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EFFECTS OF FEEDING RAW AND DIFFERENTLY PROCESSED PIGEON PEA (C*ajanus cajan* (1.) Millsp) SEED MEAL ON GROWTH PERFORMANCE OF WEANER PIGS

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ABSTRACT

A study was conducted to evaluate the effect of raw and differently processed pigeon pea seed meal on the performance of weaner pigs. Five experimental diets were formulated containing 30% raw (RPBD), toasted (TPBD), boiled (BPBD), soaked (SPBD) pigeon pea seed meal and a control without pigeon pea seed meal. Forty weaner pigs with an average weight of 7.40kg of mixed breeds were randomly assigned to the five dietary treatments in a completely randomized design (CRD). Each treatment group was replicated four times with two pigs per replicate. Results showed that there were significant ($P<0.05$) differences in all the parameters evaluated for growth performance. Final weight, total weight gain and average daily weight gain (ADWG) were similar in weaner pigs fed control and BPBD diets and significantly ($P<0.05$) higher than the other treatment diets. Total feed intake and average daily feed intake (ADFI) were significantly ($P<0.05$) higher in pigs fed the control, RPBD and TPBD, while BPBD and TPBD were similar. Feed conversion ratio (FCR) was superior in control diet (2.21), BPBD (2.02) and SBPD (2.20) while poorer FCR was observed in RBPD (3.03) and TPBD (2.63). Feed cost/kg gain was lowest in BPBD (₦190.30 while the highest cost was recorded in TPBD (₦290.20). Cost saving was higher in BPBD (₦20.80) compared to ₦5.20 in SBPD while RPBD and TPBD did not exert any positive cost saving. It can therefore be concluded that 30% boiled pigeon pea meal can be used to substitute maize in weaner pigs diets.

Keywords: Performance, weaner pigs, pigeon pea, processing methods, diets

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INTRODUCTION

There are two conditions that prevail in Nigeria with respect to the supply of animal protein. First, the demand for animal products outweighs supply. Secondly, animal products are too expensive for an average Nigerian due to high cost, scarcity and insufficient supply of plant and animal protein ingredients such as groundnuts, soyabeans and fish meal (Ukpabi *et al*., 2015; Afolabi *et al*., 2015). A significant percentage of animal protein supply had in the past depended on ruminant animals and to a lesser extent on bush game such as antelopes, deer, rabbits and other rodents (Neuman et al., 2013). With a population of over 165 million people and an estimated national population growth rate of 5.7% per annum in Nigeria (USAID, 2013), a lot of pressure has been put on these meat sources and as such, other sources of meat had to be sought; as it has become clear that these aforementioned animals alone could no longer sustain the growing demand for animal protein.

Swine industry in the last five decades has contributed tremendously in bridging the gap between demand and supply of animal protein to the human population (Ani *et al*., 2013). Pigs have fast growth rate, good feed conversion ratio, high dressing percentage of between 60-80% and are highly prolific (Olomu, 2011). Presently in Nigeria, pigs are usually fed diets composed of mainly agro-industrial by-products (palm kernel meal, wheat offal and brewers dried grain) that are characterized by very high crude fibre levels, low energy densities, low and or poor quality protein contents. This feeding practice results in sub-optimal nutrient intake, nutritional deficiencies and poor performance of pigs (Amaefule *et al*., 2016). This development has necessitated the need to search for locally available alternatives that can substitute for the conventional feedstuffs economically by reducing feeding cost, thereby making the pig enterprise a more profitable venture. One of such cheap alternative and available feedstuff is pigeon pea.

Pigeon pea is a hardy plant that has good adaptability to a wide range of soils, additionally, it is more drought and high temperature tolerant than most common plants (Lim, 2012). The crude protein content of the seeds of pigeon pea is within the range of 18 to 25% (Akande *et al*., 2010; Yisa *et al*., 2013). The seed however, contains antinutritional factors that interfere with digestion of certain nutrients in the digestive system (Iheukwumere *et al*., 2008). Therefore, these factors would have to be removed or detoxified by processing before the seeds can safely be consumed and utilized especially by monogastric animals like pigs. The objective of the study therefore was to determine the performance of weaner pigs fed raw and differently processed pigeon pea meal diets.

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MATERIALS AND METHODS

The experiment was carried out at Otukpo Swine Research Station of National Animal Production Research Institute (NAPRI), Ahmadu Bello University Zaria. Otukpo is located in the southern guinea Savanna, on latitude 7-9^{0}N and longitude 8-10^{0}E. The climate is characterized by two well defined seasons. The rainy season normally starts from April to the end of November with an average annual rain fall of 1291.4mm with its peak in August and its lowest value in November. The daily mean maximum and minimum temperature is 28^{0}C and 19.9^{0}C respectively. The dry season falls between November and April and its sub-divided into early dry season (harmattan) November to early February and late dry season from March to late April which is very hot and sunny. (BNARDA, 2010)

Collection and processing of pigeon pea seeds:

White Pigeon pea seeds variety were purchased from Ejule market in Kogi State of Nigeria and processed as follows:

Raw: Raw pigeon pea seed was sorted out to remove unwanted materials and milled and used to formulate the raw pigeon pea based diet (RPBD)

Toasting: Raw pigeon pea seed was subjected to toasting in a locally oven-like construction of 1.20m high, 2.00m long and 0.90m wide with a firmly placed frying pan on top. The seeds were stirred constantly in the frying pan to ensure that toasting of the seeds were uniform. Toasting was done over the fire until there was a change in the color from white to a dark shade of brown with a pleasant aroma emanating. At this point toasting was stopped and the seeds were poured on a cement floor to cool before being crushed (0.3-0.7mm) and then used to formulate toasted pigeon pea based diet (TPBD)

Boiling: A modified method described by Amaefule and Nwagbara (2004) was adopted for boiling the pigeon pea seeds. 75 litres of cold clean water was first brought to boiling point in a 200 litres capacity half cut drum and 40kg raw pigeon pea seeds was then poured into the boiling water and covered. The pigeon pea was allowed to boil for 30minutes. At the end of the specified period of boiling, excess water was drained off and the boiled seeds were sun-dried for 4 days to obtain a constant drying weight. It was then milled and used to formulate boiled pigeon pea based diet (BPBD).

Soaking: Raw pigeon pea seeds were soaked in a large plastic basin containing clean water for 24 hours. The water was decanted and the soaked seeds were sun-dried for 4 days. The seeds were then milled and used to formulate soaked pigeon pea based diet (SPBD).

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Experimental animals and management

A total of forty (40) crossbred weaner pigs, with an average weight of 7.4kg were obtained from Swine Research Station, National Animal Production Research Institute, Ahmadu Bello University, Zaria (NAPRI), out station, Otukpo were used for the experiment. The experiment was conducted in the out station research unit, which has a tropical-type and open-sided pig house roofed with asbestos roofing sheets. The open sides of the building are covered with expanded metal to prevent illegal entry of persons and iron net to reduce the entry of flies and other insects. The pigs were fed the experimental diet twice daily, in the morning (8.00-8.30 am) and afternoon (2.30- 3.00 pm).The wallowing trough contained water at all times while drinking water was provided *ad libitum*. The pigs were treated against ecto- and endo-parasites with Ivomectin injection prior to the start of the study. Before the start of the experiment, one-week adjustment period was observed, using a common diet. The pigs were individually weighed, and randomly distributed in all the treatments. Each of the five treatments had eight weaner pigs which were further divided into four replicates of two pigs each in a completely randomized design.

Experimental diets

Five isonitrogenous and isocaloric weaner diets were formulated to meet the nutrient requirement of weaner pigs according to NRC (1994). Diet 1 which was the control diet contained 0% pigeon pea seed meal while diets 2, 3, 4 and 5 contained 30% each of RPBD, TPBD, BPBD and SPBD respectively. The ingredients composition of the experimental diets are shown in Table 1

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Table 1: Ingredient composition of experimental diets

	Processing methods				
Ingredients	Control T1	RPBD T2	TPBD T3	BPDB T4	SPDB T5
Maize	40.07	23.06	23.06	23.06	23.06
Soyabean cake	46.23	33.24	33.24	33.24	33.24
Pigeon pea seed meal	00.00	30.00	30.00	30.00	30.00
Rice offal	10.00	10.00	10.00	10.00	10.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Common salt	0.25	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10
Total	100	100	100	100	100
Calculated analysis (%)					
Crude protein	23.00	23.01	23.01	23.01	23.01
Crude fiber	9.40	9.38	9.38	9.38	9.38
Ether extract	9.55	3.12	3.12	3.12	3.12
Ash	4.21	4.39	4.39	4.39	4.39
Calcium	0.14	0.14	0.14	0.14	0.14
Phosphorus	0.59	0.54	0.54	0.54	0.54
Lysine	0.41	0.35	0.35	0.35	0.35
Methionine	1.27	1.38	1.38	1.38	1.38
ME (Kcal/kg)	2085.02	3031.93	3031.93	3031.93	3031.93

Key: RPBD = Raw pigeon pea based diet TPBD = Toasted pigeon pea based diet
BPBD = Boiled pigeon pea based diet SPBD = Soaked pigeon pea based diet

*Vitamin/Mineral premix from Bio-organics supplied/kg. Vit A = 4,000,000.00 IU; Vit D3 = 8000.00mg; Vit E = 9,200.00mg; Niacin = 11,000.00mg; Vit B1 = 720.00mg; Vit B6 = 1200.00mg; Vit B12 = 6.00mg; Vit K3 = 800.00mg; Panthotenic acid = 3,000.00mg; Biotin = 24.00; Folic acid = 300.00mg; Choline Chloride = 120,00.00mg; Cobalt = 80.00mg; Copper = 1,200.00mg; Iodine = 400.00mg; Iron = 8,000.00mg; Manganese = 16,000.00; Selenium = 80.00mg and Zinc = 12,000.00mg; anti oxidant 250mg.

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Data collection

The pigs were weighed at the start of the experiment and thereafter on a weekly basis. Feed intake was expressed as quantity of feed offered minus quantity that was not consumed. Weight gain was determined by subtracting the initial weight from the final weight. Feed conversion ratio was calculated as the feed consumed divided by weight gain.

Chemical Analysis

Proximate composition of raw and processed pigeon pea seed meal were determined according to the procedures described by AOAC (2006).

Statistical Analysis:

Data generated were analyzed as described by Steel and Torrie, (1980) and means were separated using Duncan Multiple Range Test (Duncan, (1955).

RESULTS

Proximate composition

The results of proximate composition of the raw and processed pigeon pea seed is presented in Table 3. Dry matter content was highest in toasted seeds (92.30%) while the lowest value was observed in the raw seeds (90.8%). The crude protein value ranges from 25.88% in raw seeds to 20.59% in boiled seeds. Crude fibre and ether extract varied from 12.3% to 12.8% and 5.07% to 5.75% respectively. The lysine content in the diets ranges from 0.13% to 0.14% while the methionine ranges from 0.33% to 0.37%. Total ash, ether extract and nitrogen free extract ranges from 3.05% to 3.45%, 5.07% to 5.75% and 53.02 to 57.61% respectively. Phosphorus and calcium in the diets were in the range of 0.33% to 0.38% and 1.67% to 1.69 % respectively. The energy values were in the range of 3248 to 3273.12kcal/kg.

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Table 2: Proximate composition of differently processed pigeon pea seeds

=Ingredients (%)	Differently processed pigeon pea meal			
	Raw	Toasted	Boiled	Soaked
Dry matter	90.80	92.3	91.95	91.30
Moisture	9.20	7.70	8.05	8.70
Crude Protein	25.45	22.71	22.59	22.43
Crude Fibre	12.3	12.50	12.80	12.60
Total Ash	3.45	3.05	3.25	3.36
Ether Extract	5.35	5.07	5.75	5.26
Nitrogen Free Extract	53.02	56.27	57.61	56.35
Phosphorus	0.38	0.33	0.33	0.34
Calcium	0.14	0.13	0.14	0.14
Lysine	1.69	1.67	1.67	1.68
Methionine	0.37	0.34	0.33	0.35
*Metabolizable energy (Kcal/kg)	3273.12	3248	3272.74	3256.40

*ME=Metabolizable energy was calculated using the formula of Pauzenga, (1985). ME= 37 X CP + 81 X EE + 35.5 X NFE

Amino acid profile

The amino acid profile of raw and differently processed pigeon pea seed are presented in Table 2. The result showed that there were slight differences between the raw and the processed pigeon pea seed in all the parameters examined. However it was observed that methionine (1.18 - 1.24%) was the least among all the amino acids determined. Lysine had a higher value than methionine with a range of 6.20-6.40%.

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Table 3: Amino acid profile of differently processed pigeon pea seeds

Amino acids	Differently processed pigeon pea meal			
	Raw	Boiled	Soaked	Toasted
Methionine	1.23	1.21	1.23	1.180
Cystine	1.29	1.25	1.28	1.10
Methionine +Cystine	2.51	2.47	2.51	2.28
Lysine	6.37	6.19	6.30	6.19
Threonine	3.56	3.47	3.49	3.43
Arginine	6.14	6.05	6.08	5.99
Isoleucine	3.79	3.66	3.78	3.71
Leucine	7.23	6.95	7.15	7.15
Valine	4.42	4.34	4.49	4.43
Histidine	3.59	3.41	3.48	3.59
Phenylalanine	9.81	9.83	9.72	9.71
Glycine	3.74	3.69	3.72	3.56
Serine	4.72	4.55	4.63	4.55
Proline	4.62	4.47	4.61	4.47
Alanine	4.48	4.32	4.40	4.25
Aspartic acid	9.65	9.30	9.51	9.63
Glutamic acid	19.73	19.15	19.34	19.34
Ammonia	1.82	1.69	1.73	1.71

Growth performance

The result of the growth performance of weaner pigs fed differently processed pigeon pea seed meal is presented in Table 4. The pigs fed the boiled pigeon pea based diet (BPBD) compared favourably with the control diet and had significantly ($p<0.05$) higher final weight than all the other processed diets. The lowest value for final weight was observed in pigs fed RPBD (34.20kg) while TPBD (30kg) and SPBD (32.40kg) were similar. Average daily weight gain (ADWG) were similar ($P>0.05$) across all the treatments except in RPBD which had the lowest value of 0.33kg. Significant ($p<0.05$) differences in total feed intake and average daily feed intake between treatments were observed. Pigs fed the control (59.20kg), RPBD (60.40kg) and TPBD (58.60kg) consumed significantly ($P<0.05$) more feeds than those fed BPBD (58.60kg) and SPBD (55.60kg) diets. A similar trend was observed for average daily feed intake. ADFI was significantly lower for pigs on BPBD (1.01kg) and SPBD (0.99kg) when compared to pigs on the control (1.06kg), RPBD (1.09kg) and TPBD (1.05) diets. Feed conversion ratio (FCR)

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however was superior in pigs fed control (2.21), BPBD (2.02) and SPBD (2.20) when compared to RPBD (3.03) and TPBD (2.63) diets.

Table 4: Growth performance of weaner pigs fed differently processed pigeon pea seed meal

Parameter	Levels of differently processed pigeon pea meal					SEM
	Control T1	RPBD T2	TPBD T3	BPBD T4	SPBD T5	
Initial weight (kg)	7.30	7.50	7.40	7.50	7.50	0.85^{ns}
Final weight (kg)	34.20^{a}	26.20^{c}	30.00^{b}	35.40^{a}	32.40^{b}	2.30^{*}
Total weight gain (kg)	26.90^{a}	18.70^{d}	22.90^{c}	27.90^{a}	24.90^{b}	1.83^{*}
Average daily weight gain (kg)	0.48^{a}	0.33^{d}	0.40^{c}	0.50^{a}	0.45^{b}	0.03^{*}
Total feed intake (kg)	59.20^{a}	60.40^{a}	58.60^{a}	56.80^{b}	55.60^{b}	0.89^{*}
Average daily feed intake (kg)	1.06^{a}	1.09^{a}	1.05^{a}	1.01^{b}	0.99^{b}	0.02^{*}
Feed conversion ratio	2.21^{a}	3.03^{c}	2.63^{b}	2.02^{a}	2.20^{a}	0.09^{*}

a,b,c,d: Means on the same row with different superscript are significantly different P<0.05)

Economic analysis

The economic analysis of weaner pigs fed raw and differently processed pigeon pea seed meal is presented in Table 5. Total feed intake was observed to be higher in control (59.20kg), RPBD (60.40kg) and TPBD (58.60kg) when compared to BPBD (56.80kg) and SPBD (55.60kg). Control diet had the highest value of feed cost per kilogram (₦94.85) while RPBD had the least feed cost per kilogram (₦90.80). Cost of total feed intake revealed that the control diet (T1) had the highest value (₦5615.1) while SPBD recorded the lowest value (₦5126.3). Feed cost per kg gain (₦/kg gain) showed that diet RPBD had the highest value (₦290.2) while diet BPBD had the lowest value (₦190.3). The value for the feed cost saving was higher in BPBD (₦20.08). Weaner pigs on RPBD and TPBD diets did not exert any positive value on feed cost saving.

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Table 5: Economic Analysis of weaner pigs fed differently processed pigeon pea seed meal

Parameters	Differently Processed pigeon pea meal				
	Control T1	RPBD T2	TPBD T3	BPBD T4	SPBD T5
Average feed intake (kg)	59.20	60.40	58.60	56.80	55.60
Cost of feed /kg (₦)	94.85	90.80	93.84	93.45	92.20
Cost of total feed intake (₦)	5615.10	5484.40	5499.00	5308.00	5126.30
Total weight gain (kg)	26.90	18.90	22.90	27.900	24.90
Feed cost /kg gain (₦)	211.10	290.20	240.10	190.30	205.90
Feed cost saving (₦)		-ve	-ve	20.80	5.20

DISCUSSION

Proximate composition of pigeon pea seed

The crude protein content of pigeon pea tends to decrease when subjected to different processing methods. This is consistent with the findings of Akpojovwo (2006) who reported reduction in CP levels when pigeon pea seeds were subjected to soaking and toasting while Iorgyer *et al*., (2009) also reported reduction in CP levels when pigeon pea seeds were subjected to boiling. In the raw form, the CP in this study was slightly higher than all the processed pigeon pea. Similar observation was reported by *Nwachukwu et al.,* (1997). Processing of pigeon pea seeds by boiling or soaking reduce crude protein levels probably due to solubilization and leaching of some nitrogenous compounds into the processing water (Udedibie and Carlini, 2000; Onu *et al.,* 2001; Bamgbose *et al.,* 2007,) or denaturing of protein by heat as is obtained by toasting (Yisa et al., 2013). There appears to be variations in the values of crude fibre and metabolizable energy obtained in this study when compared to the reports of other workers (Rahman et al., 2010; Olalake and Bosede, 2010). These variations may be as a result of differences in cultivars, growth conditions, geographical locations and processing methods.

Amino acid profile of pigeon pea seed

Several studies have shown that processing of pigeon pea impacts adverse effect on the amino acid profile (Bambose *et al*., 2007; Akande et al., 2010; Yisa *et al*., 2013; Akande, 2015). In this study however, only methionine+cystine reduced in concentration as the pigeon pea were soaked in water, all other amino acids were not affected. Of all the processing methods employed,

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toasting tends to decrease the concentration of all the amino acids examined. When compared to lysine, methionine concentration was lower in all the processed pigeon pea seed evaluated. The relatively low concentrations of methionine and cystine in legumes has also been reported by Aremu *et al*., (2006)

Growth performance

Processing of pigeon pea seeds resulted in significant ($P<0.05$) improvement in performance when compared to weaner pigs on RPBD for all the parameters measured. Pigs fed BPBD compared favourably with those fed the controlled diet and were the best when compared to other processed treatments. The improved performance of pigs fed diet with BPBD could be that boiling improved the palatability of the diet by reducing the crude fibre and other anti nutritive factors in pigeon pea seeds. Awosanya *et al*., (1999) reported that boiling eliminates some of the possible anti- nutritional substances, probably because of the eluting property of boiled water.

Pigs fed RPBD however performed poor in all the parameters measured except in feed intake. This could probably be attributed to high level of inhibitors in raw pigeon pea seed, resulting in poor utilization of available nutrients. The significantly ($P<0.05$) higher feed intake recorded in weaner pigs fed RPBD and TPBD could also be attributed to nutrient unavailability (Udedibie and Carlini, 2000; Esonu *et al*., 2001) necessitating higher feed intake by the pigs to meet their nutrient requirements from a diet that contained anti metabolites as reported by Tuleun *et al.,* (2009). Onu and Okongwu (2006) also observed higher feed intake in broilers on diet containing raw pigeon pea seed meal. According to Noblet and Van Milgen (2004), pigs are known to eat to meet their energy requirement. Average daily weight gain and feed conversion ratio in this study shows that weaner pigs fed RPBD had significantly ($p<0.05$) lower body weight gain and worst feed conversion ratio than those fed other treatments. Pigs fed BPBD had the highest total body weight gain, daily weight gain and superior feed conversion ratio. Akanji *et al*. (2003), also reported that boiling of legume seeds as a processing method is better than toasting. Similar findings have also been recorded with other livestock species (Udedibie and Mba 1994).

Economic analysis

It has been established by various authors (Owen *et al.,* 2009; Okunade *et al*., 2010) that feed cost represent 65-70% of production. Lowering the cost of producing a unit of the product will create the major impetus and incentive for increased production of swine in Nigeria, especially with the use of cheap method of processing. The cost of feed per kilogram (kg) gain was cheaper for the BPBD processing method than the other diets. This is in agreement with Babiker *et al* (2006) who reported similar result. The result in this study equally indicated that up to 9.9% is saved using BPBD as compared to the control diet while 2.5% was saved using SPBD. Both

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RPBD and TPBD however could not exert any positive saving in feed cost. This finding is however contrary to the reports of Amaefule *et al*., (2016) who observed a negative gross margin in pigs fed control diets as against those that were fed raw pigeon pea that resulted in positive financial gross margin. Using BPBD therefore would cut down the cost of production and increase the profit margin of the producer.

Conclusion

It can be concluded that boiled pigeon pea seed meal supported growth performance, carcass yield and internal organs weight of weaner pigs. Boiling of pigeon pea seed also resulted in increased cost saving when compared to the other processing methods.

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