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INCLUSION OF RESIDUE MEAT FLOUR IN GROWING PIGS DIET (30-50 kg)

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Abstract

A study was carried out to evaluate the inclusion of increasing levels of a residue from the rendering plant after obtaining meat and bone meal for growing pigs on performance, carcass characteristics, incidence of diarrhea and economic viability of the diets. Forty-eight pigs were allotted in a completely randomized design with four treatments (0, 2, 4 and 6% of residue inclusion), six replicates and two animals per experimental unit (barrows and females) with 30 ± 0.662 kg of initial weight in a 24-day trial period. Statistical assumptions of normality and homogeneity were verified using Shapiro-Wilk and Barllet tests, respectively, at 5% probability. The assumptions were met and the data were subjected to analysis of variance at 5% significance. The performance variables, carcass characteristics and diarrhea incidence did not show significant differences (P<0.05) between the levels of inclusion of residue in the diet. The residue can be used up to 6% in the feed without affecting performance, carcass characteristics and diarrhea incidence in growing pigs, however, the inclusion of 4% of the residue presents greater economic viability.

Keywords co-product, production cost, animal origin, economic viability

INCLUSÃO DE RESÍDUO DE FARINHA DE CARNE EM DIETAS PARA SUÍNOS EM CRESCIMENTO (30-50 kg)

Resumo

Foi conduzido um trabalho para avaliar a inclusão de níveis crescentes de um resíduo, proveniente da graxaria, após a obtenção de farinha de carne e ossos de abatedouro de bovinos, para suínos em fase de crescimento sobre o desempenho, características de carcaça, incidência de diarreia e viabilidade econômica das dietas. Foram utilizados 48 suínos, distribuídos em delineamento inteiramente ao acaso com 4 tratamentos (0, 2, 4 e 6% de inclusão do resíduo), seis repetições e dois animais por unidade experimental (machos castrados e fêmeas) com 30 ± 0,662 kg de peso inicial em período experimental de 24 dias. Foram verificadas as pressuposições estatísticas de normalidade por meio do teste de Shapiro-Wilk e homogeneidade pelo teste de Barllet a 5% de probabilidade. As pressuposições foram atendidas e os dados foram submetidos a análise de variância e teste F a 5% de significância. As variáveis de desempenho, características de carcaça e incidência de diarreia não apresentaram diferenças significativas (P<0,05) entre os níveis inclusão do resíduo na ração. O resíduo pode ser utilizado em até 6% na ração sem afetar o desempenho, as características de carcaça e causar diarreia em suínos em fase de crescimento, no entanto, a inclusão de 4% do resíduo apresenta maior viabilidade econômica.

Palavras-chave coproduto, custo de produção, origem animal, viabilidade econômica

INTRODUCTION

The expenses with food represent around 70% of the total cost of swine production, (EMBRAPA, 2018) at that, there is a need to seek for alternative ingredients that can partially substitute corn and soybean meal without compromising the nutritional requirements of the animals in different production phases. One of the possibilities has been the inclusion of processing industry and rendering plant animal origin residues or co-products in swine feed.

One of the residues found in rendering plant is the meat meal, obtained after the processing of bovine carcass residues for the production of bone and meat meal and bovine tallow for commercialization. The co-product is denominated by the press cake manufacturer. The said product has the bromatological composition similar to the bone and meat meal, but with high concentrations of fats, with the potential of being included in growing pigs diets, however it is necessary to evaluate the performance and carcass quality of the fed animals.

The co-products, a priori considered residue waste, are constituted by viscera, feathers, tallow, blood, meat and bones, that after receiving the adequate processing can be transformed into animal meal. These meals can be used in poultry and swine feed as an elevated nutritional ingredient, acting as a source of vitamins, amino acids and macro minerals as calcium and phosphorus (REIS et al., 2013).

According to data from ABRA (2019) (Brazilian Association of Animal Recycling), Brazil produced approximately 7.475 thousand tons of slaughter residue as feedstock derived from processed ruminant animals. In relation to the consumer market of these residues, 56.2% is destined to animal production, 14.9% to biodiesel, 12.8% to the *pet food* market, 11.5% to the hygiene and cleaning sector, and 4.6% to other segments (ABRA, 2019).

The reuse percentage of residues in the livestock sector is approximately 99%, Brazil becoming a country with world-level references in animal recycling aspect (NUNES, 2020).

Non-conventional feed has been an increasing focus of researches, since it does not need to compete with human food, can be discarded and has inferior cost to conventional feed (OLIVEIRA et al., 2021).

In view of the above stated, the objective was evaluate the levels of increasing inclusion of rendering plaint residue (cake) in growing pigs feed, on the performance, carcass characteristics and incidence of diarrhea and economic viability.

MATERIAL AND METHODS

The experiment was approved in advance by the Ethics Committee in the Use of Animals (CEUA), of the Rio Pomba *Campus* of Southeastern Federal Institute of Minas Gerais registered with the protocol number 10/2018.

The food used in the study was obtained in rendering plants, resulting from bovine carcass processing, in the production of bone and meat meal and tallow. In rendering plants, there is the reception of the bovine carcass, cooking in the digesters, pressing for the separation of standardized tallow and meat meal, sterilization, milling and bagging. However, during pressing, remains adhered to the equipment a residue, out of the marketing standard, known by the cake manufacturer, with its final destination being composting or class 2 landfill.

The experiment was conducted at the Pig Farming Section of the Southeastern Federal Institute of Minas Gerais, Rio Pomba Campus, with the duration of 24 days. Forty-eight pigs were used, weighting 30 ± 0,662 kg initially. The trial design was entirely random with four treatments (inclusion of cake levels), six repetitions and two animals by experimental unit, one barrow and one female per stall, of high genetic potential (Duroc × Large White × Landrace). The animals were kept in stalls, supplied with a semi-automatic feeder and pacifier-style drinking fountains, on a masonry shed with compact floor covered with fibre cement roofing.

Four experimental diets were tested, formulated with 0; 2.0; 4.0; and 6.0% of inclusion of the meat meal residue. The bromatological composition can be found at Table 1. The experimental diets were formulated based on corn and soybean meal, being isoenergetic, isoproteic, same relation to digestible lysine: metabolizable energy (Table 2), according to the nutritional requirements for growing pigs, described by Rostagno et al. (2017).

During the trial period, the animals were allowed to freely consume water and feed. The daily intake of feed was determined by the difference between the amount of feed given and the leftovers. The weight gain was determined by the difference between the weight of the animals in the beginning and in the end of the trial period. The feed conversion was determined through the relation of feed consumption and

Table 1 - Production meat meal residue compostion (natural matter).

Analysed Composition	Results
Humidity (%)	3.24
Ethereal Extracts (%)	17.67
Mineral Matter (%)	13.05
Crude Protein (%)	50.60
Calcium (%)	3.94
Phosphorus (%)	1.89
Acidity (mg NaOH/g)	3.09
Peroxide Index (%)	2.09
Rancidity (%)	Negative
Measured Composition	
Digestible Lysine (%)	2.17
Digestible Methionine (%)	0.54
Digestible Methionine+ Cystine (%)	0.92
Digestible Threonine (%)	1.29
Digestible Tryptophan (%)	0.22
Digestible Arginine (%)	3.26
Digestible Glycine+ Serine (%)	7.28
Digestible Valine (%)	1.83
Digestible Isoleucine (%)	1.21
Digestible Leucine (%)	2.43
Digestible Histidine (%)	0.68
Digestive Phenalalanine (%)	1.21
Digestive Phenalalanine+ Tyrosine (%)	2.10
Linoleic Acid (%)	0.39
Swine metabolizable energy (kcal/kg)	2591

[1]Digestible amino acids and metabolizable energy based on the bone and meat meal composition (ROSTAGNO et al., 2017). Humidity analysis, ethereal extract, mineral matter and crude protein conducted according to AOAC (2007). Calcium, phosphorus, acidity, peroxide index and rancidity (COMPÊNDIO, 2013).

Table 2 - Centesimal composition of the experimental diets in natural matter.

	Residue inclusion levels (%)			
Ingredients (%)	0	2	4	6
Corn	65.42	67.53	68.47	69.38
Soybean meal	25.26	22.83	20.60	18.39
Common salt	0.88	0.40	0.36	0.33
Dicalcium Phosphate	1.34	1.21	1.08	0.95
Soy oil	4.29	3.62	3.48	3.34
Meat meal residue	0	2.00	4.00	6.00
Vitamin-mineral premix[1]	0.20	0.20	0.20	0.20
Calcitic limestone	0.93	0.82	0.70	0.58
Methionine	0.17	0.17	0.17	0.17
L-Lysine HCI	0.42	0.44	0.46	0.47
L-Threonine	0.08	0.08	0.08	0.09
Kaolin (inert)	1.00	0.70	0.40	0.10
Total	100	100	100	100
Measured nutritional Composition (%)				
Crude Protein	17.00	17.00	17.00	17.00
Ethereal Extract	6.20	6.20	6.59	6.98
Dry matter	87.99	87.91	87.95	87.98
Mineral matter	6.55	5.56	5.02	4.47
Calcium	0.73	0.73	0.73	0.73
Available Phosphorus	0.34	0.34	0.34	0.34
Metabolizable energy (Kcal/kg)	3.350	3.350	3.350	3.350
Digestible Lysine	1.06	1.06	1.06	1.06
Digestible Methionine	0.40	0.40	0.41	0.41
Digestible Threonine	0.60	0.60	0.60	0.60
Digestible Tryptophan	0.17	0.16	0.16	0.15

[1]Vitamin-mineral premix, composition/kg of product: Vitamin (Vit.) A minimum (min.): 3.500.000 U.I.; Vit. D3 (min.): 500.000 U.I.; Vit. E (min.): 5.000 U.I.; Vit. K-3 (min.): 1.000 mg; Vit. B-1 (thiamine) (min.): 400 mg; Vit. B2 (Riboflavin) (min.): 1.600 mg; Vit. B-6 (pyridoxine) (min.): 500 mg; Vit. B-12 (min.): 11.000 mcg; Calcium pantothenate (min.): 6.000 mg; Niacin (min.): 14.000 mg; Biotin (min.): 10 mg; Folic acid (min.): 350 mg; Butyl-hidroxi-toluene, BHT 2.000 mg; Manganese (min.): 25g; Iron (min.): 48 g; Zinc (min.): 48 g; Copper (min.): 9.000 mg; Iodine (min.): 125 mg; Selenium (min.): 75 mg.

weight gain.

The faeces consistency was determined weekly, in the morning period before stall cleaning, by one single observer, allocating the following scores: 1 -hard firm faeces; 2- well-formed faeces; 3 - loose faeces, non-diarrheal; 4- watery faeces, characteristic diarrheal symptom (FREITAS et al., 2006).

At the end of the trial period, one animal by experimental unit was chosen randomly for slaughter. This procedure is in accordance to the brazilian Ministry of Agriculture legislation (BRASIL, 1995), for carcass characteristics assessment., for carcass characteristics assessment. It was assessed weight, length and carcass yield, subcutaneous fat thickness, loin-eye area and muscle depth, based on the methodology described by Bridi and Silva, (2009).

The maximum and minimum temperatures inside the shed were registered once a day, at 3P. M, by thermo-hygrometers, distributed in different spots around the shed and positioned at swine's height. At the end of the experiment, the daily average data was measured taking into account every environmental variable in case, rates of 21.6 ± 1.7 and 32.0 ± 2.1. According to the Code of Conduct for Pig Management and Practices, the ideal temperature for pigs in growing phase is 21, and the desirable range is between 16-27, (National Farm Animal Care Council, 2014).

Statistical assumptions of normality and homogeneity were verified using Shapiro-Wilk and Bartlett tests, respectively, at 5% probability. The assumptions were met and the data were subjected to analysis of variance at 5% significance. All analysis were done with the assistance of the Statistics Program R, through ExpDes.pt statistic package (FERREIRA, 2013).

For the analysis of feed economic viability equations were used, by calculating gross margin (GM), as Sandi (2020) proposed, Feed cost per kilogram body weight (FC/kg BW), as described by Bellaver et al. (1985) and the Economic Efficiency Index (EEI), suggested by Barbosa et al. (1992).

$$GM = (FW \times PP) - (TFC \times FC) - (IBW \times PP)$$

Where:

GM= gross margin;

FW= trial period final weight;

PP= pork price by kilogram;

TFC= total feed consumed;

FC = feed cost;

IBW= initial body weight.

$$R\$/kg\ WG = (R\$/kg\ ration * RFI) / RG$$

Where:

R$/kg WG= Feed cost per kilogram of live weight gain at treatment i-th;

R$/kg ration = total feed cost per kilogram used at treatment i-th;

RFI = residual feed intake;

RG = residual body weight gain.

$$EEI = (MCe / CTei) * 100$$

Where:

MCe = lowest cost observed in diet by kilogram of body weight gain among treatments;

CTei = average cost of treatment.

RESULTS AND DISCUSSION

There was no difference ($P > 0.05$) in final weight, weight gain, feed intake and feed conversion between swines that received the experimental feeds with increasing levels of inclusion of meat meal residue (Table 3).

The results indicate that the inclusion of meat meal residue up to 6% in the swine feed for growing pigs did not impair weight gain, feed consumption and feed conversion. Rostagno, et al. (2017) point at practical level and maximum usage of meat meal (52% CP) out of 4 and 7%, respectively.

This way, the levels used were not high enough to compromise the performance, even with the studied meat meal EE levels being 17% while Meat meals

Table 3- Growing pigs zootechnical performance fed with increasing levels of inclusion of meat meal.

Variable	Residue inclusion levels (%)				CV%	*P*-value
	0	2	4	6		
Initial Weight (Kg)	32.97	33.48	33.19	33.18	-	-
Final Weight (Kg)	54.11	54.09	54.53	52.81	4.44	0.63
Average daily weight gain (Kg)	0.97	0.94	0.98	0.89	16.21	0.78
Daily feed intake (Kg)	1.85	1.95	1.96	1.94	19.47	0.96
Feed conversion ratio	1.92	2.06	2.00	2.18	11.83	0.33

CV: Coefficient of variation; Value P>0.05: not significant. Non-significant regression analysis.

52% CP described by Rostagno et al. (2017) presents 12.2% of EE.

Zanotto et al. (2019), performed a study including an animal origin co-product for growing-finishing pigs, having the bromatological composition similar to the feed object in this study, and did not find effects over performances between 10% inclusion diets and the control group. However, Zanotto, et al. (2019) worked with a mixture adding 10% of slaughterhouse-generated industrial float to 90% of inedible byproducts, obtaining a bone and meat meal with industrial float, including 10% of this mixture to swine feed.

When working with the inclusion of 0 to 20% of tilapia filleting waste meal to 15 to 30 kg piglets, Richart et al. (2016) observed that up to 10% level did not affect the piglet's final weight and average daily weight gain, however above that level there was a decrease on those variables due to possible amino acids loss, especially lysine during the thermal treatment of the residue.

The same authors observed the worsening of the feed conversion at 20% inclusion rate, possibly caused by long storage time of the meal, which is rich in fats and might have suffered peroxidation, altering palatability and resulting in the rejection by the animals. In relation to consumption and feed conversion, it can be observed that the meat meal residue certainly did not alter the diet palatability, there was no difference in this variable between the animals, regardless of the offered diet.

There were no treatment effects ($P > 0.05$) between faeces consistencies of swines fed with different inclusion levels of meat meal in the feed.

The faecal score is a determining factor when using substitute ingredients in the feed, since diarrhea promotes a larger passage rate, reducing nutrient absorption and the lack of effects on this variable ratifies the results previously obtained for performance.

Table 4- Faecal score of growing pigs fed with increasing inclusion levels of meat meal residue in the feed.

Variable	Residue inclusion levels (%)				CV%	*P*-value
	0	2	4	6		
Score*	2.22	2.45	2.22	2.30	13.67	0.57

*1-hard firm faeces; 2- well-formed faeces; 3 - loose faeces, non-diarrhoeal; 4- watery faeces, characteristic diarrheal symptom. CV: Coefficient of variation; Value P>0.05: not significant. Non-significant regression analysis.

Accordingly, there was no effect ($P > 0.05$) in the inclusion up to 6% of meat meal residue on the assessed carcass characteristics (Table 5). Possibly, resulting from the feed formulation, designed to be isonutritive in relation to the protein and energetic content.

The results found for carcass characteristics were similar to the performance results, which allows up to 6% of meat meal residue inclusion in the feed without impairing growing pigs carcass characteristics. Zanotto et al. (2019) also did not find

Table 5- Growing pigs carcass characteristics fed with increasing inclusion levels of meat meal feed.

Variable	Residue inclusion levels (%)				CV%	*P*-value
	0	2	4	6		
Weight during fasting (Kg)	50.08	48.04	50.87	49.22	6.16	0.44
Eye-loin area (mm)	41.42	42.38	45.16	42.42	22.09	0.91
Backfat thickness (mm)	14.69	14.08	12.93	13.43	18.22	0.65
Muscle depth (mm)	49.90	48.70	57.06	50.83	19.87	0.52
Carcass length (mm)	74.58	72.57	75.52	73.08	4.99	0.50
Hot carcass weight (Kg)	38.83	37.84	38.99	38.14	6.32	0.82
Cold carcass weight (Kg)	37.70	36.46	37.81	36.95	6.44	0.74
Carcass yield (%)	77.56	78.80	76.62	77.48	1.79	0.09
Chilling process losses (%)	2.35	2.90	2.34	2.42	20.48	0.21

CV: Coefficient of variation; Value $P>0.05$: not significant. Non-significant regression analysis.

significant effect to the assessed carcass characteristics.

In the same way was observed in the zootechnic performance, the meat meal residue seemed to have contributed similarly to the soybean meal with nutrients input, as essential amino acids and minerals as phosphorus for lean meat deposition in the carcass, without thickening the animals backfat. Regardless of the high ethereal extract content contained in the cake, it is worth mentioning that the assessed diets were isoenergetic and met the swine requirements, which might have influenced in the similarity of fat deposition between treatments, catering to consumer preference of low backfat thickness meat.

Regarding economic viability, the average feed cost (AFC) was reduced as the residue inclusion level was increasing, while the gross margin (GM), was lower in the treatment where there was no residue inclusion and higher at 4% level. The feed cost per kilogram of live weight gain (R$/kg WG), was lower at 4% level and higher at 6% level of meat meal residue inclusion. At last, the efficiency economic index was higher at 4% level and lower at 6%level of residue inclusion.

As the meat meal residue inclusion increased, the AFC reduced, at 6% level, it was possible to see a lower feed cost, which occurred due to the reduction of meal and soybean oil, in addition to dicalcium phosphate, and the increase inclusion of the residue.

Table 6- Economic viability analysis of increasing inclusion levels of meat meal residue feeds.

Variable	Residue inclusion levels (%)			
	0	2	4	6
AFC (R$/kg)	1.32	1.29	1.28	1.27
GM	60.75	67.19	70.86	61.60
R$/kg WG	2.65	2.62	2.56	2.76
EEI (%)	96.6	97.7	100	92.7

Date of quote: 03/18/2020; Swine price (VcP): 5,89 (R$/kg); Dollar equivalent value: R$ 5,11. AFC: average feed cost (R$/kg); GM: gross margin; R$/kg WG: feed cost per kilogram live weight gain; EEI: economic efficiency index; Total weight gain (kg): 0: 21,14; 2%: 20,61; 4%: 21,33; 6%: 19,63; Total fed intake: 0: 42,49; 2%: 41,91; 4%: 42,75; 6%: 42,48.

The animals fed with a diet containing 4% level of meat meal residue inclusion presented a lower R$/kg WG, when compared to the other treatments. The R$/kg WG tries to quantify the feed cost to obtain one kilogram of live weight.

In relation to EEI, the animals fed with 4% of meat meal residue inclusion in feed, presented higher economic viability when compared to the other treatments, the higher efficiency can be explained by the lower R$/kg WG.

It is possible to say that 4% level of residue inclusion presented higher economic viability, although there were no significant differences in performance and carcass quality.

Similarly to this study, Pizzolante et al. (2014), when using up to 5% of bone and meat meal partially replacing soybean meal in quails at initial phase diets, obtained a saving of 6% in the diet cost. This observation is of great relevance, it shows it is possible to use animal origin co-products in non-ruminant nutrition, providing lower cost production.

According to Silva et al., (2018), the usage of animal origin meal in animal nutrition is beneficial due to the high amino acids, energy, calcium and phosphorus levels in satisfactory amounts, other than satisfying protein content, as well as the studied cake.

In addition, it mitigates possible environmental impacts related to improper disposal in the environment, then the meat meal residue met the hypothesis of the research, which aimed to maintain the zootechnical performance and carcass characteristics, to not cause the animals diarrhea and reduce growing pigs production cost.

CONCLUSION

The inclusion up to 6% of meat meal residue to growing pigs feed does not affect performance, carcass characteristics and faeces consistency, however 4% level of inclusion presents higher economic viability.

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