of greater importance than the weight gain of the animals, the production of lean meat is possible with qualitative restrictions that improve utilization of dietary energy, allowing better classification and increasing the subsidies for the cold storage centers, according to Fraga et al. (2008), who used rice husk as an energy thinner in diets for pigs.

The shank yield (SY) was not affected (P>0.05) by the experimental diets. The results obtained in this study disagreed with those obtained previously by Watanabe et al. (2010), who tested the inclusion of citrus pulp at 0, 10, 20 and 30% in a qualitative feed restriction program for finishing pigs on carcass characteristics and meat quality. They observed a linear reduction in shank weight (P=0.0003) with an increase in citrus pulp in the diet, but no deterioration in carcass performance was observed.

SY values showed no difference between the males and females. Latorre et al. (2004) evaluated the effect of sex and slaughter weight on the carcass characteristics and meat quality of pigs in the finishing phase and concluded that the length of the carcass and shank did not differ between the castrated males and females. However, the circumference of the shank was greater for males than for females, although these authors also found larger shanks in the carcasses of females than males.

According to Galassi et al. (2004), the shanks of slaughtered animals of more than 130 kg represent 30% of the carcass weight, but commercially, the shanks represent up to 60% of the value of the animal because of the manufacture of cured products with high added value. Thus, it is essential that the use of qualitative feed restriction promote improved carcass quality and at least maintain the shank yield, as observed in this experiment.

No significant difference (P>0.05) was observed in the pH, with values falling within the range of variation (5.8-6.0), which is reported in the literature as ideal. The pH is the most important parameter in determining the final quality of the meat because it is related to various quality characteristics such as color, texture, water retention capacity and conservation (ROSA et al., 2001).

In a study of animals in the growth phase, Rosa et al. (2001) observed that the average pH for the first hour postmortem was 5.78. According to these authors, the value (5.78) suggests an incidence of PSE meat (pale, soft and exudative). On the other hand, a pH value of 5.66 at 72 hours *postmortem* can be considered normal, assuming that there has been no problem with acidic meat.

The color is a subjective parameter for assessing the quality of meat on a scale of 1 to 6, with3 being considered normal. Thus, lower values tend to indicate PSE meat, and higher values tend to indicate DFD meat. In the carcasses of the females evaluated in this experiment, the diets with 15 and 30% of CBB showed lower values, 2.0 and 2.25, respectively. The color of the meat is related to the myoglobin pigments existing in the muscles.

The amount of myoglobin in the muscle varies depending on the species, age, sex, and physical activity performed by the animal (SARCINELLI et al., 2007).

Obtaining PSE meat is related to pre-slaughter factors such as genetics, nutrition and management (SARCINELLI et al., 2007). Possibly, stress in the boarding period contributed to the PSE meat from thein female pigs in the qualitative feed restriction. Carcasses with PSE meat develop an accelerated decomposition function of glycogen after slaughter, leading to a higher concentration of lactic acid, which causes low muscle pH value, while the temperature of the muscle is still close to the physiological state (>38°C). This pH reduction causes denaturation of the proteins responsible for water binding capacity and, therefore, affects the color of the meat (MANGANHINI et al., 2007).

The color of the meat can be influenced by its pH; however, the final pH value of the meat of females that received the diets containing 15 and 30% CBB was considered normal at 5.92 and 5.85, respectively.

The myristic, palmitoleic, oleic, linoleic and linolenic fatty acids were not affected (P>0.05) by the levels of CBB in the diet (Table 3). According to Rule et al. (1994), the nutritional composition of pig meat and the unsaturated fatty acid content (AGI) are strongly influenced by the diet composition. The AGI of the feed is deposited directly into the tissues without chemical change, making it possible to manipulate the fatty acid composition of the meat and fat by feeding (KOUBA; MOUROT, 2011).

Table 3. Profile of fatty acids in *Longissimus dors*i muscle in pigs fed different levels of cashew bagasse bran.

Fatty acids[1]	Levels of cashew bagasse brans (%)			Average	[2]CV
	0%	15%	30%		
C14:0 (male)	1.24	1.16	1.50	1.30	48.63
C14:0 (females)	1.01	1.14	1.04	1.06	
C16:1 (male)	1.91	2.11	1.64	1.89	38.99
C16:1 (females)	2.17	3.01	2.22	2.46	
C18:1 (male)	26.11	24.49	23.46	24.69	21.05
C18:1 (females)	26.20	29.84	24.89	26.98	
C18:2 (male)	22.23	23.52	21.47	22.41	21.56
C18:2 (females)	22.30	17.82	23.07	21.06	
C18:3 (male)	0.35	0.40	0.48	0.41	60.15
C18:3 (females)	0.31	0.24	0.30	0.28	
C20:4 (male)	4.54	5.40	4.00	4.64^{B}	39.94
C20:4 (females)	6.57	8.92	7.11	7.53^{A}	

Averages followed by different capital letters vertically (sexual condition) and lowercase letters horizontally (cashew bagasse levels) differ (P<0.05) the test "t"; [1]IUPAC Classification; C14:0, Myristic; C16:1, Palmitoleic; C18:1 Oleic; C18:2, Linoleic; C18:3 Linolenic; C20:4, Arachidonic.[2]CV= coefficient of variation.

Reducing the energy content in diets containing the CBB led to a reduction in the back fat thickness of the castrated males (P<0.05) but did not cause changes in the fatty acid profile.

The loin eye represents a tissue with a very low fat content (BRAGNOLO; RODRIGUEZ-AMAYA, 2002). Therefore, a comparison of the fatty acid profile of the tissue with fat tissue is important.

However, during this experiment, no differences were observed between tissues (Table 4). This result proves that the use of CBB in a qualitative feed restriction program leads to a reduction in the fat content of the carcass but does not alter the composition of the fatty acids.

Table 4. Profile of fatty acids in the fat tissue in pigs fed different levels of cashew bagasse bran.

Fatty acids in the fat tissue[1]	Levels of cashew bagasse bran (%)			Average	[2]CV
	0%	15%	30%		
C14:0 (male)	1.57	1.54	1.55	1.55	20.84
C14:0 (females)	1.56	1.29	1.67	1.50	
C16:1 (male)	0.60	0.75	0.67	0.79	31.79
C16:1 (females)	0.85	0.80	0.70	0.67	
C18:1 (male)	38.04	37.60	38.14	37.93	3.74
C18:1 (females)	38.41	38.25	39.09	38.58	
C18:2 (male)	13.66	15.42	16.70	15.26^{B}	24.95
C18:2 (females)	21.83	18.45	19.57	19.95^{A}	
C18:3 (male)	0.72	0.68	0.61	0.67	25.74
C18:3 (females)	0.73	0.53	0.77	0.68	
C20:4 (male)	0.15	0.15	0.30	0.17^{B}	37.52
C20:4 (females)	0.30	0.23	0.24	0.26^{A}	

Averages followed by different capital letters vertically (sexual condition) and lowercase letters horizontally (cashew bagasse levels) differ (P<0.05) the test "t"; [1]IUPAC Classification; C14:0, Myristic; C16:1, Palmitoleic; C18:1 Oleic; C18:2, Linoleic; C18:3 Linolenic; C20:4, Arachidonic.[2]CV= coefficient of variation.

Watanabe et al. (2012) found no effect on the concentration of fatty acids in *longissimus dorsi* muscle samples from females fed diets with increasing levels of inclusion of ractopamine; even when the fat deposition rate decreased, the profile of the fatty acids was not changed.

Females had higher contents of arachidonic and linoleic fatty acids (P<0.05) than males. Watanabe et al. (2012) evaluated the use of ractopamine in diets for female pigs and observed no effect on the arachidonic fatty acid content, which can be explained because the AG composition of the pig muscle is obtained from the diet. Therefore, the fatty acid content provided by the diet was not enough to increase the average composition of the fatty arachidonic acid.

Rossi et al. (2010) reported that linoleic acid can be used in the transformation of arachidonic AG and linoleic acid content may contribute to lower levels of linolenic acid and its derivatives. In this study, such an effect was observed for the pig meat.

The ratio between the omega fatty acids 6/3 are bound to the action of two enzymes: desaturase and elongase, which are responsible for the synthesis of new fatty acids. The arachidonic fatty acid is synthesized from linoleic acid, and the eicosapentaenoic fatty acid (EPA) and the docosahexaenoic fatty acid (DHA) are synthesized from linolenic acid. In this process, notably, the enzymes prioritize processes involving omega 3 instead of omega 6 fatty acids; thus, increasing the ratio of these fatty acids may be beneficial to human health (MARTIN et al., 2006).

Conclusion

The inclusion of cashew bagasse bran in diets did not affect the quality of the carcasses of the females but had a positive influence on the carcasses of the castrated males, increasing the yield of meat in the chilled carcass and reducing the back fat thickness without affecting the profile of fatty acids. In this context, up to 30% inclusion of cashew bagasse bran is recommended in feed for pigs in the finishing phase and undergoing a qualitative feed restriction program.

Acknowledgements

The authors thank CNPq and UFRN for supporting the development of this experiment. We thank CNPq for the financial support for this work.

References

ALBUQUERQUE, N. I.; CONTRERAS, C. C.; ALENCAR, S.; MEIRELLES, C. F.; AGUIAR, A. P.; MOREIRA, J. A.; PACKER, I. U. Propriedades da carne e perfil de ácidos graxos do pernil de catetos (*Tayassutajacu*) alimentados com torta de babaçu (*Orbignyaphalerata*). *Arquivo Brasileiro de Medicina Veterinária e Zootecnia,* Belo Horizonte, v. 61, n. 6, p. 1419-1427, 2009.

BLIGH, E. G.; DYER, W. J. A rapid method of total lipod extraction and puricication. *Canadian Journal of Biochemistry and Physiology*, Sherbrook, v. 37, n. 8, p. 911-917, 1959.

BRAGNOLO, N.; RODRIGUEZ-AMAYA, D. B. Teores de colesterol, lipídeos totais e ácidos graxos em cortes de carne suína. *Ciência e Tecnologia do Alimento*, Campinas, v. 22, n. 1, p. 98-104, 2002.

BRIDI, A. M.; SIILVA, C. A. *Avaliação da carne suína*. Londrina: Midiograf, 2009. 120 p.

COSTA, M. C. R.; SILVA, C. A.; PINHEIRO, J. W.; FONSECA, N. A. N.; SOUZA, N. E.; VISENTAINER, J. V.; BELÉ, J. C.; BOROSKY, J. C.; MOURINHO, F. J.; AGOSTINI, P. S. Utilização da torta de girassol na alimentação de suínos nas fases de crescimento e terminação: Efeitos no desempenho e nas características de carcaça. *Revista Brasileira de Zootecnia*, Viçosa, MG, v. 34, n. 5, p. 1581-1588, 2005.

FARIAS, L. A.; LOPES, J. B.; FIGUEIRÊDO, A. V. de; ALBUQUERQUE, D. M. N.; ARAÚJO NETO, A. A. ; RAMOS, L. S. N. Pseudofruto do cajueiro (A*nacardium Occidentale L.*) para suínos em crescimento: metabolismo de nutrientes e desempenho. *Ciência Animal Brasileira*, Goiânia, v. 9, n. 1, p. 100-109, 2008.

FRAGA, A. L.; THOMAZ, M. C.; KRONKA, R. N.; BUDIÑO, F. E. L.; HUAYNATE, R. A. R.; MALHEIROS, E. B. Restrição alimentar qualitativa para suínos com elevado peso de abate. *Revista Brasileira de Zootecnia*, Viçosa, MG, v. 37, n. 5, p. 869-875, 2008.

GALASSI, G.; CROVETTO, G. M.; RAPETTI, L.; TAMBURINI, A. Energy and nitrogen balance in heavy pigs fed different fiber sources. *Livestock Production Science,* Amsterdã, v. 85, n. 2, p. 253-262, 2004.

GOMES, J. D. F.; PUTRINO, S. M.; GROSSKLAUS, C.; UTIYAMA, C. E.; OETTING, L. L; SOUZA, L. W. O.; FUKUSHIMA, R. S.; FAGUNDES, A. C. A.; SOBRAL, P. J. A.; LIMA, C. G. de. Efeitos do incremento de fibra dietética sobre a digestibilidade, desempenho e características de carcaça: I. Suínos em crescimento e terminação. *Semina: Ciências Agrárias*, Londrina, v. 28, n. 3, p. 483-492, 2007.

GOMES, J. D. F.; PUTRINO, S. M.; MARTELLI, M. R.; SOBRAL, P. J. A.; FUKUSHIMA, R. S. Desempenho e características de carcaça de suínos alimentados com dieta com feno de Tifton (*Cynodondactylon)*. *Ciência Animal Brasileira*, Goiânia, v. 9, n. 1, p. 59-67, 2008.

HARTMAN, L.; LAGO, R. C. Rapid determination of fatty acid methyl esthers from lipids. *Laboratory Practice*, Lodon, v. 22, n. 7, p. 475-476, 1973.

KOUBA, M.; MOUROT, J. A. Review of nutritional effects on fat composition of animal products with special emphasis on n-3 polyunsaturated fatty acids. *Biochimie*, Amsterdam, v. 93, n. 2, p. 13-17, 2011.

LATORRE, M. A.; LÁZARO, R.; VALENCIA, D. G.; MEDEL, P.; MATEOS, G. G. The effects of gender and slaughter weight on the growth performance, carcass traits, and meat quality characteristics of heavy pigs. *Journal of Animal Science*, Champaign, v. 82, n. 2, p. 526-533, 2004.

MANGANHINI, M. B.; MARIANO, B.; SOARES, A. L.; GUARNIERI, P.; SHIMOKOMARI, M.; IDA, E. I. Carnes PSE (Pale, Soft, Exudative) e DFD (Dark, Firm, Dry) em lombo suíno numa linha de abate industrial. *Ciência e Tecnologia do Alimento*, Campinas, v. 27, n. 1, p. 69-72, 2007.

MARTIN, C. A.; ALMEIDA, V. V.; RUIZ, M. R.; VISENTAINER, J. E. L.; MATSHUSHITA, M.; SOUZA, N. E.; VISENTAINER, J. V. Ácidos graxos poliinsaturados ômega-3 e ômega-6: importância e ocorrência em alimentos. *Revista de Nutrição*, Campinas, v. 19, n. 6, p. 761-770, 2006.

MOREIRA, I.; VOORSLUYS, T.; MARTINS, R. M.; PAIANO, D.; FURLAN, A. C.; SILVA, M. A. A. DA. Efeitos da restrição energética para suínos na fase final de terminação sobre o desempenho, característica de carcaça e poluição ambiental. *Acta Scientiarium Animal Science*, Maringá, v. 29, n. 2, p. 179-185, 2007.

ROSA, A. F.; SOBRAL, P. J. A.; LIMA, C. G.; GOMES, J. D. F. Determinação das Características físico-químicas da carne de suínos em fase de crescimento. *Revista Tecnologia da Carne*, São Paulo, v. 3, n. 1, p. 13-18, 2001.

ROSSI, C. A. R.; LOVATTO, P. A.; GARCIA, G. G.; LENHEN, C. R.; POROLNIK, G. V.; LOVATTO, G. D. Alimentação de suínos em terminação com dietas contendo ractopamina e extratos cítricos: desempenho e características de carcaça. *Ciência Rural*, Santa Maria, v. 40, n. 11, p. 2343-2349, 2010.

ROSTAGNO, H. S.; ALBINO, L. F. T.; DONZELE, J. L.; GOMES, P. C.; OLIVEIRA, R. F.; LOPES, D. C.; FERREIRA, A. S.; BARRETO, S. L. T. *Tabelas brasileiras para aves e suínos:* composição de alimentos e exigências nutricionais. Viçosa, MG: Universidade Federal de Viçosa, 2005. 252 p.

RULE, D. C.; BUSBOOM, J. R.; KERCHER, C. J. Effect of dietary canola on fatty acid composition of bovine adipose tissue, muscle, kidney, and liver. *Journal of Animal Science*, Champaign, v. 72, n. 10, p. 2735-44, 1994.

SARCINELLI, M. F.; VENTURINI, K. S.; SILVA, L. C. Características da carne suína. Série extensão. *Boletim Técnico,* Vitória, Ano 5, n. 2, p. 7-10, 2007.

SILVA, D. J.; QUEIROZ, A. C. *Análise de alimentos:* métodos químicos e biológicos. 3. ed. Viçosa, MG: Universidade Federal de Viçosa, 2002. 235 p.

STATISTICAL ANALYSIS SYSTEM - SAS. The SAS System for Windows. Release 8. 01. Cary: SAS Institute, 2002.

TRINDADE NETO, M. A.; MOREIRA, J. A.; BERTO, D. A.; ALBUQUERQUE, R.; SCHAMMASS, E. A. Energia metabolizável e lisina digestível para suínos na fase de crescimento, criados em condições de segregação sanitária. *Revista Brasileira de Zootecnia*, Viçosa, MG, v. 34, n. 6, p. 1980-1989, 2005.

WATANABE, P. H.; THOMAZ, M. C.; PASCOAL, L. A. F.; RUIZ, U. S.; DANIEL, E.; AMORIM, A. B.; CRISTANI, J.; CASTRO, F. F. Qualidade da carne de fêmeas suínas alimentadas com diferentes concentrações de ractopamina na dieta. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, Belo Horizonte, v. 64, n. 5, p. 1381-1388, 2012.

WATANABE, P. H.; THOMAZ, M. C.; RUIZ, U. S.; SANTOS, V. M.; MASSON, G. C. I.; FRAGA, A. L.; PASCOAL, L. A. F.; ROBLES-HUAYNATE, R. A.; SILVA, S. Z. Carcass characteristics and meat quality of heavy swine fed different citrus pulp levels. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, Belo Horizonte, v. 62, n. 4, p. 921-929, 2010.