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Article

Effectiveness of canola oil in pig diets to improve the lipid profile of meat

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Abstract:

The objective of this study was to determine the maximum level of inclusion of canola oil (CO) in diets for finishing pigs, to increase the content of oleic acid and unsaturated fatty acids and improve the Ω6:Ω3 ratio in meat, without affecting the productive performance, carcass characteristics and physicochemical characteristics of the meat. The treatments were: the gradual substitution of soybean oil (6 %) for CO in diets for pigs at finishing stage I and II (0, 2, 4 and 6 % of CO). The experimental units were 48 castrated pigs with initial live weight of 50.00 ± 4.5 kg, evaluated for four weeks at each stage. With the data obtained, an ANOVA was performed, and linear or quadratic trends were detected ($P \leq 0.10$). At finishing stage I, the average daily gain decreased with the inclusion of 2 % of CO, although the incorporation of 2 and 4 % of CO had no effect. At finishing stage II, a level between 2-4 % of CO reduced average daily feed intake and improved feed conversion ($P \leq 0.05$). The addition of CO did not modify the characteristics of the carcass and did not affect the physicochemical characteristics of the meat ($P \geq 0.10$). CO in the diet increased the concentration of monounsaturated fatty acids (MUFAs) and oleic acid ($P \leq 0.05$); it reduced linoleic acid ($P \leq 0.03$), polyunsaturated fatty acids ($P \leq 0.07$) and the Ω6:Ω3 ratio ($P \leq 0.01$). In conclusion, the addition of CO (2-6 %) in the diet of finishing pigs gradually increases the content of oleic acid and MUFAs, in addition, it improves the Ω6:Ω3 ratio in pork, without affecting the productive variables and the quality of the meat.

Key words: Productive performance, Carcass characteristics, Fatty acid profile, Oleic acid.

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Introduction

The quantity and quality of the fat in diet affect human health[1]. Low intake of saturated fatty acids (SFAs)[2], high consumption of monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs)[3] are related to aspects beneficial to human health. Likewise, the consumption of Ω3 fatty acids (FAs) represents potential benefits in health and prevention of certain diseases[4]; however, human eating patterns have led to lower consumption, causing an inappropriate relationship with Ω6 FA[5]. On the other hand, the consumption of oleic acid has shown positive effects on health, preventing human diseases[6,7]. Due to the above, it is important to consume foods that improve the dietary fatty acid profile of people[8].

The amount and composition of fatty acids in the pig diet reflects and changes the lipid composition in meat[9]. In swine nutrition, typical feeding practices (cereal-soybean meal) give it a high ratio of

PUFAs and a high Ω6:Ω3 FAs ratio to meat[10-13]. To change the profile and improve the ratios between FAs, it is necessary to supply food components with a fat profile related to the objective pursued[14,15].

The use of canola oil (CO) in the diet of pigs appears to be a good lipid source of MUFAs and PUFAs because it is composed mainly of oleic (59.8 %), linoleic (20.6 %), linolenic (8.49 %) fatty acids and an appropriate ratio of Ω6:Ω3 FAs[16]. However, a higher proportion of MUFAs and PUFAs could have a negative influence on the technological properties of pork and its oxidative stability, as well as on the sensory characteristics[1].

Some studies[17,18,19] have explored the possibility of using CO (2-4 %) in swine nutrition as a source of unsaturated FAs in meat, without affecting the productive performance and physicochemical characteristics of the meat. In general, it is observed that the inclusion of CO in the diet increases the content of oleic, linolenic acid and MUFAs, reduces the concentration of linoleic acid, PUFAs, and improves the Ω6:Ω3 ratio in meat.

Considering that the profile of ingested fatty acids can alter the development of the adipose tissue of pig and be deposited directly in the body fat, the objective of this study was to determine the maximum level of inclusion of CO in diets for finishing pigs to increase the content of oleic acid, unsaturated fatty acids and improve the Ω6:Ω3 ratio in meat, without affecting the productive performance, carcass characteristics and physicochemical characteristics of the meat.

Material and methods

The study was carried out at the Swine Unit of the Experimental Farm of the Colegio de Postgraduados, located in Montecillo, Municipality of Texcoco, State of Mexico, located at 98º 48’ 27” W and 19º 48’ 23” N and an altitude of 2,241 m asl, with a temperate subhumid climate with summer rains, average annual temperature of 15.2 °C and average annual rainfall of 644.8 mm[20].

Animals and experimental diets

The treatments (Tr) consisted of the gradual substitution of soybean oil (6 %) for CO in diets for pigs in the finishing stages I (50-75 kg of weight) and II (75-100 kg of weight): 0, 2, 4 and 6 % of CO (Table 1). The experimental units were 48 castrated male hybrid (Landrace×Yorkshire×Pietrain) pigs (12 animals per treatment in both stages), with average initial live weight (ILW) of 50.00 ± 4.5 kg evaluated for four weeks in each stage, distributed in a completely randomized design. The pigs were housed in individual pens equipped with hopper-type feeder and nipple drinker. The diets were formulated with the Solver command[21], according to the requirements suggested by the NRC[22] for the two stages (Table 1). For the diet of pigs from 75 to 100 kg, ractopamine (10 mg kg^{-1}) was added to all treatments, for which the concentration of nutrients recommended by the NRC[22] when using this additive was considered.

Table 1: Experimental diets for finishing pigs

Ingredient (%)	Finishing I (canola oil %)				Finishing II (canola oil %)			
	0	2	4	6	0	2	4	6
Sorghum	62.19	62.49	62.80	63.10	66.19	66.52	66.84	67.17
Soybean meal	14.53	14.48	14.44	14.40	10.08	10.01	9.94	9.87
Wheat bran	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Soybean oil	6.00	4.00	2.00	0.00	6.00	4.00	2.00	0.00
Canola oil	0.00	2.00	4.00	6.00	0.00	2.00	4.00	6.00
Calcium carbonate	0.54	0.54	0.54	0.55	1.01	1.01	1.01	1.01
Orthophosphate	0.94	0.94	0.93	0.93	0.21	0.21	0.21	0.20
Sand	4.40	4.14	3.88	3.62	4.65	4.39	4.13	3.87
Vitamins and minerals[A, B]	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Lysine	0.62	0.62	0.62	0.62	0.70	0.70	0.70	0.70
Methionine	0.04	0.04	0.04	0.04	0.09	0.09	0.09	0.09
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Threonine	0.09	0.09	0.09	0.09	0.20	0.20	0.20	0.20
Tryptophan	0.00	0.00	0.00	0.00	0.22	0.22	0.22	0.22
	Nutritional contribution (%)							
ME (Mcal/kg)	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30
CP	14.87	14.88	14.89	14.90	13.50	13.50	13.50	13.50
Arginine	0.77	0.77	0.77	0.77	0.64	0.64	0.64	0.64
Lysine	0.85	0.85	0.85	0.85	0.93	0.93	0.93	0.93
Methionine+Cystine	0.41	0.41	0.41	0.41	0.42	0.42	0.42	0.42
Threonine	0.52	0.52	0.52	0.52	0.57	0.57	0.57	0.57
Tryptophan	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.16
Valine	0.66	0.66	0.66	0.66	0.56	0.56	0.56	0.56
Total calcium	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
Total phosphorus	0.45	0.45	0.45	0.45	0.30	0.30	0.30	0.30

[A] Provided per kg of feed: vitamin A, 15,000 IU; vitamin D3, 2,500 IU; vitamin E, 37.5 IU; vitamin K, 2.5 mg; thiamine, 2.25 mg; riboflavin, 6.25 mg; niacin, 50 mg; pyridoxine, 2.5 mg; cyanocobalamin, 0.0375 mg; biotin, 0.13 mg; choline chloride, 563 mg; pantothenic acid, 20 mg; folic acid, 1.25 mg. [B] Provided per kg of feed: Fe, 150 mg; Zn, 150 mg; Mn, 150 mg; Cu, 10 mg; Se, 0.15 mg; I, 0.9 mg; Cr, 0.2 mg

Response variables and carcass characteristics

The response variables studied in both experimental stages were: productive performance (average daily feed intake, ADFI; average daily gain, ADG; feed conversion, FC; fat free lean gain, FFLG; and final live weight, FLW) and carcass characteristics (backfat thickness, BT; lean meat percentage, %LM; *Longissimus dorsi* muscle area, LMA). DF and ALM were measured using real-time ultrasound (SonoVet 600, Medison, Inc., Cypress, California, USA) at the beginning and end of each stage. With these data and with the initial and final live weight, FFLG was calculated using the equation of the National Pork Producers Council[23].

Physicochemical characteristics

At the end of the second experimental stage, five pigs per treatment (about 100 kg of live weight) were randomly selected and slaughtered. The slaughter was carried out at the slaughterhouse of the experimental farm, complying with the Official Mexican Standard NOM-033-SAG/ZOO-2014[24]. A sample of leg (*Biceps femoris*) meat and a sample of loin (*Longissimus dorsi*) meat were obtained from each animal, and pH, color, water retention capacity and texture were measured. Meat samples were kept in refrigeration at 4 °C. Part of the samples were frozen until the determination of fatty acids.

Color determination was measured at 24 h *post mortem*, using a portable colorimeter (Hunter Lab, Chroma meter CR-410, Konica Minolta Sensing, Inc. Japan). It was calibrated with the white color at three different points on the surface area of the leg and loin of the pig (in a meat sample 15 mm thick) to measure the variables luminosity (L*), red (a*) and yellow (b*)[25].

The pH was measured directly in the leg (*Biceps femoris*) muscle and the loin (*Longissimus dorsi*) at 24 h *post mortem* with a portable puncture potentiometer (Model pH1100, Hanna® Mexico)[26].

The water retention capacity (WRC)[26] was performed 24 h *post mortem*: 2 g of finely chopped leg and loin meat were weighed, placed in a centrifuge tube, samples were homogenized with 5 ml of a 0.6 M sodium chloride solution and stirred in a vortex (1,000 rpm) for one minute. The samples were left to stand for 30 min in a refrigerator at 4 °C and then centrifuged for 15 min at 3,500 *g* (Beckman J-MI centrifuge). The supernatant was decanted and measured in a graduated cylinder. The retained volume of distilled water is reported as the amount of water retained in 100 g of meat. Measurements were made in triplicate, average measurements were calculated and recorded.

Texture determination was performed 24 h *post mortem*; leg and loin meat samples were taken, a TA-XT2 texture analyzer (Texture Technologies Corp., Scarsdale, NY) with a Warner-Bratzler razor were used. Cubes of raw meat of 1 cm^3 were cut, placed with the muscle fibers transversely on the razor's edge, using the record of the maximum force to cut and the known force[27]. Measurements were made in triplicate, average measurements were calculated and recorded.

Fatty acid profile

The fatty acid profile in meat was determined based on the method described by Folch *et al* [28]. For the determination of the fatty acid profile, the standard HP® (Model 6890) chromatograph of Supelco 37 (Component FAME Mix Catalog N0.47885-U) methyl esters was used, with a Supelco column (SP™- 2660 FUSED SILICA Capillary Column, 100 m x 0.25 mm x 0.2 µm film thickness).

Helium was used as a carrier gas at 0.8 ml/min; the sample injection was 1 µl in 1:10 Split mode manually, with an initial temperature ramp of 140 °C by 1.00 degree min^{-1}, with an increase to 3 °C min^{-1} at a temperature of 210 °C, and a decrease of 0.7 degrees min^{-1} and a final temperature of 235 °C. The total time to analyze each sample was 60 min.

Statistical analysis

For the two experimental stages, a completely randomized design was used, with four treatments and twelve replicates in each, considering each pig as an experimental unit to evaluate the productive performance. For the fatty acid profile and physicochemical characteristics of the meat, five pigs from each treatment were randomly selected at the end of the second experimental phase. When the pigs were slaughtered, a leg and a loin sample were taken from each animal. The Shapiro-Wilk and Levene tests were used to verify the normal distribution and homogeneity of the variance of the variables. With the data obtained, an ANOVA was performed using the GLM procedure and to detect linear and quadratic trends in response to the inclusion of canola oil in the diet, orthogonal polynomials were used ($P \leq 0.10$)[29]. ILW was used as a covariate for ADFI, ADG, FLW, FC and FFLG ($P \leq 0.10$). Whereas, for BT, LMA and %LM, their respective initial measurements were used as a covariate ($P \leq 0.10$).

Results

The results of the productive response and carcass characteristics are shown in Table 2. In the finishing stage I (50-75 kg LW), ADG and FLW showed a quadratic trend (P=0.08), decreasing with the inclusion of 2 % of CO in the diet; the incorporation of 4 and 6 % of CO had no negative effect. The rest of the variables in the finishing stage I were not modified by the substitution of soybean oil for canola oil (*P*>0.10). For the finishing stage II, ADFI behaved quadratically (*P*=0.03), reducing with a level between 2 and 4 % of CO without affecting ADG and FLW, which led to the improvement of FC (*P*=0.05) with these same levels of CO. In the finishing stage II, backfat thickness decreased linearly (*P*=0.01), and the percentage of LM increased linearly (*P*=0.05) in response to the inclusion of CO in the diet. For the rest of the variables, there was no effect (*P*>0.10) when substituting soybean oil for CO in both stages.

Table 2: Productive performance of finishing pigs fed four levels of canola oil in the diet

	Finishing stage I							**Finishing stage II**						
	Canola oil (%)					***P*-value**		**Canola oil (%)**					***P*-value**	
	0	**2**	**4**	**6**	**SE**	**L**	**Q**	**0**	**2**	**4**	**6**	**SE**	**L**	**Q**
ADFI, kg d^{-1}	2.66	2.47	2.54	2.59	0.10	0.77	0.24	3.06	2.82	2.92	3.08	0.09	0.72	0.03
ADG, kg d^{-1}	0.71	0.63	0.69	0.67	0.02	0.53	0.08	0.84	0.84	0.85	0.81	0.03	0.55	0.52
FLW	73.41	70.95	72.62	72.30	0.58	0.52	0.08	96.20	96.14	96.51	95.32	0.85	0.54	0.52
FC	3.74	3.97	3.71	3.85	0.13	0.87	0.73	3.64	3.39	3.45	3.90	0.18	0.29	0.05
FFLG, kg d^{-1}	0.27	0.24	0.26	0.26	0.01	0.62	0.29	0.26	0.27	0.29	0.27	0.01	0.44	0.40
BT, mm	10.61	10.39	10.57	10.77	0.48	0.77	0.66	15.34	14.53	13.78	13.31	0.60	0.01	0.75
LMA, cm^2	28.05	27.19	27.88	27.66	0.72	0.88	0.66	32.72	32.71	33.56	33.58	0.94	0.92	0.61
% LM	39.27	39.33	39.21	39.36	0.28	0.90	0.89	37.01	37.21	37.65	37.59	0.24	0.05	0.62

ADFI= average daily feed intake, ADG= average daily gain, FLW= Final live weight, FC= feed conversion, FFLG= fat free lean gain, BT=backfat thickness, LMA= *Longissimus* muscle area, LM= lean meat, SE= standard error of the mean, L= linear effect, Q= quadratic effect.

The results of the physicochemical characteristics of leg and loin meat are shown in Table 3. For color, WRC and texture, no significant differences (*P*>0.10) were found due to the effect of CO levels, with the exception of L* (*P*=0.03), which increased in loin meat when using 2-4 % of CO. In leg and loin, the pH tended to decrease (*P*=0.01) as the concentration of CO in the diet increased.

Table 3: Physicochemical characteristics of the meat of finishing pigs 75-100 kg, fed four levels of canola oil

	Leg meat							**Loin meat**						
	Canola oil (%)					***P*-value**		**Canola oil (%)**					***P*-value**	
	0	**2**	**4**	**6**	**SE**	**L**	**Q**	**0**	**2**	**4**	**6**	**SE**	**L**	**Q**
pH	6.74	5.43	5.44	5.70	0.10	0.01	0.01	6.64	5.63	5.49	5.69	0.20	0.01	0.01
L*	45.38	46.54	46.20	47.52	1.60	0.41	0.96	55.98	58.84	56.24	54.10	1.71	0.92	0.03
a*	19.44	19.78	19.56	19.40	0.52	0.89	0.64	17.24	16.86	17.62	16.84	0.51	0.84	0.70
b*	4.36	4.54	4.00	4.94	0.53	0.62	0.49	6.04	9.38	5.80	5.22	1.21	0.28	0.12
WRC, ml/g	0.89	0.99	0.86	0.87	0.13	0.96	0.84	0.89	0.87	0.88	0.86	0.15	0.95	0.83
Texture, g	1225	1318	1294	1443	155	0.38	0.86	1791	1406	1446	1445	222	0.34	0.39

L*= luminosity; a*= red index; b*= yellow index; WRC= water retention capacity, SE= standard error of the mean, L= linear effect, Q= quadratic effect.

Table 4 shows the results of the lipid profile of leg and loin meat. In both samples, myristic acid (P=0.01) and palmitic acid (P=0.06 and P=0.01 respectively) showed a quadratic trend, observing a reduction with 2 % of CO. In both leg and loin, the concentration of oleic acid increased linearly (P=0.01), and linoleic acid reduced (P=0.03 and P=0.01 respectively) in response to the increase in dietary CO. The linolenic acid content in meat was not modified (P>0.10); however, the Ω6:Ω3 ratio reduced linearly (P=0.01) in leg meat when substituting soybean oil for CO. The total SFAs in leg and loin reduced (P=0.06 and P=0.01 respectively) with 2 % of CO, although the other levels of CO did not modify the concentration of these fatty acids. In leg and loin, MUFAs increased linearly (P≤0.01) and PUFAs reduced (P=0.07 and P=0.01 respectively) linearly due to the effect of the inclusion of CO in the diet.

Table 4: Fatty acid profile of the meat of finishing pigs, fed five levels of canola oil

Fatty acid	Leg meat Canola oil (%)					*P*-value		Loin meat Canola oil (%)					*P*-value	
	0	2	4	6	SE	L	Q	0	2	4	6	SE	L	Q
Myristic	1.99	1.28	1.41	1.79	0.19	0.56	0.01	2.04	1.35	1.51	1.93	0.19	0.84	0.01
Palmitic	24.80	22.37	23.25	23.22	0.65	0.18	0.06	26.17	23.17	24.56	24.39	0.54	0.09	0.01
Stearic	11.94	10.17	11.24	10.79	0.58	0.37	0.27	12.53	10.67	11.83	11.48	0.60	0.43	0.21
∑SFAs	38.73	33.82	35.9	35.8	1.14	0.23	0.06	40.74	35.19	37.9	37.8	1.07	0.17	0.01
Palmitoleic	3.07	3.09	2.67	3.17	0.26	0.92	0.34	3.28	3.31	3.49	3.40	0.20	0.55	0.78
Oleic	39.90	42.07	42.86	45.09	1.13	0.01	0.98	40.49	45.06	45.23	46.45	0.86	0.01	0.07
Eicosanoic	0.53	0.72	0.68	0.74	0.09	0.11	0.44	0.60	0.69	0.63	0.60	0.06	0.82	0.35
∑MUFAs	43.5	45.88	46.21	49.0	1.21	0.01	0.86	44.37	49.06	49.35	50.45	0.94	0.01	0.09
Arachidonic	1.08	1.35	1.28	1.03	0.10	0.79	0.12	0.84	0.93	0.76	0.93	0.13	0.86	0.73
Linoleic	14.75	16.36	14.41	11.63	1.07	0.03	0.05	12.26	12.84	10.39	8.94	1.02	0.01	0.31
Linolenic	1.38	1.83	1.59	1.73	0.15	0.22	0.27	1.33	1.42	1.15	1.21	0.15	0.30	0.87
Eicosadienoic	0.55	0.74	0.60	0.55	0.10	0.77	0.20	0.45	0.53	0.43	0.27	0.11	0.21	0.28
∑PUFAs	17.76	20.28	17.88	14.94	1.17	0.07	0.04	14.88	15.72	12.73	11.35	1.19	0.01	0.32
Ω6:Ω3	12.04	10.19	10.54	7.64	0.69	0.01	0.48	10.57	10.22	10.65	8.65	1.21	0.29	0.47

SFAs=saturated fatty acids, MUFAs= monounsaturated fatty acids, PUFAs= polyunsaturated fatty acids, L=linear effect, Q=quadratic effect

Discussion

The quadratic behavior of ADG and FLW has no clear explanation, since the diets were formulated isoenergetic and isoprotein, assuming that the energy values and nutrients in general for each diet and oil source(22) were appropriate for the productive stage, and therefore a similar response would be expected in the productive variables. According to some authors(10,13,30), when evaluating different sources of fat (soybean, palm, olive and flax oil) in isocaloric diets for finishing pigs, they found no negative effect on the productive performance and carcass characteristics.

The change in the lipid profile of the diet when substituting 2 % of soybean oil for CO was marginal, considering that in diets where the productive performance was not affected, substitution was 4 and 6 %, modifying the fatty acid profile to a greater degree. Therefore, a change in the productive response (negative or positive) would be expected when using a greater amount of CO in the diet. Unlike what was obtained in the present research, studies on pigs in the finishing stage(19,31,32) report that the inclusion of CO (4, 3, 2.5 and 3.5 % respectively in each of the studies) in substitution of other oils of vegetable origin (soybean or corn) or animal fat did not affect the productive parameters, as long as the concentration of nutrients in the diets was respected, emphasizing mainly energy. Moreover, when evaluating CO levels of 0, 5 and 10 %, there was a linear effect to improve feed consumption, weight gain and feed conversion in growing-finishing pigs, in addition, there was no effect on backfat thickness and LMA[33].

In the present work it was assumed that, by not altering the general concentration of nutrients, but that of some fatty acids, the physicochemical characteristics of the meat could have minimal alterations. This assumption was supported by studies conducted with the addition of 2.5-4 % of CO in the diet of pigs on meat characteristics, where it is reported that the inclusion of CO had no negative effect[18,19,31]. In fact, other researchers[16] found that the inclusion of 2 % of CO in the diet of pigs increased the pH, favored the sensory characteristics and the marbling of the meat, compared to diets without the addition of oil. Although the use of very high concentrations (10 %) of CO in the diet affected the marbling and color of the meat, it also reduced the firmness of fat[33], probably because that level of oil addition in the diet provides too many monounsaturated and polyunsaturated fatty acids, which are deposited in adipose and muscle tissue, which changes the characteristics of meat and fat.

In the present investigation, the increase in CO reduced the pH, tending to reach the maximum and minimum pH values (5.4-5.8)[34]. In this *post-rigor* interval of the meat, they indicate that the production of putrefaction compounds, such as biogenic amines, aldehydes, ketones and short-chain fatty acids, has not begun, since the pH depends on the time: *post-mortem* temperature relationship, consequently, chemical compounds that cause the pH to increase are generated[34]. Also, the texture in leg and loin was not affected by the different treatments, probably because the long-chain polyunsaturated fatty acids were incorporated into the fatty tissue and not into the muscle tissue, since the hardness of the meat is due to the structures of the muscle fibers formed in a high percentage by proteins, therefore, polyunsaturated fatty acids did not affect the hardness of the meat as lipids were not significantly incorporated into the muscle fibers[35]. Regarding the WRC variable, in the same way, it was not affected in leg and loin by the different treatments; this is probably explained because when adding long-chain polyunsaturated fatty acids to non-ruminant diets, there is an increase in the ratio of saturated to unsaturated fatty acids in the fat of the pig, since the higher the degree of unsaturation, the lower the quantity of electrical charges that can interact with water[36].

The decrease in linoleic acids and PUFAs, and the increase in oleic acids and MUFAs as the level of CO increased, coincides with the results obtained in other studies when adding from 3 to 10 % of CO[3,19,33]. In previous reports[3,19,31], they found no changes in the content of myristic acid and SFAs when substituting some type of oil for CO, contrary to what was found in the present study; however, the reduction of palmitic acid was observed when adding from 4 to 10 % of CO[3,33].

Supplementation from 3-4 % of CO in substitution of soybean oil in diets for pigs in the finishing stage increased the content of oleic, linolenic acids and MUFAs, reduced the concentration of linoleic acid, PUFAs, total Ω6 and the Ω6:Ω3 ratio in meat fat[3,19]. By adding 5 or 10 % of CO in diets for finishing pigs, oleic, linoleic, linolenic acids, MUFAs and PUFAs increased linearly, and palmitic acid in meat fat reduced compared to oil-free diets[33]. CO (2.5 %) in diets for finishing pigs increases the content of oleic acid and MUFAs, reduces the amount of linoleic acid and PUFAs in body fat[31], increases the content of linolenic acid and improves the oxidative stability in meat[17,18,31] compared to corn oil.

Another possible option to try to improve the lipid profile of pork would be to use different types of oil, since in some studies[19,37], they have found that the combination of CO (1-1.5 %) with flaxseed oil (1.5-2.3 %) has a favorable response in the fatty acid profile in meat, since they increase oleic, linolenic acids and MUFAs, decrease linoleic acids, PUFAs, total Ω6 and the Ω6:Ω3 ratio.

The results of the present work show that the fatty acid profile in pork is modified depending on the content of FAs in the oil source of the diet; since CO and soybean oil have different fatty acid profiles[22] with a predominance of oleic and linoleic unsaturated fatty acids, respectively.

In pigs, the fatty acid profile of the diet is reflected in the body fat, because part of the ingested fatty acids is deposited directly in the tissues[30,38,39]. The degree of change of body fatty acids depends on the time and percentage of fat supplementation in the diet[40,41]. Specific fatty acids have different rates or potential for change in body fat induced by the fat supplementation in the diet[12,19,38]. In addition, the supply of fats in the diet reduces lipogenesis[42,43], therefore, an increase in the incorporation of the fatty acids of the diet into body fat.

Conclusions and implications

The inclusion of canola oil (2-6 %) in the diet of pigs in the finishing stage is effective in proportionally increasing the oleic acid content, improving the Ω6:Ω3 ratio, reducing the content of saturated fatty acids and increasing monounsaturated fatty acids in meat. In addition, the use of up to 6 % canola oil in the diet does not affect the productive performance, carcass characteristics and positively stabilizes the pH of the meat.

Acknowledgements and conflict of interest

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