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Pumpkin seed flour (*Cucurbita pepo l.*) as an alternative source in the feeding of pigs in the initial phase of production

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ABSTRACT. Food production in a sustainable way is based on the association between animals and vegetables to minimize costs, environmental impact, and the use of insums in the breeding process. The objective of this work was to evaluate the effect of the inclusion of pumpkin seed flour (*Cucurbita pepo L.*) in the diet on the performance of early-stage pigs and the reduction of endoparasites in a commercial rearing system. The experimental design was completely randomized, with three treatments and six replicates, and the experimental unit consisted of two animals, totaling 36 animals. The treatments were the basal diet and two levels of inclusion of pumpkin seed: 5 and 10%. The animals were of the Agroceres line, with 42 days of age and an average weight of 12 kg. The animals and rations were weighed at the beginning and at the end of the 35-day experimental period to obtain the performance variables. A bromatological analysis was performed to evaluate the composition of pumpkin seed and for parasitic analysis, feces were collected individually from the animal. There was no significant effect for the Tukey test at the level of 5% probability, of the inclusion of pumpkin seed flour on in the parameters of weight gain and feed conversion. Was observed the reduction of helminth eggs present in feces using egg count and oocysts per gram of feces (OPG), performed at the beginning and end of the experiment. It is indicated the inclusion of 10% of pumpkin flour in the feeding of pigs in the initial phase by reducing contamination by verminosis and does not alter animal performance.

Keywords: pumpkin seed; piglet nutrition; alternative food; natural vermifuges.

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Introduction

The pig production activity has intensified due to technological aspects that involve the management of rearing and feeding. The costs that involve the feeding of pigs correspond to about 76 - 80% of the expenses incurred in the production system, with the need for research and alternatives that minimize the expenses related to the production of diets (Evangelista, Zeferino, & Brennecke, 2021; da Silva et al., 2021).

Alternative foods can be obtained utilizing surplus or local by-products, aiming at the partial or total replacement of some commonly used ingredients (Barros et al., 2020; Horwat, Poltroniere, Nack, & Brum, 2021). Therefore, the use of co-products in diets has been a constant concern in animal nutrition, aiming to reduce the costs of the production of commercial pigs without affecting animal performance, making this activity more competitive in the market (Vilela et al., 2021).

Greater attention to the use of products that are generally not used by the food industry and the population has been aroused aiming at more sustainable production systems and the accessibility of diets (Silva et al., 2019). Only part of the food is used directly for human consumption, and the rest is wasted, but to include its precise levels of inclusion of alternative foods, it is necessary to detail its form of inclusion, nutritional value, consumption rates, and feed conversion (Tonet, Silva, & Pontara, 2015).

It is estimated that about 30% of residues are generated during the processing of products, among these residues, during pumpkin processing stands out the seed that corresponds to 3% of the fruit weight (Lima et al., 2020). Pumpkin seed is a source of protein (320 g kg^{-1}) and lipids (450 g kg^{-1}), its intake can be whole, toasted, or farelated (Carvalho, Nachtigall, Garcia, & Natel, 2021). Thus, it is shown to be a potential substitute for soybean in the animal diet, which can reduce costs, acting as a vermifuge and reducing waste and disposal of waste in the environment (Severino et al., 2019; Soares, 2014; Bissacotti & Londero, 2016).

Despite the growth of pig farming and modern techniques for the treatment of parasites, its presence should not be ignored in production systems. Changes in the rearing system may reduce infection rates, however, agents may prevail at a lower intensity (Nishi et al., 2000). Parasites can act as production limiters, through the deleterious effect, influencing performance, feed conversion, growth rate, and production costs with the increase due to the expense of prophylactic treatments and in more extreme cases can lead the animal to death (Lopes, Oliveira, Melo, Barbosa, & Evangelista, 2017).

Pumpkin seed has a component called cucurbitacin (glycide) that has an anthelmintic action (Zitter, 1998). In clinical studies with humans, it was observed that seeds may be beneficial for people with worm infestation (Queiroz-Neto et al., 1994).

Thus, the objective of this research is to evaluate the chemical composition of pumpkin seed and its use in the feeding of piglets in the initial phase, analyzing the performance and reduction of helminth eggs present in the feces of animals.

Material and methods

The experiment was conducted in the pig farming sector of the Federal Institute of Education, Science, and Technology (IFMG – Campus Bambuí). Thirty-six animals (castrated males and females) of the Agroceres scan were used, with an initial average weight of 12 kg and 42 days of age. The experimental design used was completely randomized, being 3 treatments, with six replicates and 2 animals per experimental unit, totaling 36 animals.

The animals were weighed on the first day and last experimental day, totaling 35 days of evaluation when the animals were around 77 days of age. The raction and the water were made available at will. During this period, the variables related to the performance of the animals were evaluated, such as feed intake, final weight gain, and feed conversion.

Pumpkin seeds were collected and dried at room temperature for two months in the municipality of Carmo da Mata in Minas Gerais. Subsequently, crushed and analyzed in the laboratory of bromatology and animal nutrition of the institution. To evaluate the composition of pumpkin seed, moisture and ash analysis was performed by the gravimetry method, after drying the material at 100ºC and incineration in the muffle at 550ºC, thus obtaining the dry matter (DM) and ash (MM) content. The ether extract (EE), using *the intermittent extractor of Soxhlet* and crude protein (CP) by *the Kjeldahl digestion method,* uses the factor of 6.25 for the conversion of nitrogen into proteins. Neutral detergent fiber (NF) content was determined by Van Soest method (1963) and calcium by oxidimetry (Table 1).

Table 1. Chemical composition of pumpkin seed flour.

Components	FSA
MS (%)	90.29
Ca (%)	0.78
*P (%)	0.32
PB (%)	31.78
* EB (%)	6266.4
EE (%)	33.95
FDN (%)	43.67

The treatments were three experimental diets, being basal diet (Table 2) and two test diets, treatment 1 with the substitution of 5% of the basic diet and treatment 2 replacing 10% of the basic diet that was calculated based on Rostagno et al. (2017).

Samples of the experimental diets were collected according to each treatment, followed by grinding and analysis to detail their composition. The composition of dry matter (DM) was determined by gravimetry after drying the samples in an oven at 100°C. The ether extract (EE) was determined in an intermittent Soxhlet extractor, using ethyl ether as a solvent, and proteins (CP) were determined by the Kjeldahl digestion method and the factor of 6.25 was used for the conversion of nitrogen into proteins. Calcium (Ca), phosphorus (P), and crude energy (EB) of the diets were estimated according to the equations proposed by Rostagno et al. (2017), as shown in Table 3.

Table 2. Percentage composition of experimental diets (T) based on natural matter.

Ingredients	Control %
Pre-initial – Control Diet	
Corn	46.5
Soybean meal	23.5
Sugar	5.0
Degummed oil	2.0
Pre-initial Core*	22.85
Lysine	0.15
Total 1	100
Initial – Control Diet	
Corn	63.8
Soybean meal	27.6
Sugar	2.5
Degummed oil	2
Initial core**	4
Lysine	0.15
Total 2	100

*Warranty levels per 1000 g of product: ACE. Folic 2.70 mg; at c. Pantothenic 24.75 mg; Biotin 495.00 mcg; Ca (Max) 1.80%, Cu 397.50 mg, Co 1,470.00 mg; Eterium Extract (Min.) 3.00%; Fe 202.50 mg; P (Min) 1.00%; Halquinol 300.00 mg; Iode 2.25 mg; Lysine 9,870.00 mg; Mn 135, 00 mg; Mineral Matter (Max) 12.00%; Methionine 6,400.00 mg; Niacin 56.25 mg; If 0.68 mg; Threoin 5,130.00 mg; Tryptophan 720.00 mg; Vit. At 11925ui, Vit. B1 1.80 mg; Vit. B12 54.00 mcg, Vit. B2 9.00 mg, Vit. B6 3.40 mg; 1.910ui Vit.D3; Vit. And 100.00 mg; Vit. K3 3.40 mg; Zn 7,200 mg; **Warranty levels per 1000g of product: vit. To 195.500IU, vit. D3 34.300UI, vit. And 278II, vit. K3 53.5 mg, vit. B1 26.5 mg, vit. B2 106.5 mg, vit. B6 53.5 mg, vit. B12 373.5 mg, niacin 833.5 mg, ace. 13.5 mg, ace. panthenic 698 mg, choline 5,000 mg, biotin 1.3 mg, If 11.2 mg, I 20 mg, Co 17.5 mg, Fe 2710.5 mg, Cu 3600 mg, Mn 1131 mg, Zn 2010.5 mg, b.t.h 386 mg, Ca 202 g, P 70 g, F (Max) 681. 7 mg, Na 48.5 g, tyrosine 1000 mg.

Table 3. Chemical composition of experimental diets (T) based on dry matter.

Pre-initial	T1 Control	T2 5%	T3 10%
Dry matter (%)	89.18	89.33	89.48
Crude protein (%)	20.84	21.22	21.94
Ether extract (%)	3.39	3.33	5.48
FDN (%)	16.83	18.55	20.8
**Calcium (%) *	0.81	O.82	0.79
Phosphorus (%) *	0.47	0.42	0.35
Dirty energy (cal kg^{-1}) *	3250.83	3265.99	3500.82
Initial			
Dry matter (%)	89.24	89.19	88.95
Crude protein (%)	18.82	19.34	20.6
Ether extract (%)	4.32	4.81	6.69
FDN (%)	19.6	20.32	21.41
**Calcium (%) *	0.72	0.73	0.73
Phosphorus (%) *	0.5	0.47	0.49
Dirty energy (cal kg^{-1}) *	3228.31	3300.65	3530.51

*Estimated according to the prediction equations proposed by Rostagno et al. (2017); **Y= (266.2 - 2.125X + 0.0089X^2) /1000; Where Y = nutrient and X = crude protein (CP) content Y= 224.7 - 1.926X + 0.0092X^2) /1000; Where Y = nutrient and X = crude protein (CP) content; ****EB = 51,65 x PB + 91,45x EE + 21,08 x MS - 0,95 x FDN

The evaluation of the effect of pumpkin seed flour on helminth count present in animal feces was performed using the OPG (Eggs per gram of feces) test one day before starting the experiment and on the last day of the experiment. The method consists of the use of a counting camera that allows microscopically examining a known volume (2 x 0.15 mL) of fecal suspension, as proposed by Gordon and Whitlock (1939), so two grams of feces were diluted in 0.28 mL of saturated saline solution, part of the homogenized solution was transferred to McMaster's camera, for 5 minutes for fluctuation, allowing the counting of eggs and the result being multiplied by 50.

The feces were collected individually, by repetition, being packed and identified in plastic pots of the collector type, and taken to the animal biology laboratory of the institution itself, to perform the parasitological analyses on the same day of collection.

The variables final weight (PF, kg), total weight gain (GPT, kg), feed conversion (CA, kg kg^{-1}), and egg count g^{-1} of feces (OPG) were summoned as means and standard deviations and statistical differences were measured using variance analysis (ANOVA) and confirmed by the Tukey test at 5% significance, using the SAS program (2012).

Results and discussion

The chemical composition of pumpkin seed flour can be compared to other seeds that make up animal rations such as toasted whole soybean (SIT), according to Table 4. In the Brazilian Tables of Poultry and Pigs (2017), the SIT contains: 7.5% humidity; 37.3% crude protein; 0.24% calcium; 0.53% phosphorus; 18.88% ether extract; 5098 kcal g^{-1} gross energy; 14.4% of NF. Demonstrating the ability to be used as a potential soybean substitute in diets of growing pigs.

Table 4. Comparison of the mean values of the analyses of pumpkin seed flour (FSA) and toasted whole soybean (SIT) according to Rostagno et al. (2017).

Components	FSA	SIT
MS (%)	90.29	90.27
Ca (%)	0.78	0.23
P (%)	0.32	0.52
PB (%)	31.78	37.0
EC (%)	6266.4	4938.0
EE (%)	33.95	17.86
FDN (%)	43.67	15.07

The mean value evaluated for protein (31.78%) was relatively higher than that evaluated by Silva, Simão, Marques, Leal, and Corrêa (2014) who found a protein value of 28.37%. The value of the ether extract content obtained here (33.95%) was also higher than that analyzed by the same author, who found values of 38.27%. For the content found in this study for calcium (0.78%) and phosphorus (0.32%), it was relatively similar to the value found by Pumar Freitas, Cerqueira, and Santangelo (2008), 0.76 and 0.34%. The value found of crude energy (6266.42 cal g^{-1}) was considerably higher than that found by Pumar et al. (2008) who obtained 3974.1 cal g^{-1}, and by Cerqueira, Freitas, Pumar, and Santangelo, (2008) who found in seed 3899.2 cal g^{-1} of EB.

According to the analyses performed, the food can be considered an excellent energy and protein source, since these are the most costly nutrients in the diet.

Through the analysis of variance and regression applied to FSA levels, a significant effect ($p < 0.05$) was observed only for the variable egg count per gram of feces (Table 5).

Table 5. Effect of the inclusion levels of pumpkin seed flour (FSA) on the variables: Final weight (kg), Total weight gain (GPT, kg), and Egg count g^{-1} of feces (OPG).

Variables	FSA inclusion levels				Effect	R2
	0%	5%	10%	CV		
Final weight (kg)	36.65a	37.55a	35.46a	8.84	NS	-
GPT (kg)	22.65a	24.66a	22.87a	11.53	NS	-
OPG Final**	979.16a	93.75b	179.17b	40.7	Linear	0,6707

** ($p < 0.05$) Averages followed by different letters in the same line differ from each other by the Tukey test at 5% probability and regression effect of FSA levels.

It was observed for egg count per gram of feces linear effect ($p < 0.05$) on FSA levels (0, 5, and 10%). With the lowest OPG count at the 5% level of FSA inclusion in the diet. According to Lima et al. (2020), dosages of 3 g kg^{-1} of FSA are not sufficient for the release of anthelmintic substances, due to the difficulty of fermentation of the ingested food, thus accelerating the excretion process.

Figure 1 shows the lowest OPG count level corresponding to the level of 5% FSA in the diet. The control diet, without the inclusion of FSA, demonstrated the highest level of OPG.

Based on the results presented above, it can be inferred that the level of 5% FSA presented the lowest OPG without compromising the performance of the animals.

Pumpkin seed flour is a food rich in phenolic compounds (103, 10 mg 100 g^{-1} MS). These compounds act as antioxidants with a wide spectrum of medicinal properties, such as antiallergic, anti-inflammatory, antibacterial, antithrombotic, and vasodilators, thus being a justification for the lowest levels of OPG count (Silva et al., 2014).

Pumpkin seed, according to Rupa and Jayanta (2013), has anthelmintic activity due to its presence and a component called cucurbitacin that is associated with active ingredients such as flavonoids, terpenes, and saponins. Substances such as fatty acids, berberine, and palmitin alkaloids are then associated with reducing the presence of helminths (Grzybek et al., 2016).

The use of herbal foods is well discussed in the current literature, Silva et al. (2019) using banana leaf in the diet of Carijó laying hens verified a significant effect ($p < 0.05$) on the percentage of infections of parasites present in excretes. Among the treatments evaluated, banana leaf supplementation reduced the presence of endoparasites of the genus *Strongyloides spp by 26.54%*, indicating the possibility of use.

Although the variables weight gain (GP kg^{-1}) and final weight (PF kg^{-1}) did not result in significant data ($p < 0.05$), T2 (5%) performed better when compared to the other treatments (T1 and T3) according to Figure 2.

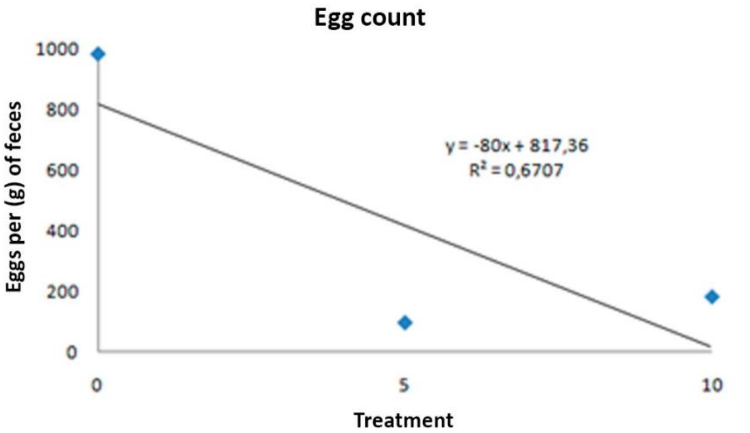

Figure 1. Effect of the inclusion levels of pumpkin seed flour (FSA) on the variable: Egg count g^{-1} of feces.

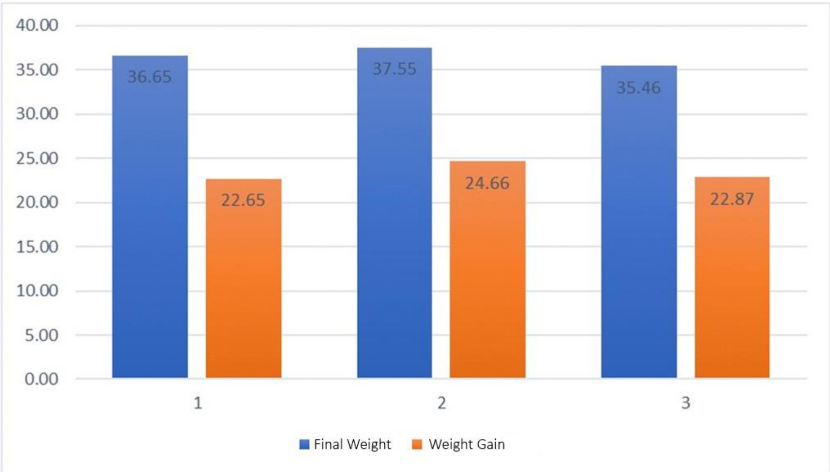

Figure 2. Comparison of treatments T1 (control), T2 (Inclusion of 5% pumpkin flour), and T3 (Inclusion of 10% pumpkin seed flour) as a function of Weight Gain (kg) and Final Weight (kg).

In studies carried out by Pumar and Freitas (2008), it was found that there is a proportional relationship between the amount of insoluble fiber excreted and fecal weight, confirming the laxative effect provided by the insoluble fiber. This may have been significant, evaluating that the higher level of inclusion of pumpkin seed flour provided a lower weight gain.

Carvalho et al. (2021) systematically evaluated studies indexed in the last 10 years (2011 to 2020), involving the bromatological and therapeutic characteristics of flours containing pumpkin residues (*Cucurbita moschata*) for use in food, and found that research indicated that pumpkin waste flour is a good source of lipids, fibers, proteins, minerals, and antioxidant agents, and can be included in human and animal food as a functional and nutritional source.

There is the possibility that pumpkin seed has some antinutritional factors, which directly interfere with the digestibility and absorption of nutrients, and may be toxic to the animal organism depending on the amount in which it is ingested (Benevides, Souza, Souza, & Lopes, 2011). These antinutritional factors when ingested in incorrect concentrations can cause damage to health, thus reducing the availability of essential amino acids and minerals, besides damaging the digestive system, thus causing difficulty in the process of selection and efficiency of biological processes (Benevides et al., 2011).

However, it is observed in the present study that there was no influence on the levels of inclusion of pumpkin seed in the diet of animals and the visual observation of diarrhea or any damage to the health of the piglet, thus indicating the possibility of using this co-product in the production of pigs.

Conclusion

The bromatological analyses of pumpkin seed flour proved to be a protein and energy source of high biological value. Pumpkin seed promoted a reduction in the egg count of the *Ascaris suum* parasite, and the levels of 5 and 10% of the inclusion of pumpkin seed flour did not compromise the performance of the animals.

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