



EFFECTS OF DIETARY OIL INCLUSION ON MEAT QUALITY OF IMMUNOCASTRATED MALE PIGS

Efeitos da inclusão de óleo dietético na qualidade da carne de suínos machos imunocastrados

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ABSTRACT: Diets high in fat have been used in the production of pigs in the growing and finishing stages for the improvement of meat production and quality parameters. Therefore, this study was conducted to evaluate the effect of adding different oil sources to the diet of immunocastrated male pigs on meat quality characteristics. Ninety-six pigs were randomly allotted to one of four dietary treatments, with six replicate pens per treatment and four pigs per pen. Dietary treatments consisted of diets supplemented with 1.5% soybean oil (SO; control) or 3% oil from SO, canola oil (CO), or fish oil (FO). After 98 days on trial, 18 pigs per treatment ($n = 72$) were slaughtered and samples of the *Longissimus dorsi* muscle were taken for Warner-Bratzler shear force and color (L^* , a^* , and b^*) measurements. Loins from pigs fed diets containing either 3% SO or CO had decreased Warner-Bratzler shear force ($P = 0.04$) than those from pigs fed the control diet. Dietary treatments had no effect on color components of fresh loin. These results indicate that feeding 3% SO or CO increased pork tenderness, without compromising color meat of immunocastrated male pigs.

Key words: canola oil, fish oil, oleic acid, soybean oil

RESUMO: Dietas ricas em gordura têm sido utilizadas na produção de suínos nas fases de crescimento e terminação para a melhoria dos parâmetros produtivos e de qualidade da carne. Portanto, este estudo foi conduzido para avaliar o efeito da adição de diferentes fontes de óleo à dieta de suínos machos imunocastrados sobre características de qualidade da carne. Noventa e seis animais foram distribuídos aleatoriamente em um de quatro tratamentos dietéticos, com seis baias replicadas por tratamento e quatro suínos por baia. Os tratamentos dietéticos consistiram em dietas suplementadas com 1,5% de óleo de soja (SO; controle) ou 3% de óleo de SO, óleo de canola (CO) ou óleo de peixe (FO). Após 98 dias de experimento, 18 suínos por tratamento ($n = 72$) foram abatidos e amostras do músculo *Longissimus dorsi* foram coletadas para medidas de força de cisalhamento Warner-Bratzler e cor da carne (L^* , a^* e b^*). O lombo dos animais alimentados com as dietas contendo 3% de SO ou CO diminuíram a força de cisalhamento Warner-Bratzler ($P = 0,04$) em relação aos alimentados com a dieta controle. Os tratamentos dietéticos não tiveram efeito nos componentes da cor do lombo fresco. Esses resultados indicam que a suplementação com 3% de SO ou CO aumentam a maciez da carne suína, sem comprometer a cor da carne de suínos imunocastrados.

Palavras-chave: óleo de canola, óleo de peixe, óleo de soja, qualidade da carne

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INTRODUCTION

An important source of fatty acids in the human diet is meat, which is rich in saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids. These fatty acids contribute to the nutritional value of the meat, and their deposition and composition in skeletal and adipose tissue are directly influenced by the animal diet (WOOD et al., 2008). Because of the increased concerns of consumers regarding food safety and food quality, the interest in the production of meat with high nutritional value is also increasing (MOREL et al., 2013; DOKMANOVIC et al., 2015).

Regarding the use of fatty acids in pig nutrition, we can observe an increased application because of several benefits. Among these benefits, (1) the fatty acids can be used to easily increase the energy density of swine diets, which is important in the feeding of heat stressed pigs and of high producing lactating sows; (2) can improve the overall feed efficiency because the animal metabolizes it into body mass live weight gain (carcass weight and lean meat content are desirable); and (3) can be utilized as fat-soluble vitamins, essential fatty acids, and molecular signaling; can reduce the production cost increasing the financial return (BENZ et al., 2005; LAURIDSEN et al., 2007; WOOD et al., 2008; APPLE et al., 2009).

Other potential benefits of the use of different oil sources in pig nutrition are increasing tenderness, palatability, flavor, color, and the alteration of the fatty acid profile of the meat, which are characteristics that influence the consumer's purchase decisions (HUANG et al., 2020). The use of the specific oil sources in pig nutrition provide a different fatty acid profile on the diet and consequently the meat fatty acid profile (NAKAMURA; NARA, 2003).

A common oil used in animal production is soybean oil, which presents an important amount of polyunsaturated fatty acids (PUFA) such as the linoleic acid (n-6) and linolenic acid (n-3). However, some other fatty acids have been described as an important nutrient for human health and meat quality, monounsaturated fatty acid (MUFA) the oleic acid (n-9) and PUFAs the docosahexaenoic acid (DHA, n-3), and eicosapentaenoic acid (EPA, n3). These fatty acids are found in abundance in olive oil and also in grains such as sunflower and canola oil (CO), and in marine fat sources like fish oil (FO), respectively.

In general, the pigs diet used in most commercial production presents 1.5% SO in growing-finishing phases, however, no studies have investigated in detail the impact of the dietary oil inclusion of different sources on meat quality characteristics such as shear force and color of immunocastrated and genetically lean male pigs of Large White breed. Thus, the main goal of this study was to evaluate the increasing growing-finishing dietary supplemental oil through different sources on meat quality characteristics such as shear force and color of immunocastrated and genetically lean male pigs of Large White breed.

MATERIAL AND METHODS

Experimental protocol has followed ethical principles in animal research according to the Guide for the Care and Use

of Agricultural Animals in Agricultural Research and Teaching (FASS, 2010) and was approved by the "Luiz de Queiroz" College of Agriculture Animal Care and Use Committee (Universidade de São Paulo, Piracicaba, Brazil, number CEUA 2018-28).

Animals and dietary treatments

A total of 96 immunocastrated male pigs genetically lean of Large White breed and halothane homozygous-negative (NN) were used in a 98-day study. The animals were blocked by initial body weight (28.44 ± 2.95 kg) and allotted to a randomized complete block design with four treatments, six replicate pens per treatment, and four pigs per pen. Pigs were housed in an all-in/all-out double-curtain-sided building with partially slatted concrete floor pens. All pigs had ad libitum access to feed and water throughout the experimental period. Intact male pigs were injected with 2-mL primer dose (Vivax®, Pfizer Animal Health, Parkville, Australia) on day 56 and second 2-mL dose on day 71.

Diets were formulated to meet or exceed the nutritional requirements of growing-finishing pigs set by Rostagno et al. (2011). Dietary treatments consisted of a corn-soybean meal-based diet with 1.5% soybean oil (SO; control) or 3% oil from either SO, canola oil (CO), or fish oil (FO). Each of the oil sources was chosen to represent a different fatty acid profile. The canola oil is an important source of oleic acid (OA; C18:1 n-9), and SO is rich in linoleic acid (LA, C18:2 n-6), whereas FO is an important source of eicosapentaenoic acid (EPA; C20:5 n-3) and docosahexaenoic acid (DHA; C22:6 n-3). The canola oil used in this study were analyzed and indicated a high content of OA (64.2%) and low content of alpha-linolenic acid (C18:3 n-3; 7.6%) compared to a traditional CO (56.1% OA and 9.3% C18:3 n-3) available on the market as described in NRC (2012). No antibiotic growth promoters were used in this trial.

Pig slaughter and meat quality assessment

At the end of the study, three pigs from each pen (n = 72; 18 pigs per treatment) were randomly chosen and slaughtered according to the industry standards after a 16-hour rest period in the lairage pens, without feed but with free access to water. Animals were slaughtered (final body weight of 132.7 ± 10.9 kg) by electrical stunning followed by exsanguination. The *Longissimus dorsi* muscles were taken from the region between the 10th and 11th rib 24 hours after slaughter and cut into 2.5 cm thick chops for meat quality assessment.

The Warner-Bratzler shear force (WBS) was measured as suggested by Honikel (1998). Briefly, six 1.27-cm-diameter cores from each cooked pork chop were obtained parallel to the muscle fiber orientation after chilling overnight at 4 °C. Three cores were sheared once through the center using a Warner-Bratzler shear device with a crosshead speed of 3.33 mm/s. Samples were sheared perpendicular to the long axis of the core, and Warner-Bratzler shear force measurement was taken to be the peak force of the curve. The shear-force value for each chop was reported as the average of the shear-force values of the six cores.

A Konica Minolta digital colorimeter with calibration parameters according to the manufacturer's supply (D65, $Y=93.7$, $X=0.3160$, $y=0.3323$) was used to record color as lightness (L^*), redness (a^*), and yellowness (b^*) values on fresh meat as proposed by the Commission Internationale de l'Eclairage (CIE). Three measurements were made at random locations of each chop and the average was used for statistical analysis.

Statistical analyses

Data were analyzed as a randomized complete block design using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC), and the pen was considered the experimental unit. Outliers were removed from the data sets and residuals were tested for a normal distribution using the Shapiro-Wilk test (UNIVARIATE procedure). Dietary treatment and block were included in the model as the fixed and random effects, respectively. LSMEANS option was used to generate treatment means, which were separated using the PDIFF option based on Student's t test. Significance was declared at $P \leq 0.05$.

RESULTS AND DISCUSSION

Loins from immunocastrated male pigs fed diets with 3% SO or CO had decreased WBS ($P = 0.04$) when compared to loins from control-fed pigs (Table 1). These results agree

with previous results of Miller et al. (1990), which observed that pigs fed diets containing CO showed a softer meat. In a similar way to the present study, a study by Scheeder et al. (2000) that aimed to evaluate the influence of fatty acids, pigs received two diets with different oils, the animals that were submitted to the treatment with SO presented a lower shear force, thus indicating a better quality of the meat in relation to tenderness. This reduction may be associated with the greater deposition of mono (OA) and polyunsaturated fatty acids (LA and LNA) in the intramuscular fat and in the lipid layer of the cells, which may be associated with greater meat palatability and juiciness.

In a Grela et al. (2020) study where pigs received a supplementation with milk thistle seeds (*Silybum marianum* L.) that contained high levels of linoleic acid and oleic acid, it was demonstrated that these fatty acids influence the quality of meat. The supplementation used resulted in lower shear strength (GRELA; FLOREK; WOJTASZEWSKA, 2020), as was verified in this study. Thus, studies such as these demonstrate to be important in determining diets that contain functional components that result in improving the health of the animals and the quality of the meat produced.

Adding 3% oil, regardless of source, had no effect on meat color (L^* , a^* , and b^*) of the *Longissimus dorsi* muscle (Table 1). The monounsaturated fatty acids have a rapid capacity to oxidize, which influences the color of the meat, resulting in the change from red oxymyoglobin to brown metamioglobin (ABUELFATAH et al., 2016).

Table 1 – Effects of dietary oil sources on *Longissimus dorsi* muscle quality of immunocastrated male pigs

Item	Dietary treatment ¹				SEM ²	P-value
	Control	SO	CO	FO		
WBS ³ , kg	4.73 ^a	3.54 ^b	3.65 ^b	4.16 ^{ab}	0.18	0.04
L^*	51.99	52.14	52.50	51.02	0.38	0.58
a^*	6.83	7.12	7.13	7.30	0.13	0.69
b^*	0.79	1.17	0.87	0.83	0.10	0.56

¹The added oil diets consisted of 1.5% soybean oil (SO; control) or 3% SO, canola oil (CO), or fish oil (FO).

²Standard error of the least square means.

³Warner-Bratzler shear force.

^{a,b}Within a row, values without a common superscript differ ($P \leq 0.05$) by the Tukey Test.

In a study with different nutritional management of pigs, whose animals were fed *ad libitum* diets enriched with oleic acid (low, medium and high oleic acid with 0.93, 2.28 and 3.79 g of oleic acid per 100 g of concentrate, respectively) for 57 days, also did not observe any differences regarding the characteristics of fat yellowness and lean redness (CARRAPISO et al., 2020). However, the high oleic acid diet increased the values of lean brightness in this same study.

Similarly, Morel et al. (2013) reported in their studies with pigs, also fed different diets rich in fatty acids and with *ad libitum* access to feed and water, that the dietary treatment did not show significant difference for the parameter of muscle staining. Thus, the addition of different sources of oil in the diet had no effect on the pig meat color.

CONCLUSION

Formulating immunocastrated male pig diets containing either 3% CO or SO increased pork tenderness, without affecting objective color measurements of fresh loin.

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