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Carcass characteristics and meat quality of heavy swine fed different citrus pulp levels

[*Características de carcaça e qualidade da carne de suínos com elevado peso de abate, alimentados com dietas contendo diferentes níveis de polpa cítrica*]

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ABSTRACT

An assay with 36 swine initially weighting 83.7±5.1kg body weight (BW) was carried out to evaluate the effects of the use of different dietary citrus pulp levels, 0, 10%, 20%, and 30%, upon digestive organs weights, carcass characteristics, and meat quality of animals subjected to qualitative feed restriction program, and slaughtered at 130kg BW. Linear response ($P<0.05$) on the weight of stomach, colon, and liver were observed. Negative linear responses ($P<0.05$) on final BW and carcass yield relative to citrus pulp addition to the diet were observed. Although a negative linear effect ($P<0.05$) of increasing dietary levels of citrus pulp had been observed on ham weight, yield of this by product was not affected ($P>0.05$). Higher levels of citrus pulp neither decreased backfat thickness nor increased amount of lean meat, indicative that qualitative feed restriction was not efficient. Positive linear effect ($P<0.05$) on pH measured 24 hours after slaughter and negative linear effect ($P<0.05$) on color characteristics as function of citrus pulp dietary levels were verified. Citrus pulp addition in qualitative feed restriction program may not be effective. As no deleterious effects upon meat qualities were observed, citrus pulp can be used as an alternative feedstuff for finishing swine.

Keywords: swine, carcass typification, feed restriction, soluble fiber

RESUMO

Foi realizado um ensaio utilizando 36 suínos machos castrados, com peso inicial de 83,7±5,1kg, para avaliar o efeito da inclusão de polpa cítrica, 0, 10, 20 e 30%, em um programa de restrição alimentar qualitativa para suínos abatidos aos 130kg de peso, sobre o peso dos órgãos do sistema digestório e sobre características da carcaça e da qualidade da carne. A inclusão de polpa cítrica proporcionou aumento linear ($P<0,05$) nos pesos do estômago, cólon e fígado, e efeito quadrático ($P<0,05$) no peso do ceco. Foi observada redução linear ($P<0,05$) no peso, no rendimento da carcaça e no peso do pernil, porém não houve efeito ($P>0,05$) sobre o rendimento do pernil. Maior inclusão de polpa cítrica não foi suficiente para reduzir a espessura do toucinho e aumentar a quantidade de carne magra na carcaça, mostrando que a restrição alimentar qualitativa não foi eficiente. Foi observado aumento linear ($P<0,05$) do pH da carcaça resfriada e linear negativo ($P<0,05$) sobre as variáveis indicativas de cor da carne em função da inclusão da polpa cítrica nas dietas. A adição de polpa cítrica em programas de restrição alimentar qualitativa não foi eficiente. Por não promover nenhum efeito deletério sobre as características da carne, a polpa cítrica pode ser utilizada como ingrediente alternativo para suínos em terminação.

Palavras-chave: suíno, fibra solúvel, restrição alimentar, tipificação de carcaça

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INTRODUCTION

Since its implementation in 90's, electronic typification of pork carcasses has contributed enormously to swine production sector for the benefit of consumers, offering commercial products with better appearance and quality (Silveira, 2003). Using this system, carcasses receive higher bonus according to their percent of lean meat disqualifying those with high fat contents (Fávero et al., 1997). Development of new presentations and commercial cuts of products have led industries to search heavier carcass from animals weighing around 130kg of body weight, which in turn promote a decrease on operational cost of swine slaughter processes (Zagury, 2002).

However, finishing swine present high fat deposition (Whittemore, 1993), and slaughtering them at 130kg of body weight (BW) without any prior nutritional management may result in low bonus return, reasons that do not justify this procedure.

Thus, it is necessary to adopt restriction program either qualitative or quantitative to feed swines heavier than 100kg of body weight. For swine producers, qualitative feed restriction is more convenient since it implies only on energetic dilution of the ration by inclusion of fibrous ingredients, as residues of human food industries. Rice hulls from rice process industry (Fraga et al., 2009) as well as residues obtained from wheat processing plant (Lee et al., 2002), both tested on qualitative feed restriction programs, improved pork carcass characteristics. Other marketable subproducts can be used, but their nutritional effects should be attested.

Citrus pulp, a residue obtained from orange juice industry, is by far found at large amount in the State of São Paulo (Subprodutos..., 2006). It is an ingredient with high level of fibers, mainly soluble, and thus suitable to be used on qualitative feed restriction program for swine. Therefore, this study aimed to evaluate the effects of the utilization of different dietary levels of citrus pulp on weights of digestive organs, carcass characteristics, and meat quality of swine subjected to a qualitative feed restriction program.

MATERIAL AND METHODS

Thirty-six Topigs barrows with high capacity of lean deposition and weighing 80.4±2.7kg BW were allotted in individual pens (2.55m^2) equipped with semi-automatic feeders and communicating vessel drinkers.

Increasing levels of citrus pulp were added to the diets of animals distributed in four treatment groups during five days of adjustment before reaching the total amount of citrus pulp established in the trial protocol. Afterward, the experimental period started with barrows weighing 83.7±5.1kg BW on average. Diets (Table 1) were formulated to meet requirements of barrows weighing 105kg BW, high genetic potential for growth, and reared at a room temperature of 24°C, as proposed by NRC (Nutrient…, 1998). The values of digestible energy (DE) and calcium of citrus pulp considered to formulate diets were 2,496.04kcal/kg and 0.009%, respectively.

Experimental treatments were: control diet – corn-soy diet without citrus pulp; Cp10 diet – formulated to have the same level of digestible Lys, Ca, and non-phytate P of control diet, plus 10% of citrus pulp; Cp20 diet – formulated to have the same level of digestible Lys, Ca, and non-phytate P of control diet, plus 20% of citrus pulp; and Cp30 diet - formulated to have the same level of digestible Lys, Ca, and non-phytate P of control diet, plus 30% of citrus pulp.

The proposed final BW to conduct the swine for slaughtering was 130kg BW. After last weighing on the farm followed by 15h of solid fast period, swine were re-weighed and slaughtered. Slaughtering procedure included stunning with electric charge, bleeding, scalding, scraping, and evisceration. Thereupon evisceration, organs of digestive system were collected and emptied. Stomach, small intestine, cecum, colon, liver, and pancreas were weighed. Longitudinal cut followed by weighing of half eviscerated carcasses were done. Half-carcass weight was expressed as percentage of live body weight. Processed dressed carcasses were then refrigerated at 4ºC for 24h for posterior evaluations.

Table 1. Composition of experimental diets formulated to barrows with 105kg body weight

Feedstuff, %	Diet			
	Control	Cp10 (1)	Cp20 (1)	Cp30 (1)
Corn	81.78	71.01	60.24	49.43
Soy meal	16.40	17.17	17.94	18.75
Citrus pulp	0.00	10.00	20.00	30.00
Limestone	0.58	0.58	0.57	0.57
Dicalcium phosphate	0.64	0.64	0.65	0.65
Salt	0.30	0.30	0.30	0.30
Vitamin-mineral premix (2)	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00
Calculated composition(3)				
Digestible energy, kcal/kg	3,391	3,294	3,197	3,100
Crude protein, %	14.87	14.28	14.37	14.48
NDF, %(4)	11.88	12.61	13.33	14.06
ADF, %(4)	4.23	5.35	6.46	7.57
NDSF, %(4)	7.41	10.95	14.63	18.04
Starch, %(4)	54.91	48.34	41.76	35.17
Digestible Lys, %	0.58	0.58	0.58	0.58
Digestible Met + Cys, %	0.46	0.43	0.41	0.38
Calcium, %	0.44	0.44	0.44	0.44
Non-phytate phosphorus., %	0.18	0.18	0.17	0.17

[1]Citrus pulp on 10, 20, and 30% of inclusion.
[2]Vitamin premix – amount per kg of product: 2,500,000UI vitamin A; 500,000UI vitamin D3; 50mg biotin; 50mg choline; 10,000mg niacin; 3,000mg calcium pantotenate; 7mg vitamin B12; 1,800mg vitamin B2; 7,500mg vitamin E; and 1,000mg vitamin K3. Mineral premix – amount per kg of product: 40,000mg Fe; 35,000mg Cu, 20,000mg Mn; 40,000mg Zn; 360mg Co; 840mg I; and 120mg Se.
[3]Nutritional composition according to Rostagno et al (2005).
[4]NDF: neutral detergent fiber; ADF: acid detergent fiber; NDSF: neutral detergent-soluble fiber.

According to the Brazilian Method for Carcass Classification (Método…, 1973), the following evaluations of each right carcass were done: carcass length; backfat thickness measured at the first and last thoracic vertebrae, and last lumbar vertebra; loineye area, fat area; and fat/lean expressed as percentage of fat area relative to loineye area. Other carcass characteristics also measured were: weight of hot carcass without legs and head (HCW), backfat thickness (BT), and loin deep (LD) that was obtained between the last and penultimate ribs 6cm far from the media dorsal line of right half carcass with the aid of a paquimeter to reproduce the use of a typification pistol. Taking into account HCW, BT, and LD values, amount (LMA) and percent (LM%) of lean meat were calculated according to equations proposed by Guidoni (2000). Bonification index (BI), that is a correction factor of the carcass value expressed as percentage, was determined using LM% and HCW results as described by Fávero et al. (1997).

Longissimus and *Semimembranosus* muscles pH from right half carcass of each animal were determined 45min *post mortem* (pH45’) and on refrigerated carcass (pH24h) maintained in cold chamber (4ºC) for 24h.

From the right half-carcasses, a 15-cm-tick chop of *Longissimus* muscle was sampled without adjacent fat. These samples were sent for physical analyses of meat. Objective colour measurements were taken on fresh meat using the Minolta Chroma-Meter, to record color as L*, a*, and b* values. Other analyses included drip loss, water-holding capacity, Warner-Bratzler shear force, and cooking loss. Also, a lipid oxidation assay was done by comparative analysis, observing the reactivity of the substances with 2-tiobarbituric acid (TBA) in samples stored in cold chamber for one and eight days after slaughtering, according to the method described by Pikul et al. (1989).

Four treatments with nine replications of one animal each were carried out according to a randomized block design to control differences on initial weight. Data formerly tested for normality of studentized residues (Cramer Von-Mises test at 5%) were submitted to ANOVA, and processed with the aid of *PROC GLM* of SAS/1998 software, performed by linear multiple regressions until third degree. Final BW was used as covariate of all parameters analyzed in the statistical model.

RESULTS AND DISCUSSION

Addition of citrus pulp at different levels promoted an increase on weights of stomach, colon, cecum, and liver (Table 2), but did not on small intestine and pancreas weights (P>0.1). Table 3 presents prediction equations of these weights as function of citrus pulp levels.

Table 2. Mean values and coefficients of variation (CV) of weights of digestive organs from swine fed different levels of citrus pulp

Organ	Level of citrus pulp, %				CV %	Regression	P
	0	10	20	30			
Stomach, g	503.33	553.89	535.56	598.33	8.18	Linear	0.0013
Small intestine, g	1,702.22	1,725.00	1,827.78	1,904.44	11.03	-	>0.1
Colon, g	1,440.00	1,541.11	1,640.00	1,913.89	8.37	Linear	<0.0001
Cecum, g	168.33	163.89	187.22	218.89	12.87	Quadratic	0.0314
Pancreas, g	162.22	156.11	175.00	176.11	10.53	-	>0.1
Liver, g	2,187.80	2,577.30	3,097.80	3,422.80	12.04	Linear	<0.0001

Table 3. Prediction equations of weights of digestive organs from swine fed different levels of citus pulp

Variable	b_0	b_1	b_2	R^2
Stomach, g	545.66000	+ 2.87200	-	0.42
Colon, g	1,445.50000	+ 15.88300	-	0.69
Caecum, g	144.02700	- 0.00096	+ 0.00009	0.64
Liver, g	2.15500	+ 0.00460	-	0.73

A linear increase of stomach weight (P=0.0013) as consequence of the citrus pulp inclusion to the diet (Table 3) was observed. According to Low (1989), consumption of diet with high level of non-starch polysaccharides (NSPs) promotes an increase in gastric secretion resulting in high-volume-digesta due to their hydrophilic characteristics. So, the highest NSPs content, as the pectin of citrus pulp, higher should be the digesta volume in the stomach and hence the weight of the organ.

High levels of soluble NSPs cause hypertrophy of large intestine, local where microbial fermentations of these carbohydrates occur. As consequence of citrus-pulp increment to the diet, linear effect on colonic weight (P<0.0001) and quadratic effect on caecal weight (P=0.0314) were registered (Table 3). Higher corn level of control ration probably resulted in a diet with large amount of resistant starch whose physical characteristic inside the cecum is similar to NSP with respect to its fermentative potential (Kreuzer et al., 2002), what can explain the effect of CP10 ration upon this hindgut part. Addition levels of citrus pulp above 10% determined higher caecal development which could be attributed to the great content of soluble NSPs in the diet. Pluske et al. (1998) also observed higher large intestine development from swine fed high level of soluble NSPs; they concluded that fermentation resultant short-chain fatty acids, mainly butyrate, were responsible for the higher cellular development of the colon mucosa.

Martelli et al. (1999) evidenced an increase on villus heights of caecal mucosa in swine averaging 160kg BW fed diets with 15% of sugar beet pulp silage. Wyatt et al. (1989) affirmed that ingredients that promote augmentation of the digesta viscosity, as the soluble fibrous fraction, cause higher wall activity of the large intestine for establishment of the gut peristaltism, leading to muscular hypertrophy and, as consequence, to higher cecum and colon weights.

Weight of pancreas was not affected (P>0.05), but liver showed higher development (P<0.0001) following the increment of citrus pulp levels to the diets (Table 3). Fraga et al. (2009) also observed an increase in liver weight of swine fed diets with rice hulls in feed restriction program. As the liver is the main local of energetic metabolism (Lehninger et al., 1995), where the major part of the synthesis of lipids and their lipoprotein carriers take place, activity highly depend on available energy (Bruss, 1997), it was expected a reduction of its weight as the levels of citrus pulp added to the diet increased. However, it is possible to explain the augmented liver sizes of animals fed citrus pulp since higher production and liberation of biliar salts may occur to adsorb the NSPs present in this ingredient. Sambrook (1981), evaluating inclusion of feedstuffs rich on soluble (barley) and non-soluble (cellulose) NSPs, observed that diets containing the highest level of soluble NSPs caused an increase on biliar salts production.

Data related to carcass characteristics of swine as function of dietary citrus pulp levels are indicated in Table 4. Table 5 presents those characteristics affected by the use of citrus pulp.

Table 4. Mean values and coefficients of variation (CV) of carcass characteristics from swine fed different levels of citrus pulp

Characteristic	Level of citrus pulp, %				CV, %	Regression	P
	0	10	20	30			
Final body weight, kg	129.6	129.4	130.5	129.6	1.53	-	>0.1
Carcass weight, kg (1)	105.4	104.2	102.3	99.8	2.29	Linear	<0.0001
Carcass yield, % (1)	81.8	81.1	79.2	77.7	1.51	Linear	<0.0001
Carcass length, cm (1)	101.5	100.1	102.3	100.4	2.65	-	>0.1
Backfat thickness, mm (1)	30.9	31.6	28.5	29.0	10.03	-	>0.1
Loineye area, cm^2 (1)	52.7	56.9	49.0	46.6	9.28	Quadratic	0.0388
Fat area, cm^2(1)	25.0	24.9	23.9	23.6	14.70	-	>0.1
Fat/meat ratio (1,2)	0.48	0.44	0.49	0.54	14.68	-	>0.1
Ham weight, kg(1)	16.26	16.32	15.69	15.22	4.28	Linear	0.0003
Ham yield, %(1)	30.86	31.31	30.69	30.52	4.27	-	>0.1
Hot carcass weight, kg(3)	99.2	97.3	95.0	93.6	1.31	Linear	<0.0001
BT, mm(4)	15.9	15.9	14.9	16.2	14.77	-	>0.1
LD, mm(4)	77.4	78.9	72.2	68.9	8.61	Linear	0.0029
Carcass lean meat, kg	55.9	55.5	54.9	52.9	2.48	Linear	0.0001
Carcass lean meat, %	59.8	59.9	60.0	58.8	2.90	-	>0.1
Bonification index, %	116.0	116.1	116.0	114.4	1.73	-	>0.1

[1]Carcass weight and mean backfat thickness according to ABCS (Método…, 1973).[2] Fat/meat ratio = fat area divided by loineye area. [3] Carcass weight without legs and head according to Guidoni (2000). [4] BT and LD – backfat thickness and loin depth, respectively, measured between last and penultimate ribs, 6cm far from the median dorsal line.

Table 5. Prediction equations of carcass characteristics from swine fed different levels of citus pulp

Variable	b_0	b_1	b_2	R^2
Carcass weight, kg	105.904	- 0.199	-	0.77
Carcass yield, %	82.130	- 0.145	-	0.67
Loineye area, cm^2	53.318	-	- 0.018	0.37
Ham weight, kg	16.447	- 0.038	-	0.35
Hot carcass weight, kg	98.908	- 0.198	-	0.75
Loin depth, cm	79.207	- 0.324	-	0.24
Carcass lean meat, kg	56.271	- 0.103	-	0.38

As consequence of slaughter standard procedures, weight at slaughtering and carcass length were not affect (P>0.1) by the inclusion of different citrus pulp levels to the diet. However, linear reductions on weights and yields of carcasses were observed (Table 5). Such decreasing were determined by the higher hindgut organ weights from those animals fed higher levels of citrus pulp, since great amount of NPSs determine an increase on gut secretions, high volume of the digesta, distention and hypertrophy of stomachal muscles (Low, 1989), high development of mucosal cells (Pluske et al., 1998), and hypertrophy of large intestine (Wyatt et al., 1989), resulting in higher weight of these organs. While Fraga et al. (2008) did not observe inferior carcass yield due to the inclusion of 19% rice hull to the diet of swine averaging 130kg BW swine, Scipione et al. (1991) detected significant carcass yield reduction in animals fed sugar beet pulp silage and slaughtered at 144kg. Pluske et al. (1998) related negative correlation between NSPs intake and carcass yield. Under commercial point of view, this relation is indicative that exist some limitations on the use of rich-NSP feedstuffs to swine diet, as the remuneration of the producer is based on carcass characteristics and not on viscera, like liver and pancreas.

Beyond backfat thickness and fat area decreasing (P<0.001), two important characteristics of pork carcass typification, inclusion of citrus pulp to the diet determined a quadratic effect on the loineye area with higher loin development at 8.0% of addition (Table 5). Candek-Potokar et al. (1999), testing the effect of 30% quantitative feed restriction upon loineye area of swine slaughtered at 130kg BW did not observe higher development of this muscle, concluding that high level of quantitative feed restriction may leave to a deficiency on nutrients required for muscular grow, being the main cause of short size of muscular fiber.

A linear decrease on ham weights (P=0.0003) as function of higher levels of citrus pulp addition to the diet were observed (Table 5), but ham yields were not affected (P>0.1). Considering the finest part of the pork carcass, the ham of 130-kg-BW swine yielding only 30% commercially represent at least 60% of the meat value as they are destined to the processing of smoke-cured products with high aggregate price values. Thus, it is vital to use a feed restriction program that promote an improvement on carcass quality, maintaining at least good ham yield, result herein achieved.

For carcass typification, hot carcass weight (HCW), backfat thickness (BT), and the loin depth (LD) should be taken into consideration (Zagury, 2002). Linear decrease as function of dietary citrus pulp use for HCW (P=0.0001) and LD (P=0.0029) were observed, but not for BT (P>0.1). Considering these three characteristics (BT, HCW, and LD) to lean meat quantification (kg), a linear decrease (P=0.0001) was detected (Tables 4 and 5) as an indicative that qualitative feed restriction by citrus pulp inclusion was not efficient.

Table 6 shows values relative to qualitative meat characteristics. Prediction equations of pH24h and color parameters of muscles are found in Table 7. Notwithstanding the non effect (P>0.1) of dietary citrus pulp level for pH45h of *Longissimus* and *Semitendinosus* muscles, a positive linear trend (P<0.05) for pH24h measured on the same place was registered (Table 7).

Table 6. Mean values and coefficients of variations (CV) of qualitative meat characteristics from swine fed different levels of citrus pulp

Qualitative characteristic	Level of citrus pulp, %				CV, %	Regression	P
	0	10	20	30			
pH45´ *Longissimus*	6.12	6.13	6.11	6.32	3.62	-	>0.1
pH45´ *Semitendinosus*	6.06	6.04	6.11	6.23	2.42	-	0.055
pH24h *Longissimus*	5.47	5.49	5.50	5.60	1.15	Linear	0.0005
pH24h *Semitendinosus*	5.45	5.45	5.50	5.53	0.87	Linear	0.0021
Drip loss, %	12.44	12.55	11.48	9.11	5.32	-	0.0549
L* value	59.01	61.56	57.89	55.70	5.54	Linear	0.0307
a* value	8.73	8.91	7.05	6.95	14.38	Linear	0.001
b* value	7.19	6.74	5.29	4.60	31.84	Linear	0.0024
Cooking loss (evaporation), %	28.77	29.85	27.32	27.52	10.25	-	>0.1
Cooking loss (drip), %	12.45	12.55	11.48	9.11	23.80	-	>0.1
Cooking (total), %	30.95	31.35	29.68	29.64	9.51	-	>0.1
Shear force, kgf/cm^2	2.59	2.92	2.99	2.84	16.28	-	>0.1
WHC, %(1)	68.45	68.42	70.55	71.82	4.07	-	>0.1
TBARS, mg/kg(1)	0.58	0.50	0.46	0.46	44.81	-	>0.1

WHC: water holding capacity; TBARS – thiobarbituric acid reactive substances.

Table 7. Prediction equations of qualitative meat characteristics from swine fed different levels of citus pulp

Variable	b_0	b_1	R^2
pH24h *Longissimus*	5.371	+ 0.004	0.31
pH24h *Semitendinosus*	5.361	+ 0.002	0.29
L* value	60.584	- 0.136	0.13
a* value	9.306	- 0.085	0.28
b* value	7.634	0.116	0.24

Citrus pulp inclusion to the diet did not affect drip losses of the carcasses. Despite the superior results obtained (11.4%) for this characteristic, higher than the desired 5%, this augment should not be attributed to the addition of the citrus pulp to the diet since all treatments presented similar values. The amplitude of the values found by Souza et al. (1998) for drip loss was from 4.5 to 10.4%, showing that many factors could influence this meat characteristic, e.g., correct application of electric insensibilization, interval between insensibilization time, bleeding, and carcass refrigeration.

The use of citrus pulp altered color parameters, being observed linear reduction ($P<0.05$) of L*, a*, and b* values (Table 7) as the dietary levels of the feedstuff increased. Lower color values are indicative of darker meat, less red, and less yellow, respectively (Warris, 1995). Fraga et al. (2008) also observed reduction of the a* and b* values, but not L*, with the inclusion of rice hulls to diets of 130-kg-BW swine, probably due to the reduction of dietary pigments as consequence of the low level of corn in the ration. However, Martelli et al. (1999) did not observed any effects of the use of dietary sugar beet silage upon pH or color values from 160-kg-BW swine meat.

As swine show a tendency of increasing subcutaneous and intramuscular lipid depositions with increasing weight, slaughtering heavier animals can result carcasses with higher intramuscular fat content, altering b* color parameter (Varnam and Sutherland, 1995). According to Joo et al. (2002), alterations of the b* values indicate modification on fat acid composition of the intramuscular fat.

Besides the diet, feed restriction may also modify meat color parameters. According to Candek-Potokar et al. (1999), 30% of feed restriction to swine slaughtered at 130kg BW affected muscular configuration of the loin, showing higher relative area occupied by red muscular fiber of slow contraction, and decrease of a* and b* values as consequence.

For cooking loss characteristics (evaporation, drip, and total), no effects of dietary citrus pulp inclusion were observed ($P>0.1$). Mean values of total cooking losses observed in this experiment (30.4%) were similar to 32.3, 30.8, and 27.8%, obtained by Hodgson et al. (1991), Pires et al. (2002), and Bridi et al. (2006), respectively.

As the shear force, mean result was 2.83kgf/cm^2, but no differences on meat tenderness were observed. Bridi et al. (2006) evaluating addition of ractopamine to the diet of 100-kg-BW slaughtered swine found 3.44kgf/cm^2, which is superior to the value here obtained. On the other hand, Latorre et al. (2002) reported values around to 2.70 kgf/cm^2 for 133-kg-BW animals in a study of pork meat quality.

Respecting to water holding capacity, no effects of inclusion of different levels citrus pulp to diet were detected. Fraga et al. (2008) verified no effects on the water holding capacity in an evaluation of qualitative feed restriction program, registering mean value of 64.8% which is similar to the mean 69.8% here obtained.

Lipid oxidation is also an important characteristic for the evaluation of pork carcass, as the main consequence is a modification on the flavor of the meat with the emergence of rancidity, causing depreciation or refusal of the meat for the consumer and/or meat processor (Silva et al., 1998). According to Sabarense (2003), the diet can modify the meat fat acid profile, and the tendency of its lipid oxidation. Lipid oxidation indexes (TBA) here observed are indicative that the inclusion of citrus pulp did not cause ($P>0.1$) high peroxidation and/or high level of products resulting of its degradation, such as malonaldeyde. The TBA value here obtained (0.50mg/kg) is similar to 0.52mg/kg found by Joo et al. (2002) evaluating the inclusion of conjugated linoleic acid to diet of 105-kg-BW slaughtered swine. Being a comparative analysis of the evaluation of the lipid stability under refrigeration, the inclusion of the citrus pulp in program of feed restriction did not negatively affect meat quality nor shorten its shelf time.

CONCLUSION

The citrus pulp addition in qualitative feed restriction program for swine slaughtered at 130kg BW may not be effective. However, as no deleterious effects upon meat qualities were observed, citrus pulp can be used as an alternative feedstuff for finishing swine.

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