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THE INFLUENCE OF BY-PRODUCTS ON THE PRODUCTION PARAMETERS AND NUTRIENT DIGESTIBILITY IN FATTENING PIGS DIET (60-100 kg)

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Abstract

The study was conducted in order to determine the effects of the dietary flax and grape seeds meals and of the pumpkin waste in pig diets (60-100 kg) on the production parameters and nutrient digestibility. The 40-day feeding trial used 9 pigs assigned to 3 groups (C, E1, E2), housed in individual metabolic cages. The average initial body weights of the pigs were 65.25±14.49 kg (C), 65.33±3.78 kg (E1) and 65±10.03 kg (E2). Group C diet (19.59% crude protein; 7.16% fibre and 3232 kcal metabolisable energy/kg) was conventional, with corn meal, wheat and soybean meal. Differently from group C formulation, the E1 diet included 5% flax meal and 1% grape seeds meal, while E2 diet included 5% pumpkin waste. The average daily feed intake was significantly (P≤0.05) higher in group E2 (3.394±0.36 kg feed/pig/day) compared to groups C (3.034±0.44 kg feed/pig/day) and E1 (3.332±0.36 kg feed/pig/day). There were no significant (P≥ 0.05) differences in the feed conversion ratio (kg feed/kg gain). Fibre absorption coefficient was significantly (P ≤ 0.05) lower in group E2 (pumpkin waste), by 24.83% compared to group C and by 17.60% compared to group E1.

Key words: *pigs, by-products, feeding quality, digestibility, meat development.*

INTRODUCTION

The food industry by-products are residues produced in large amounts worldwide. They account for more than 50% of the total residues produced in some countries, 60% of them being organic matter. Food industry by-products storage and management cause serious environmental and sustainable development problems (Brenes et al., 2016). In Romania, the food industry accounts for 17% of the industrial GDP, and its turnover increases continually, exceeding 10 billion Euro/year. Using it as animal feed is the most efficient way of using the food by-products, but there are legal restrictions and limits generated by the nature of these by-products. Thus, the compound feeds industry plays an important role in the policy of reducing the food residues (Romans et al., 1995b). Furthermore, animal feeding with these food industry by-products allows their transformation, through animal metabolism, into animal products, which is why they should have priority relative to all the other utilisations. In these recent years, the practice of introducing functional foods into human diets gained momentum, and part of these food industry by-products can be valuable sources of nutrients which bestow functional properties to the foods. Thus, the oil industry meal has nutraceutic and therapeutic properties, which make it a food ingredient with high added value (Goyal et al., 2014). The flax can be given to pigs in different forms (seeds, oil, cakes, meal), given the increasing interest to produce meat enriched in polyunsaturated fatty acids (PUFA) (Mathews et al., 2000; Olomuand Baracos, 1991). Various studies on meat animals aimed to increase the level of PUFA, of the alpha linolenic (omega 3) fatty acids, particularly, in the meat and meat products (Enser et al., 1996; Raes et al., 2004; Pogurschi et al., 2009). Romans et al. (1995a) gave ground flax seeds to finishing pigs and obtained significant increases of omega-3 PUFA levels in the muscle tissue, without affecting pig performance. Matthews et al. (2000) fed pigs with diet formulations which included 0.5 or 10% flax (whole plant) and didn't notice any change in pig performance. A high PUFA content of the fat may affect adversely the quality of the meat and of the meat products because of the lower oxidative stability (Daza et al., 2005; Musella et al., 2009). Antioxidants can be used to counter this effect, introduced either directly in animal diets, or in the processed products (Arteel and Sies, 1999). The presence of phenolic compounds with antioxidant activity in grapes, winery by-products and extracts, was confirmed by the studies of Rotava et al., 2009. The main phenolic compounds in the winery by-products (grape peels and seeds) are catechins, epicatechins and gallic acid, together with other phenolic acids (Lafka et al., 2007; Shi et al., 2003). Therefore, the grapes and their by-products are an important source of antioxidants for the food processing industry and for the animal industry. Carpenter et al. (2007) confirmed the antioxidant effect of the grape seeds extract when added directly to rawor cooked pig meat. A study by Gessner et al. (2013), noticed that feeding grape seeds and grape marc extract improved the feed conversion ratio of the weaned piglets (Gessner et al., 2013). The pumpkin is another vegetal source for pig feeds, due to significant concentration of minerals, vitamins and betacarotene, particularly (Gwanama et al., 2001). However, only the flesh of the pumpkin isused, which means that some 24,000 tons of pumpkin seeds are discarded yearly, which have about 94% dry matter and a lot of proteins, amino acids and lipids (Martínez et al., 2008). The pumpkin grounds result from the cold extraction of pumpkin oil from pumpkin seeds, and studies are investigating whether they can be used as animal feed. Thisby-product is the least processed form of protein from pumpkin seeds and it has 63% protein, 12% carbohydrates, 4.5% gross fibre, 8.4% oils and 13% other components (Pericin et al., 2007). This by-product might be a good substrate for fermentation (Pericin et al., 2007) and a source of bioactive phenolic acids (Pericin et al., 2009) given its high level of proteins (60-65%), which make it an attractive and promising source of plant proteins (Pericin et al., 2008). Within this context, we conducted an experiment to evaluate the digestibility of the basic nutrients and the quality of meat from pigs (60-100 kg) fed on diets which included flax meal, grape seeds meal and pumpkin grounds.

MATERIALS AND METHODS

The efficiency of the diet formulations which included food industry by-products (flax meal, grape seeds meal and pumpkin grounds) was assessed in a feeding trial on fattening pigs (60-100 kg) conducted in the experimental hall of the Laboratory of nutrition physiology of the National Research Development Institute for Animal Biology and Nutrition - IBNA. The 40-days feeding trial was conducted on 9, TOPPIGS pigs assigned to three groups (C, E1 and E2) with an average initial weight of 65.25±14.49 kg/pig (C), 65.33±3.78 kg/pig (E1) and 65±10.03 kg/pig (E2). The pigs were housed in individual digestibility cages which allowed the daily recording of the compound feeds intake and of the excreta. The experimental hall had controlled microclimate conditions, according to the management guide of the hybrid pigs: 22.04±1.23^{o}C temperature and 42.18±1.60% humidity. The pigs had free access to the feed and water. Group C received a conventional diet (Table 1) based on corn flour, wheat and soybean, with 19.59% crude protein, 7.16% crude fibre and 3232 kcal/kg metabolisable energy. Differently from group C, the diet formulation for group E1 included 5% flax mealand 1% grape seeds meal (19.36%, 7.84% and 3200 kcal/kg), while the diet formulation for group E2 included 5% pumpkin grounds (19.13%, 6.43% and 3200 kcal/kg). The studied by-products (flax meal, grape seeds meal and pumpkin grounds) were purchased from a local SME from Teleorman County (2ePROD.SRL), which produces food supplements. The diets were formulated using the mathematical model for energy and protein metabolism simulation (Burlacu, 1983). To facilitate nutrient digestibility and provide a healthy gut, the experimental diet were supplemented with 15 g pre/probiotic feed/kg and 10 g organic acids/kg feed (Table 1). The pro/prebiotic feed is a combination of four active ingredients with synergic action:

probiotic - *Enterococcus faecium*; prebiotic - fructo-oligosaccharide - inulin; cell wall fragments and phicophytic substances such as sea weeds extracts). The other product is a synergic combination of organic acids, inorganic acids and their salts which, by the combination with the plant extracts prepare the gut improving digestibility and inhibiting the proliferation of Gramm-negative bacteria. It contains: formic acid (19.2%); propionic acid (19.2%); lactic acid; citric acid; sorbic acid, with pH 4.0.

The pigs were weighed weekly to determine the rate of growth. Two, 5-days balance periods were conducted during the experimental period. Ingesta and faeces samples were collected on a daily basis from each pig, on the experimental weeks 3 and 6, and assayed to determine the coefficients of nutrient apparent absorption. The daily samples of ingesta and faeces were used to form average weekly samples, which were died for 48 h at 65°C in a drying closet. The samples were assayed for dry matter, protein, fat, fibre and ash.

Table 1. Diet formulation

Specification	C	E1	E2
	%		
Corn	32.85	36.54	54.78
Flax meal	-	***5***	-
Grape seeds meal	-	***1***	-
Pumpkin grounds	-	-	***5***
Barley bran	10	8.23	10
Wheat	30	25.38	5
Canola meal	12	12	12
Soybean meal	11.93	8.27	8.62
Monocalcium phosphate	0.82	0.87	0.77
Calcium carbonate	0.63	0.5	1.57
Salt	0.43	0.43	0.46
Methionine	-	0.04	0.09
Lysine	0.26	0.41	0.38
Choline	0.08	0.08	0.08
Vitamin-mineral premix	1	1	1
Biomin IMBO	-	0.15	0.15
Biotronic Se Forte	-	0.1	0.1
Total ingredients	100	100	100
Assayed			
Dry matter,%	89.52±0.075	89.63±0.22	89.61±0.08
Crude protein, %	19.59±0.37	19.36±1.85	19.13±0.10
Ether extractives, %	3.32±0.71	3.46±0.39	5.16±0.33
Fibre, %	7.16±1.75	7.84±1.03	6.43±0.12
Ash, %	5.70±0.58	5.73±0.57	6.48±0.31
Linolenic acid (g/100 g fatty acids)	2.16±0.20	11.03±0.50	1.65±0.07

**1 kg premix contains: (1500000 IU/g vitamin A; 500000 IU g vitamin D3; 500 IU/kg vitamin E; 200 mg/kg vitamin K; 200 mg/kg vitaminB1; 480 mg/kg vitamin B2; 1485 mg/kg pantothenic acid; 2700 mg/kg nicotinic acid; 300 mg/kg vitamin B6; 4 mg/kg vitamin B7; 100 mg/kg vitamin B9; 1.8 mg/kg vitamin B12; 2500 mg/kg vitamin C; 7190 mg/kg manganese; 6000 mg/kg iron; 600 mg/kg copper; 6000 mg/kg zinc; 50 mg/kg cobalt; 114 mg/kg iodine; 18 mg/kg selenium.*

In the end of the feeding trial, the pigs were taken to an authorised slaughter house. The pigs were electrically stunned; following exsanguination, the carcasses were scalded, dehaired and eviscerated. Live weight at slaughter and hot carcass weight were recorded. Meat samples were collected (leg, tenderloin, chop and neck) to evaluate the feeding value of the pork (basic chemical composition and fatty acids profile). Samples of the studied products (flax seed meal, grape seed meal, pumpkin waste) and of the compound feeds were collected and assayed for the basic chemical composition: dry matter, crude protein, crude fibre and ash, using the chemical methods from Regulation (CE) no. 152/2009 (Methods of sampling and analysis for the official inspection of feeds). The crude protein of the meat was determined using a semiautomatic classical Kjeldahl method using a Kjeltek auto 1030 - Tecator (SR ISO 973, 2007). The meat fat was extracted using an improved version of the classical method by continuous extraction in solvent, followed by fat measurement with Soxhlet after solvent removal (SR ISO 1444, 2008). The meat ash was determined by calcinations at 550°C (SR ISO 936, 2009). The meat fatty acids composition was determined by gas chromatography. After lipid extraction from the samples, the fatty acids were transformed into methyl esters by transmethylation, and the components were separated in the capillary chromatograph column. The fatty acids were identified by comparison with blank chromatograms and were subsequently determined quantitatively as percent for 100 g fat.

The analytical data were compared by variance analysis (ANOVA) using STATVIEW for Windows (SAS, version 6.0). The difference between the means was considered significant at P<0.05. The results were expressed as mean ± standard deviation.

RESULTS AND DISCUSSIONS

Table 2 shows the basic chemical composition of the meals. The highest level of crude protein was found in the flax meal (31.95%) followed by the pumpkin grounds (20.62%) which also had a high level of fat (36.31%). Because of the high fibre level, 34.04%in the grape seeds meals and 12.64% in the pumpkin grounds, these plant by-products must be used in moderate levels in the compound feeds. In pigs the influence of fibre is given both by the properties of the fibre and by its origin (Lindberg, 2014).

Furthermore, the extent of fibre utilization is influenced by the animal age, breed or hybrid. It was shown that in pigs, the microbial degradation of the fibre in the cecum and colon yields fatty acids, which can supply 5-28% of the energy requirement for growing pigs (Krass et al., 1980; Marin et al., 2010). The fatty acids profile of the studied products showed, as expected, the highest concentration of α linolenic acid (PUFA omega 3) in the flax meal (Table 2).

Table 2. Chemical composition of the studied products*

Items	Flax meal	Grape seeds meal	Pumpkin grounds
Dry matter, %	92.47	92.98	94.43
Organic matter, %	87.38	90.13	89.83
Crude protein, %	31.95	13.26	20.62
Ether extractives, %	15.52	8.00	36.31
Crude fibre, %	12.94	34.04	12.64
Nitrogen-free extractives, %	26.98	34.82	20.26
Ash, %	5.09	2.85	4.60
Gross energy, kcal/kg	1515.23	1763. 55	1366.86
Linolenic acid, (g/100 g total fatty acids)	60.80	0.18	0.41

*Chemical composition on dry matter (DM) basis

The basic chemical composition of the compound feeds (Table 1) shows differences in the fat content of the compound feeds for groups C and E2. The higher dietary fat level was given by the use of pumpkin grounds, which is highin fat, 36.31% (Table 2).

However, the compound feeds manufactured according to the new formulations have a feeding value comparable to that of the control compound feed.

The concentration of linolenic acid (C18: 3n-3) determined in the compound feeds samples (Table 1), was highest in the compound feed for groups E1 (11.03%), as expected, because of the high level of this omega 3 polyunsaturated fatty acid in the flax meal (Table 2).

Pig performance values showed significant differences (P≤0.05) between groups concerning the average daily feed intake (Table 3). In group E2, the average daily feed intake (3.394±0.36 kg feed/pig/day), was significantly P<0.05) higher compared to groups C (3.034±0.44 kg feed/pig/day) and E1 (3.332±0.36 kg feed/pig/day). During the experimental period, final weight and average daily gain, were slightly increased (P>0.05), for C group (Table 3), but the difference was not statistically significant.

There was no effect on overall growth performance of pigs. A study of Romans (1995), conducted on fattening pigs, showed that the use of flax meal didn’t affect any production parameter or carcass measurements.

Table 3. Pig performance (average values/group)

Item	C	E1	E2
Initial weight (kg/pig)	65.25±14.49	65.333±3.78	65.00±10.03
Final weight (kg/pig)	105.75±18.03	105.00 ±0.86	104.66±11.13
Average daily weight gain (kg gain/pig)	1.015±0.092	0.993±0.091	0.993±0.035
Average daily feed intake (kg CF/pig/day)	3.034±0.446[bc]	3.332±0.365[a]	3.394±0.361 [a]
Feed conversion ratio (kg CF/kg gain)	2.971±0.592	3.378±0.325	3.428±0.255

*where a, b, c show significant (P≤0.05) differences from C, E1 and E2

Table 4 shows the basic chemical composition of the average weekly samples of faeces collected from each pig during weeks 3 and 6 of balance.

Table 4. Basic chemical composition of the faeces (average values/group)

Items	C	E1	E2
Dry matter,%	28.79±3.22	27.45±2.04	26.67±4.65
Crude protein,%	5.57±0.66	5.56±0.54	4.90±0.78
Ether extractives,%	1.52±0.36	1.70±0.34	1.77±0.58
Fibre, %	5.28±0.68	5.30±0.66	4.99±0.87
Ash, %	5.56±0.52	4.73±0.62	4.93±0.98

*where a, b, c show significant (P≤0.05) differences from C, E1 and E2

On the basis of the daily recording of theingested feeds and excreted faeces, corroborated with the analytical data on the concentration of nutrients in the feeds andfaeces, we calculated the coefficients of apparent absorption of the nutrients (Table 5).

Table 5. Coefficients of apparent absorption of the nutrients (average values/balance)

Specification	Item	C	E1	E2
Dry matter, %	Ingesta, g	2785.07±483.38	3041.16±1.05	2208.61±0,001
	Excreta, g	318.88±52.86	414.33±14.93	334.63±58.39
	Absorption coef. %	88.57±0.03	86.41±0.48	85.01±2.50
Organic matter, %	Ingesta, g	2463.96±427.65	2676.39±0.93	1929.65±0.001
	Excreta, g	242.12±41.87	317.43±6.72	253.80±45.62
	Absorption coef. %	90.19±0.11	88.17±0.24	86.98±2.23
Crude protein, %	Ingesta, g	585.29±101.58	690.47±0.24[c]	426.08±0.01[b]
	Excreta, g	59.09±8.12[b]	84.96±7.78[ac]	61.68±5.39[b]
	Absorption coef. %	89.83±0.33[c]	87.75±1.11	85.71±1.17[a]
Ether extractives, %	Ingesta, g	80.25±13.93[c]	99.19±0.03	114.63±0.01[a]
	Excreta, g	15.53±0.57[bc]	27.45±1.27[ac]	21.35±1.39[ab]
	Absorption coef. %	79.93±2.58[b]	72.48±1.34[ac]	80.99±1.06[b]
Fibre, %	Ingesta, g	269.27±46.73[c]	284.40±0.09[c]	152.92±0.01[ab]
	Excreta, g	56.57±13.03	79.25±0.18	62.59±10.24
	Absorption coef. %	79.09±1.24[c]	72.15±0.06[c]	59.45±6.45[ab]
Nitrogen-free extractives, %	Ingesta, g	1529.13±265.40	1602.32±0.55	1236.02±0
	Excreta, g	110.93±20.15	125.76±2.53	108.17±28.59
	Absorption coef. %	92.82±0.23	92.17±0.16	91.38±2.18
Asf, %	Ingesta, g	174.62±30.30	204.79±0.07	159.69±0
	Excreta, g	59.92±10.97	71.01±3.86	61.98±12.81
	Absorption coef. %	65.93±0.62	65.39±1.80	61.64±7.83

*where a, b, c show significant (P≤0.05) differences from C, E1 and E2

The data on the coefficients of apparent absorption of the nutrients (dry matter, organic matter, crude protein, ether extractives, fibre, nitrogen-free extractives and ash) absorbed in the intestine by the animals from the experimental groups (E1 and E2) were comparable with those from group C (Table 5). The fat absorption coefficient was significantly (P≤0.05) higher in groups E2 (pumpkin grounds) compared to group E1. This difference is justified by the high fat level of the raw materials (Table 2), but also of the compound feeds, which was 5.16% in the compound feed for group E2 (Table 1). The fibre absorption coefficient was significantly ($P \leq 0.05$) lower in group E2 (pumpkin grounds), being 24.83% lower than in group C and 17.60% than in group E1. This decrease of the fibre absorption coefficient is correlated with the fact that both in the chemical composition of the compound feed for group E1 (Table 1), and concerning the pumpkin grounds (Table 2), the fibre was lower compared to groups C and E1.

All pigs were slaughtered in the end of the feeding trial and samples of leg, tenderloin, chop and neck were collected and assayed for the basic chemical composition and fatty acids profile (Table 6).

Table 6. Slaughter measurements

Item	**C**	**E1**	**E2**
Final carcass weight (kg)	79.00±13.72	80.63±2.97	80.80±8.48
Slaughter yield (%)	74.7	76.79	77.2
Fat layer thickness (mm)	17.150±1.344	13.867±2.558	16.867±1.365
Muscle depth (mm)	45.800±3.818	51.433±9.018	51.333±4.110
Average meat percent (%)	54.850±1.626	58.267±2.950	55.967±0.586

Table 7. Basic chemical composition of the pig meat samples (average values/group)

Specification		**C**	**E1**	**E2**
Leg	Dry matter, %	38.15±3.889	30.753±1.873	33.92±6.241
	Crude protein, %	21.145±4.674	17.423±1.336	19.153±2.634
	Ether extractives, %	14.04±0.566	12.093±0.866	13.157±3.167
	Ash, %	1.195±0.247	0.943±0.147	1.243±0.326
Tenderloin	Dry matter, %	38.63±4.554	43.317±3.489	40.867±3.508
	Crude protein, %	21.592±2.488	23.403±3.107	22.188±1.617
	Ether extractives, %	13.76±2.164	15.757±1.079	16.047±1.664
	Ash, %	1.135±0.064	1.247±0.429	1.00±0.044
Chop	Dry matter, %	30.525±0.29	29.457±1.25	31.927±4.598
	Crude protein, %	22.75±0.834	22.047±0.853	23.427±3.853
	Ether extractives, %	6.43±0.693	6.157±0.976	6.863±0.708
	Ash, %	1.195±0.106	1.213±0.038	1.303±0.199
Neck	Dry matter, %	36.66±6.375	37.94±3.934	38.42±4.935
	Crude protein, %	19.19±3.608	18.41±2.474	19.35±1.532
	Ether extractives, %	15.53±4.755	16.82±3.676	17.15±4.212
	Ash, %	0.67±0.266	0.89±0.095	1.00±0.107

Table 6 data show that the slaughter yield was higher in the experimental groups (E1 and E2) compared to the control group, but the differences were not statistically significant. Both for muscle depth and for the average meat yield, the values recorded for the two experimental groups are higher than in group C. The fat layer was higher in group C (17.15 mm) compared to E1 (13.87 mm) and E2 (16.87 mm). Bertol (2013) showed that in a feeding experiment on males and females of the same hybrid, the lowest proportion of fat was recorded in the pigstreated with a diet formulation based on canola oil and flax oil. Kloareg et al. (2007) reported that different fatty acids profiles in the diets might lead to different levels of fat retention between genotypes, because they differ in their fat retention capacity. Bertol (2017) reported that the inclusion of grape pomace in the diet did not affect ($P > 0.10$) the backfat fatty acid profile, apart from the C18: 3 (n-3) content, which was slightly reduced compared to the C group diet without grape pomace.

Table 7 data show that there are no statistically significant differences in the basic chemical composition of the meat samples. However, the fat from E2 meat samples showed the highest concentration of fat/sample in the tenderloin sample, being 16.62% higher than in group C.

This is due to the fat of the dietary pumpkin grounds (Table 2) and to the fat level of the compound feed (Table 1). The increase of 10.43% compared to group C, for the neck samples and just 1.8% in the tenderloin samples and 1.96% for the neck samples, compared to group E1 (5% flax meal and 1% grape seeds meal).

Table 8. Fatty acids profile in the meat samples

Specification		C	E1	E2
		g/100 g total fatty acids		
Leg	SFA	41.01±1.27	41.06±0.45	40.74±0.62
	MUFA	48.16±0.35	46.63±1.57	48.30±0.71
	PUFA, of which:	10.65±0.97	12.19±1.05	10.78±0.31
	Ω3	1.32±0.14	2.12±0.54	1.38±0.11
	Ω6	9.33±0.89	10.07±0.50	9.40±0.19
	Ω6 / Ω3	7.06±0.07	4.75±1.10	6.81±0.42
Tenderloin	SFA	45.31±1.27	42.82±4.43	45.33±0.17
	MUFA	42.67±0.20	45.78±3.74	42.81±0.27
	PUFA, of which:	11.69±1.03	11.17±0.74	11.25±0.08
	Ω3	1.37±0.14	1.42±0.54	1.12±0.10
	Ω6	10.32±0.67	9.75±0.22	10.13±0.24
	Ω6 / Ω3	7.53±0.30	6.87±3.99	9.04±0.60
Chop	SFA	40.99±0.12	40.84±0.53	40.84±0.03
	MUFA	48.63±0.16	48.98±0.22	48.91±0.23
	PUFA, of which:	10.01±0.006	9.98±0.38	10.25±0.19
	Ω3	1.57±0.10	1.66±0.20	1.62±0.02
	Ω6	8.53±0.17	8.32±0.22	8.63±0.18
	Ω6 / Ω3	5.43±0.44	5.01±0.55	5.32±0.07
Neck	SFA	42.49±0.06	42,46±0.24	42.31±0.24
	MUFA	45.83±0.22	45.97±0.11	46.18±0.26
	PUFA, of which:	11.58±0.29	11.57±0.14	11.45±0.08
	Ω3	1.25±0.04	1.39±0.02	1.19±0.21
	Ω6	10.33±0.27	10.18±0.12	10.26±0.13
	Ω6 / Ω3	8.26±0.29	7.32±0.03	8.62±1.51

Where: PUFA = polyunsaturated fatty acids; MUFA = monounsaturated fatty acids; SFA= saturated fatty acids

The meat fatty acids profile (Table 8) show higher omega 3 PUFA values in the leg samples from group E1 (flax meal). This is due to the dietary 5% flax meal, high in omega 3 PUFA. The results of the present study are in agreement with Romans et al. (1995a), Romans et al. (1995b), Enser et al. (2000), Kouba et al. (2003), and Juárez et al. (2010), who found that including flax seed in diets for pigs results in an increased *n*-3 fatty acid content in body fat. Yan L. (2011) reported, regarding the fatty acids composition in *longissimus* muscle, that a significant differences was noticed on for the arachidic fatty acid (C: 20: 0), which was lower ($p<0.05$) in the grape seeds diet compared to group C diet. No differences in the total SFA, MUFA, PUFA and PUFA/SFA ratio in the tenderloin. On the contrary, Romans (1995) reported higher values for the alfa-linolenic acid and eicosapentaenoic acid in the tenderloin and liver samples. Also, Bertol (2013) reported that the sum of MUFA was lower ($P<0.01$) and the sum of n-6 fatty acids was higher ($P<0.01$) in the tenderloin and in the backfat of pigs in a diet formulated with soybean oil, while the sum of PUFA and the n-6/n-3 ratio was lower ($P<0.01$) in the canola− and canola + flax oil-fed pigs. The lowest n-6/n-3 ratio was obtained with the canola + flax oil diet.

CONCLUSIONS

In the end of the feeding trial, no statistically significant differences of the performance were noticed between the groups. In the experimental groups (E1 and E2), thes laughter yield was higher than in group C, but not statistically significant. Muscle depth and the average meat yield from both experimental groups were higher than in group C. Because of the dietary pumpkin grounds, the absorption coefficients for the fat were significantly

($P \leq 0.05$) higher in group E2 compared to E1, while the absorption coefficient for the fibre was significantly ($P>0.05$) lower in group E2, decreasing by 24.83% compared to group C and by 17.60% compared to group E1. The sum of the omega 3 polyunsaturated fatty acids was higher ingroup E1 (5% flax meal and 1% grape seedsmeal) than in groups C and E2. The use of vegetal by-products (flax seed meal and grapeseed meal) improved the feeding quality of the pigs meat. Therefore, the vegetal by products rich in nutrients can be used in pigsfeeding (with limits), which can improve the feeding quality of the pork meat.

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