PRODUCTION AND QUALITY OF CARCASS IN PIG FED DIETS WITH RAW AND TREATED SORGHUM (Sorghum vulgare) GRAIN HIDROTHERMALLY, DURING THE PHISIOLOGICAL STATE THE GROWTH AND TERMINATION

PRODUCCIÓN Y CALIDAD DE LAS CARCASAS DE CERDOS, QUE FUERON ALIMENTADOS CON SORGO CRUDO Y TERMOPROCESADO DURANTE EL CRECIMIENTO Y LA TERMINACIÓN.

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Abstract

The research work was to determine if the processed sorghum grain into balanced diets, improves porcine productivity and carcass quality. This suggested, determine weight gain, backfat thickness and lean percentage *in vivo* and *post mortem* and age slaughter weight. Content and composition of the different fatty acids in the dorsal fat pig at 90 kg live weight, from *in vivo* samples obtained by biopsy and the iodine value of fat. Too quality factors of fresh meat such as tenderness, juiciness and through the meat pH, shear force, relative abundance and types of fatty acids. Females sorghum hydrothermally treated - fed did not improve significantly their daily weight. Barrows showed higher rate of growth and back fat thickness in carcass than females. The quality was more lean as much in barrows as in females, in the treatments with grain thermal process. Sorghum - fed pigs, regardless of its presentation have been exposed animals best for fresh consumption because of its pH, water losses due to cooking and cutting resistance. Both crude sorghum diets such as hydrothermally treated sorghum, carcasses exposed in relation ω 6 / ω3 under 20 were diets for such significantly higher than the corn diet.

Key words: cereals hydrothermal processes, pig productivity, quality meat.

Resumen

El trabajo de investigación fue determinar si el grano de sorgo procesado en dietas equilibradas, mejora la productividad y la calidad de las canales de porcino. Esto sugiere, determinar la ganancia de peso, el espesor de grasa dorsal y porcentaje de magro in vivo y post mortem y el peso y edad a faena. Se evaluó el contenido y la composición de los diferentes ácidos grasos en el cerdo en la grasa dorsal a los 90 kg de peso vivo, a partir de muestras obtenidas por biopsia *in vivo* y el valor de yodo de la grasa. Otros factores de interés son calidad de carne fresca como la terneza, jugosidad y por el pH de la carne, la fuerza cortante, abundancia relativa y tipos de ácidos grasos. Las hembras que consumieron sorgo tratado hidrotérmicamente no mejoraron significativamente su peso diariamente. Los machos castrados mostraron una mayor tasa de crecimiento y espesor de grasa dorsal en la canal que las hembras. La calidad fue más magra tanto en machos castrados como en las hembras, en los tratamientos con grano procesado térmicamente. - Cerdos alimentados con

sorgo, con independencia de su forma de presentación del la dieta (cruda o tratada) han expuesto carcasas mejo es para el consumo en fresco debido a sus pérdidas de agua por cocción, pH, y la resistencia al corte. Ambas dietas sorgo crudo como el sorgo tratado hidrotérmicamente, expusieron carcasas con relación ω 6 / ω3 menor a 20, resultados significativamente mejores que en dietas de maíz.

Palabras clave: grasa porcina, composición de ácidos grasos, sorgo termoprocesado.

INTRODUCTION

Three factors are relevant to consumer's meat quality the tenderness, juiciness and flavor. Objective measurements are related to them as the pH_1 and pH_{24} (1 and 24 hours *post mortem*), intramuscular lipid content and tenderness, latter as determined by the water asset capacity and cut force of *Longissimus dorsi* muscle. The pH is associated with tenderness and pH_1 (5.5 – 6.3) is generally suitable for fresh meat supply. The measure of values of pH on the different muscles of the carcass aims to check the evolution of this parameter during the processes of transformation in flesh. Used for its measurement times close to obtaining the carcass within in the sacrifice (pH_1) and 24 hours *post-mortem* (pH_{24}) latter being the moment when it reaches pH more under and from that moment stays or begin to rise according to the ambient temperature (Barton Grade, 1997) Oliver et al., 1998). The location of the measure is important because speed of decrease of pH depends on selected muscle and the fall of the same temperature, which also modulates the speed of the *post mortem* glycolysis, so high around 35 ° C temperatures accelerate the decrease in pH still needed fewer hours to achieve the final, pH_{24} (Pearson & Tauber, 1984). The importance of food in the incidence of these problems is little determinant being factors genetic and management pre - sacrifice the most important. However some patterns of food may be useful in reducing the incidence of these anomalies. The physiological mechanism responsible is vital to identify best practices. The speed and the magnitude of the fall of pH after the sacrifice is possibly the most important single cause of the variation exists in the pig meat quality. Speed reduction of pH and temperature which produces affect the protein denaturation in the muscle *post mortem*. A rapid decline in pH while the carcass is still at high temperature (> 37 ° C) causes the denaturation of myofibrillar proteins (Eggert et al., 1999). The other hand the acidity is linked with quality pork sausage cooked and dry. The greatest challenge is the reduction of the content of fatty acids saturated in meat, mainly of the palmitic acid, and the increase of the quantity of fatty monounsaturated and polyunsaturated acids. The fall until a pH close to isoelectric point (5.0 - 5.1) of the muscle protein greatly reduces its ability to retain water. The result is soft exhudative and white meat due to the limited capacity of retaining liquids. If the fall is insufficient result is contrast, dark meat, firm and dry. Changes in pH after the sacrifice are basically due to the degradation of glycogen to lactic acid by glycogenolysis and glycolysis in anaerobic conditions. For fresh meat three factors that may be affected by genetic variation and are highly relevant to consumers tenderness, juiciness and flavor. A series of objective measurements are related to them as pH_1 (1 hour post mortem) and pH_{24} (24 hours post mortem), intramuscular fat content and tenderness. The pH is associated with the acidic meat tenderness and have lower water retention capacity. Tenderness is positively related to the water retention capacity. Overall pH1 (5.5 - 6.3) is indicated for supply of fresh meat. The acidity is linked with the quality of the meat to other destinations such as cooked

meats and dry. Industry requires that the fluid loss during cooking are minimal for maximum performance (Cobos et al., 1993). Both for reasons of quality of meat and pig welfare should rest for 2 hours before being slaughtered (Milligan et al., 1998). Author's comments on thousands of pigs indicate that moving to the stunning area immediately after landed were much harder to handle than those who had rested for at least one hour. Perez et al., (2002) found that both do not lock up like pigs in a while do for an excessively long time compromise the welfare and meat quality of animals. The composition of the diet does not usually affect the muscle glycogen content when using conventional energy sources. However the administration of sugars during long waiting periods before slaughter has been defined as an effective preventive measure in cases of white meat and exhudatives (Gardner & Cooper, 1979; Pethick et al., 1997). This mechanism would allow a rapid loss prevention glycogen. Although this practice may result in an increase in the incidence of these meats especially in cases of stress-susceptible animals or systems where stress pre slaughter is high (Pethick et al., 1997). The addition of technology in the processing of grain to feed the development of today admits that they can be used at high levels and thus provide excellent nutritional values that translate into high quality pig carcasses for fresh consumption and sausage. Producers must ensure that changes in feeding strategies result in the expected improvements in production yields. Food plays a key role in fattening pigs which incorporates other mnogastric species fatty acids supplied by the diet in adipose tissue with little transformation. By contrast, theintramuscular fat composition is fairly constant and would only be affected by diet in the muscles much fat marbling (Morgan et al., 1992). This necessitates taking special carewith fat sources used in the food. The main saturated fatty acids (SFA) of pork are high to low concentration of palmitic (C 16:0), stearic (C 18:0) and myristic (C 14:0). Oleic acid (C 18:1) is monounsaturated (MUFA) most abundant followed by palmitoleic (C 16:1). Linoleic acid (C 18:2), linolenic (C 18:3) and arachidonic (C 20:4) are the main PUFA. The SFA and MUFA are the majority in the triglycerides of the fat from meat (Rhee, 1992). It is essential to reducing the content of SFA in meat mainly palmitic acid and increase the amount of MUFAs and PUFAs for human health benefits (Cobos et al., 1993). The reduction of the SFA is advisable because the presence of cholesterol and of these together in human diets, elevate the concentration of low density lipoprotein (LDL) in serum situation that is associated with the presentation of coronary heart disease (Weiland et al., 1980). If PUFA replace SFA reduces LDL but also decrease high-density lipoprotein (HDL), the latter linked to health benefits. However, the MUFA decreased LDL levels without lowering HDL (Mattson & Grundy, 1985, Grundy, 1986). There was an inverse relationship between HDL concentration in blood and the incidence of cardiovascular disease (Castelli et al., 1977). Among the saturated fatty acids, not all are equal and that only C 12:0 fatty acids, C 14:0 and C 16:0 raise cholesterol. C 18:0 fatty acids and longer chain do not contribute to increased serum cholesterol in humans (Bonamone & Grundy, 1987). Most PUFA are mainly grouped into two sets. In the series ω 6 linoleic acid is the most common and is found in plants and animal tissue and can not be synthesized by animals so fatty acids is the leading group of essential fatty acids. It is the precursor in the body of all the series ω 6 by desaturation and elongation enzyme (German, 1990). The gamma-linolenic acid is the first intermediate is formed. The dihomo-gamma-linolenic acid is another series ω 6 produced in fermentation conditions. Arachidonic acid is the most important because this series is used in the synthesis of phospholipids to form the cell membrane and is also hormone precursor. Is known eicoesanoic components including

prostaglandins. In the series ω 3 is linolenic acid, also from it originate AG ω Series 3 by desaturation and elongation enzyme in cell metabolism. Stearidonic acid is a precursor of eicosapentaenoic (EPA). The EPA and docosahexaenoic acid (DHA) also belong to this series ω 3. Linoleic acid is an unsaturated fatty acid with two 18-carbon double bonds in positions 9 and 12, both in the *cis* configuration. The conjugated linoleic acid (CLA) isomers are a mixture of double bonds which changed places in the position of the carbons of the chain.

Currently accepting a minor dietary cholesterol unlike AGS in hypercholesterolemic effects by the need to control the intake of PUFA, lowering the ratio ω 6 / ω 3 and trans fatty acid consumption, to increase the contribution of natural antioxidants and nutraceuticals such as DHA and CLA isomers. Studies related to the quality of meat from outdoor pig systems or semi-confinement have demonstrated the influence of supply and production system on the nutraceutical value of meat. Of these it was concluded that the fattening of pigs outdoors with quality pasture availability confers favorable attributes to human health in the composition of intramuscular fat, such as a higher content of C18: 3, CLA, EPA and MUFA as well as an ω 6 / ω 3 more close to that recommended by nutrition professionals (Basso et al., 2006). Meat from monogastric animals, pigs and poultry, reflect the composition of lipids ingested by the animal and are therefore not easily modifiable. The lipids of ruminants instead under go a process of biohydrogenation in the rumen that converts linoleic acid (C18: 2 ω 6) and linolenic (C18: 3 ω 3) of grains and grasses in a saturated fatty acid but fortunately not hypercholesterolemic, the stearic acid (C18: 0). It is important to know if sorghums termoprocesados included in diets for pigs produce quantitative and qualitative zootechnical benefits in pig carcasses. In pigs the lipid profile is strongly related to the diet. This is especially noticeable with linoleic acid and other PUFA due to the inability of the enzyme systems of higher animals to synthesize linoleic acid and linolenic acid (Cava et al., 1999) and (Ziller, 1996). It is expected therefore a higher concentration of linoleic acid in animals fed diets rich in this fatty acid, as has been observed in experiments performed with different white pig breeds (Morgan, 1992). The weight of the lipid composition of the diet on the lipid profile of animals varies with growth stage under consideration. In the early stages of growth of 80% of pork lipids are synthesized from glucose in the diet which is the main physiological precursor fatty acids (Henry, 1977). In later times when the thickening growth begins to be predominant effect of diet on the lipid profile is becoming increasingly apparent. With increasing the degree of fat is a decrease of saturated fatty acids increase the other, reflecting the fatty acid profile of fat from food. In saturated fats, stearic acid is found in greatest proportion in adipose tissue and is correlated with the consistency and the melting point of the fat (Wood, 1984). The melting point of the fat increases with length chain fatty acids. Like wise it is higher in nature saturated fatty acids in the unsaturated (Lehninger, 1981). Of the unsaturated fatty acids oleic acid does not appear to correlate with the melting point and consistency of fat linoleic acid, another acid abundant in pig adipose tissue negatively correlated with the consistency of the fat and the melting point (Lopez de Torre et al., 2001). PUFAs are substrates of lipid oxidation. In his oxygen double bonds are fixed starting the oxidation reaction. So, the more the presence of PUFA increased susceptibility to oxidation (rancidity and color deterioration) at the expense of quality (Lopez-Bote, 1998) although a moderate oxidation contributes the emergence of volatile compounds responsible for desirable flavor of the meat (Rhee, 1992). If it is excessive rust will result smell and yellow color and fading (Girard, 1988). The purpose of this research was to

determine whether different sorghum grain processing prior to inclusion in balanced diets for growing pigs and finishing to improve the quality of the carcass and on the assumption that pigs fed diets made with cereals treated, improve carcass fat quality in relation to grain-fed untreated in this research, we aimed to evaluate carcass lipid characteristics in pigs by use of hybrid corn and sorghum grain ground, sorghum crushed-rolled and extruded wet sorghum in diets for growth and fattening. By measuring the quantity and quality of fatty acids present in the backfat of pigs to 90 kg live weight.

MATERIALS AND METHODS

The experiment was conducted in semi-arid pampas (Latitude 36 º 46 'South, Longitude 64 º 16' west, altitude 210 m above sea level). The experimental pigs were castrated male and female F2. After staying for 32 days of lactation, were arranged in four groups of 4 pigs with two males and two females that were housing in growh-finished sities of concrete floor and 75% of the area covered, hopper feeders provided and boxes with piglet drinking bowls, where led growth and termination. When pigs arrived at 30 kg live weight, after a period of 30 days socializing, began to consume the rations of growing up to 60 kg live weight. From there to 105 kg live weight, when the trial ended, were given diets of termination. The units are arranged in a completely randomized design. They formed four treatments (diets) with four experimental units (replicates) per treatment. The treatments were characterized by: T1 = control diet (D1) pellets balanced, consisting of grain corn as the main energy ingredient. T2 = diet (D2) pellets balanced, consisting of grain sorghum as main energy ingredient. T3 = diet (D3) pellets balanced, consisting of crushed-rolled sorghum as main energy ingredient, and T4 = diet (D4) pellets balanced, consisting of extruded sorghum wet and main energy ingredient. Diets were formulated from the nutritional needs of pigs in the categories concerned by the pigs of the NRC (2001), composed of grain corn, sorghum, short-cycle three conditions of presentation: milled, rolled and extruded; flour meat (allowed in Argentina), soybean expeller, bran of wheat, salt, bentonite, synthetic lysine, methionine synthetic, vegetable oil, bone ash, vitamin-mineral premix, flour shell and parasite control. Were fed *ad libitum* and the presentation of the diets during the whole experience was pellets. The pH at the time of slaughter, pH_1 and pH_{24} *post mortem* were evaluated through a peachimeter electrode calibrated with buffer solutions, in the eye of beef of the cutlet for the *longissimus dorsi* muscle at the junction with the 3 rd and 4 th ribs. Weight losses by cooking (%) were determined by a thermal bath at 72 ° C for 50 minutes at 100 g samples of *longissimus dorsi* muscle following the guidelines set by Honikel (1997). The sample from which the cooking was done consisted of a slice of 2 cm-thick *longissimus dorsi* muscle taken after slaughter cut fresh. Then after one day cooling this sample was vacuum packed and frozen until the day before cooking in the fridge that was left at 4 ° C until next days. Prior to cooking each sample was weighed on scales with an accuracy of ± 0.01 g before cooking. Were processed to a maximum of 3 samples simultaneously because the introduction of a greater number to the bath produced a sharp drop in temperature of the water and undesirable. Each of the samples was fed a puncture thermometer so that this measurement performed exactly in the center of the meat sample. The temperature of the cooking water reached 72 ° C. Samples were introduced in plastic bags suspended in the water so that the upper edge of the bag was opened and the liquid. The time that the samples remained in the water was monitored. The process stopped when the last thermometer puncture showed that at the

center of the sample temperature reached was 70 ° C, at which time all samples were taken from the cooking bath and placed in another bath at 15 ° C for 5 minutes .Subsequently the samples were extracted from the bags, patted dry with laboratory paper and weighed. The test result was expressed as a percentage of cooking losses calculated by the following operation: % BW = 100 - [(Po / Pf) x 100]. % BW = percentage of cooking losses. Po = initial sample weight. Pf = Final weight of the sample (after firing). Tenderness of the meat was measured in the *longissimus dorsi* muscle through the cutting force. We used a Warner Bratzler blade attached to a software "Warner Bratzler Shear Test" described by Honikel (1998) which establishes measures such force and tenderness of the meat after cooking, expressed as kg force or Newtons. The machine used was a texture analyzer (Stable Micro Systems Texture Analyser, Model TA-XT plus, UK), which by force of guillotine cuts the sample. The sample consisted of a rectangular cut away section of 1 cm^2 with the fiber direction parallel along the rectangle with a length of not less than 30 mm. The samples were sectioned at right angles to the axis of the fibers. The test speed was applied to 3.33 mm / sec. In the finishing stage pigs were obtained on samples of backfat experimental in vivo at the level of the last rib floating and 5 cm from the midline of the animal at each side at 90 kg. This known measuring point P2 coincides with the space between the last and penultimate rib. Is the mean subcutaneous fat thickness between the sector dorsal, lumbar and caudal of the animal and its fatty acid composition have a high correlation with the rest of the carcass fat and particularly with the intramuscular fat content. Biopsies were performed with a scalpel and cannulas 2 mm in diameter, the samples were stored at - 20 ° C until assayed. The extraction, purification and stabilization of total lipids of all experimental samples by Jordi Folch method (Christie, 2003). Quantitative analysis of components of the sample, using a technique of gas chromatography - mass spectrometer (GC - MS) to identify the most abundant fatty acid of the sample and the % of relative abundance of other acids fatty components of the analyzed samples (Roach, et al., 1998). Identifying peaks in the chromatograms was based on retention times and the classification is carried out with standard patterns. Finally the calculation of specificity and / or reproducibility of retention indices (time) and fragmentation patterns obtained by mass spectrometry established the proportions of fatty acids present in the samples (Ryhage and Stenhagen, 1960). The methylated esters of fatty acids were analyzed following a gas chromatograph Hewlett-Packard 5972 Series C coupled to mass selective spectrometer and ion trap Hewlett Packard-5973 Inert MSD (Mass Selective Detector) equipped with an automatic injector (HP 7683 series injector) using tripentadecanoin (T4257, Sigma-Aldrich) as internal standard, attentive to ISO method 5509-1978. According to the results of the validation of chromatographic method coupled to mass spectrometry was possible to work with more than 20 fatty acids with external standards. For calibration of the device as a reference standard material was used from Sigma, Supelco and Alltech, which identified more than 20 fatty acids, all in its methylated form. Quantification was performed based on the response factors obtained by linear regression of the areas of peaks of the chromatograms of the patterns, which were injected at three different concentrations in duplicate. The results are given in % of each fatty acid on total fatty acids. In those cases where patterns were not available methyl esters for quantification response was taken as the corresponding isomer. The pH, tenderness, loss of water by cooking results relative abundance of fatty acids were analyzed statistically by analysis of variance and mean differences by the Tukey HSD test.

RESULTS AND DISCUSSION

Table 1 shows that in the treatments no significant differences in the pH of the meat at the time of slaughter. Changes in pH after slaughter are basically due to the breakdown of glycogen to lactic acid by glycogenolysis and glycolysis in anaerobic conditions. This would imply that it is not as such decisive power in the organoleptic quality of flesh but rather defined by the treatment and management of pre and post slaughter pig. The pH of the 1st hour and after 24 hours was significantly different in the control diet of corn compared to the sorghum, something that causes a greater loss of meat with fresh water and higher shear strength to have less tenderness. This last question is acceptable when interpreting the shear force carried in T1 is correlated with water loss by cooking, the T1 loses less water by cooking it also retained less fresh water for the significant drop in pH in the first 24 hs. Can then be understood that in T1 pH_1 exposes a normal meat and not white, soft and exudative although the values of shear strength and water retention. However pH_{24} in T1 indicate meat unsuitable for fresh consumption by the largest decrease of pH of the assay. The values of the remaining treatments state that it is very suitable meat for fresh consumption and industrialization. As pointed out by Cobos et al., (1993), the tenderness is positively associated with retention. So pH_1 is indicated for supply of fresh meat, significantly favorable situation for T3 and T4. Acidity is also linked with the quality of the meat to other destinations such as cooked meats and dry. Industry requires that the fluid loss during cooking are minimal for maximum performance. This reflection allows the inference that pig meat from T2, T3 and T4 not only have better quality for a smaller fall in pH at first time but it also retain more water into fresh, something that is reflected in the significant differences that have T1 respect to water loss by cooking.

The saturated and unsaturated fatty acids synthesized in the body of the most common experimental units were: palmitic (C 16), stearic (C: 18) and arachidonic (C 20:4), among others, as mentions in his research Cava et al., (1999). But this experience is highlighted in the least significant presence of stearic and arachidonic acids in pigs fed diets D3 and D4 especially in a way that confirms those reported by Ziller (1996) to mention that a very low proportion of AA (araquidonic acid) is synthesized in animal tissue. Similarly, the increased presence of stearic D1 and D2 do not imply lower quality of meat because the SFA would not increase total cholesterol in the blood serum of humans as mentioned Ziller (1996). While the main content of MUFA, oleic, is significantly lower in pig carcasses obtained with diets containing sorghum treated the sum of MUFA significantly higher percentages present in these animals compared to those of D1 and D2, noting with this result then, that MUFA metabolism is very active, leading to substantial changes of dietary origin in contrast to what mentioned Cobos, et al., (1993). In this experiment the values of C18: 1 are greater than 25% of total MUFA that were about 45% in all treatments and were significantly higher values in treatments with respect to treated grain sorghum and corn. Response that benefits these meats to improve consumer health. It is known that diets for human consumption demand lipid products with low levels of SFA, MUFA and increased supply of adequate amounts of PUFA families ω 6 and ω 3, and decrease the ratio ω 6 / ω 3. Also presence of nutraceutical substances as natural antioxidants, CLA, DHA and EPA. All have been observed and calculated on the component fatty acids of backfat in pigs subjected to experimental diets being lower the amount of SFA in pigs fed on D3 and D4. D1 and D2 but not significant differences. As noted by Morgan et al.,(1992) the type of food plays a key role in fattening pigs which like other monogastric species, incorporates

fatty acids supplied by the diet in adipose tissue with little transformation. By contrast, the intramuscular fat composition is fairly constant and would only be affected by diet high in fat infiltrated muscles, that is to say breeding pigs in little lean. PUFA and MUFA values of the experimental treatments correspond to those cited in the literature but with a different distribution. Sorghum treatments increased the presence of MUFA and significantly improved the relationship ω 6 / ω 3, D4 mainly in respect of others, no significant differences between D2 and D3 and undesirable relationship and significantly higher in the control D1. This distribution coincides with that reported by Cava et al., (1999) which states that the fatty acid composition of some animal products varies with several factors including the type of diet. Of note is the lowest value of oleic acid in the fat of pigs fed corn compared to the values observed for treatments with sorghum. According to Basso, et al., (2006) for this acid are clearly values above 45% only when part of the diet corresponds to the herbaceus tapestry from the pig housing. The presence of linoleic acid was significantly higher in fat pig carcasses from pigs fed raw cereals (D1 and D2), while the response was reversed when it came to linolenic acid. This result is important because they highlight the pig meat consumption is substantial presence of these two precursors of fatty acid ω 6 (AA) from linoleic and ω 3 (EPA) of linolenic acid. These fatty acids provide a high degree of fluidity to the cell membrane allowing the movement of proteins on its surface and within the lipid bilayer lipidic greater water retaining capacity, softness and juiciness to fresh meat. The series PUFA ω 6 (linoleic acid) increased in all treatments compared to the values that indicates the literature, especially in D1. Is due to consumption of grains that are part of a 70% of the diet. That is why part of the series PUFA ω 3 virtually disappear from the fat of these animals. These deficiencies are passed on to consumers of these products causing a deficit of ω 3 and excess fatty acids ω 6 by feeding, expressed in cardiovascular disease of our time. Wild animals still living in the wild have concentrations of AA and EPA-DHA in similar proportion between them and this relationship could traslator a man, if this was their main source of food as it was when humans appeared on earth. Today after industrialization and as a result of grain-concentrate diets, the grouping of these two fatty acids changes in the cells of the flesh of animals by increasing the ratio to 20 times or more AA what EPA-DHA. In the present investigation both raw and sorghum sorghums hydrothermally treated, exposed in carcass relation ω 6 / ω3 significantly lower than the corn diet as main energy ingredient. In the experience DHA content was significantly higher in treatments with sorghum compared to the control, while the most notable difference is significant in the content of EPA in the hydrothermally treated sorghum treatments. As noted by Castelli et al., (1977) is important from the stand point of the nutraceutical quality of pork, sometimes, when the values are too low, below 0.01 mg per 100 g EPA back fat is essential to improve the diets with fish oil, which increases significantly the cost thereof. Aspect that would not happen with the experimental diets composed of sorghum. In our experience the presence of the conjugated isomer CLA in pig fat had no significant difference between treatments.

Table 1: Values of the variables ± 1 SE

Variables	D1	D2	D3	D4
pH at slaughter	7,2 *(0,18)* ***a***	7,0 *(0,17)* ***a***	6,9 *(0,16)* ***a***	7,1 *(0,17)* ***a***
pH_1	6,0 *(0,21)* ***b***	6,3 *(0,25)* ***ab***	6,5 *(0,21)* ***a***	6,5 *(0,26)* ***a***
pH_{24}	5,0 *(0,22)* ***b***	5,5 *(0,23)* ***a***	5,4 *(0,22)* ***a***	5,3 *(0,21)* ***a***
Weight loss by cooking (%)	21,3 *(1,63)* ***b***	24,5 *(1,55)* ***a***	24,3 *(1,50)* ***a***	24,5 *(1,51)* ***a***
Shear force (kg force)	8,73 *(0,22)* ***b***	8,08 *(0,22)* ***a***	8,00 *(0,22)* ***a***	7,90 *(0,21)* ***a***
C14:0 - Miristic	2,68 (0,18) ***a***	2,70 (0,17) ***a***	2,31 (0,16) ***a***	2,38 (0,18) ***a***
C16:0 - Palmitic	25,13 (0,69) ***a***	25,76 (0,67) ***a***	24,89 (0,71) ***a***	25,42 (0,63) ***a***
C16:1 - Palmitoleic	2,62 (0,17) ***a***	2,82 (0,17) ***a***	2,41 (0,23) ***a***	2,35 (0,13) ***a***
C18:0 - Estearic	18,90 (0,59) ***a***	17,63 (0,61) ***b***	17,19 (0,56) ***b***	16,10 (0,70) ***c***
C18:1 ω-9 - Oleic	28,72 (0,85) ***a***	27,95(0,74) ***ab***	27,69(0,83) ***bc***	26,09 (0,92) ***c***
C18:2 ω-6 - Linoleic	13,11 (1,12) ***a***	11,23 (0,98) ***b***	9,36 (1,03) ***c***	8,96 (1,02) ***c***
C18:3 ω-6 – gama linoleic	4,50 (0,20) ***a***	4,18 (0,23) ***a***	3,76 (0,19) ***ab***	3,18 (0,269) ***b***
C20:4 ω-6. Araquidonic	3,00 (0,19) ***a***	2,54 (0,22) ***a***	2,08 (0,12) ***b***	1,76 (0,13) ***b***
C18:3 ω-3 - Linolenic	0,43 (0,014) ***a***	0,54 (0,015) ***b***	0,53 (0,011) ***b***	0,57 (0,017) ***b***
C20: 5 ω-3 EPA	0,04 (0,002) ***a***	0,07 (0,005) ***b***	0,09 (0,003) ***c***	0,10 (0,008) ***c***
C22: 6 ω-3 DHA	0,01 (0,001) ***a***	0,03 (0,002) ***b***	0,03 (0,001)***b***	0,04 (0,003) ***b***
C18:2 - 2 ω-6 (9cis – 11trans) CLA	0,61(0,019)***a***	0,63 (0,018)***a***	0,59 (0,014)***a***	0,65 (0,023)***a***
SFA	38,68 (1,12)***a***	37,65 (1,06)***a***	36,61 (1,00)***a***	36,45(1,13)***a***
MUFA	46,39 (1,03) ***a***	46,98 /0,87) ***a***	47,75 (0,88) ***b***	48,35 (0,37) ***b***
PUFA	10,93 (0,41) ***a***	12,37 (0,46) ***b***	11,64(0,45) ***ab***	12,20 (0,31) ***b***
PUFA/SFA	0,28 (0,04) ***a***	0,33 (0,02) ***b***	0,32 (0,05) ***b***	0,33 (0,01) ***b***
ω-6	20,91 (1,34) ***a***	18,25 (1,01) ***b***	15,50 (1,16) ***c***	14.2 (1,07) ***c***
ω-3	0,78 (0,13) ***a***	0,94 (0,11) ***b***	0,97(0,09) ***b***	0,96 (0,14) ***b***
ω-6/ ω-3	26,81(3,92) ***a***	19,41(2,98) ***b***	15,98(3,01) ***c***	14,79(3,22) ***c***

Means with same letter in row are not significantly different according to Tukey HSD test ($p < 0.10$, $p < 0.05$, $p < 0.01$)

The hardest was the meat of pigs fed corn which averaged 8.73 kg of force (Newton 85.64). Set as the maximum force to break the prism of meat, which means less tenderness value, less water retention in fresh and pH_1 and pH_{24} less, for that T1 set bad meat than other treatments. In other studies with pork that have used the same methodology as in the present to evaluate the tenderness values were found between 40 and 80 N (4.8 to 8.81 kg force). In this work it is noteworthy that the differences detected in the tenderness of the samples analyzed were due to genotype or conditions of sacrifice, is not clear whether the type of power generated or not bad meat.

In this experience fed pigs exposed hydrothermally treated sorghum best meat for fresh consumption because contain more energy reserves in their muscles, because of the greater efficiency of utilization of dietary energy provided by the prior hydrolysis of starch to treat sorghum grains heat - pressure, rather than for other reasons or genetic abnormalities.

This greater reserve improves the pH during the first 24 hours and improves water holding capacity, perspectives that improve the quality, tenderness and juiciness for fresh consumption and industrial quality sausages. The high ratio ω 6 / ω 3 in the test is largely due to the proportion of corn and sorghum diets are. But are appreciably high amounts of ω 6 in back fat of animals on diets of corn and sorghum milling. As expressed by Basso (2006) about 48% of the fat swine contains MUFA oleic acid type.

In our experience the D4 exhibited significantly this value compared to other treatments. The intake of this type of fat helps reduce total cholesterol levels in blood at the expense of LDL colesterol and increase HDL cholesterol levels. The truth is that SFA, those who consumed in excess are harmful for the heart, in this study represent a lower percentage compared to other meats.

It can be inferred that pigs fed the D3 and D4 to slaughter weight may reflect the fatty acid composition of the food acids which were somewhat modified by heat and pressure in the grain component of the diet.

CONCLUSION

The values of pH_1 and pH_{24} of sorghum treatments said its treated meat suitable for fresh consumption and industrialization. According to the results it can be concluded that meat quality is defined not only by factors inherent to the animal and welfare conditions at the time, of slaughter but also by the type of diet they receive. The values found for most of the characteristics of the technological quality, such as water retention capacity, softness and pH of the meat were within the ranges quoted in the literature for the pork, with some disadvantages to those fed grain of corn. The pig carcasses obtained from diets containing sorghum treated with quality fats exposed to the health of humans, due to the reduced presence of SFA increases the plasticity of cell membranes and reduces heart risk, as well as increased presence of PUFA especially in relation ω 6 / ω 3 relatively low also increases the plasticity of the cell membrane and thus avoids risks of cardiovascular and / or arterial. Hence the transcendent of this investigation, as sorghum is a grain that is adapted to semiarid regions and can replace 100% of corn in diets for pigs and with the added benefit of exposing a leaner beef and with a fatty acid ω 6 / ω 3 substantially favorable to the health of consumers.

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