Evaluation of Pork Quality and Carcass Attributes in Growing Pigs Fed Processed Avocado (*Persea americana*) Seed Meal

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Abstract

With the escalating prices of conventional feed ingredients, there is an urgent requirement to investigate sustainable alternatives that have the potential to improve performance, carcass yield, and meat quality. Twenty-four growing pigs (mixed sexes) were utilized to assess the carcass and sensory attributes of pork derived from pigs fed a diet incorporating processed Avocado (Persea americana) seed meal. The pigs were divided into four groups of six, and further replicated thrice with two pigs each, following a completely randomized design. The feeding trial spanned 70 days, during which the pigs were randomly allocated to one of the four dietary treatments containing 0 %, 2.5 %, 5 %, and 7.5 %, and designated as T_1, T_2, T_3, and T_4 respectively. At the end of the study, eight pigs (two per treatment) were randomly selected for carcass assessment. The results revealed a noteworthy increase in carcass yield with significant differences ($p<0.05$) between pigs in treatment 3, followed by treatments 2 and 4, which did not exhibit significant differences ($p>0.05$), whereas pigs in treatment 1 displayed the lowest carcass yield. Significant differences ($p<0.05$) were observed in primal cuts (except for the chump chop), with treatment 3 yielding the highest values, followed by treatments 2, 1, and 4, respectively. Organ weights showed no significant differences ($p>0.05$), suggesting that the inclusion of Avocado seed meal did not adversely affect the organs. There was a decrease in abdominal fat with increasing levels of Avocado seed meal, while the meat-to-bone ratio increased in treatment 3, followed by treatment 2, with treatment 1 exhibiting the least increase. The sensory evaluation revealed notable differences ($p<0.05$) in all assessed parameters, except for colour. Treatment 3 displayed significantly higher values across all parameters. Overall acceptability scores positioned treatment 3 as the highest, followed by treatment 2, while treatments 4 and 1 received the lowest scores. In conclusion, incorporating processed avocado seed meal at a 5% dietary inclusion level improved both the carcass attributes and sensory quality of pork.

Key words: Pork, Growing pigs, Avocado seed meal, Feeding, Sensory evaluation

1.0 Introduction

In the field of livestock production, it is increasingly important to find efficient and sustainable methods. Pig farming, as a vital part of global meat production, faces the challenge of optimizing feed resources to ensure healthy growth and the production of high-quality meat (EMN, 2019). In the context of growing environmental concerns, and the need for cost effective feed alternatives, this study delves into a promising avenue: the use of processed avocado seed meal in growing pig diets. Pig farming plays a pivotal role in meeting the growing demand for meat products in Nigeria and other developed countries due to their short gestation period and high

prolificacy (Ekpo and Okon, 2023). Pigs, like rabbits, belong to a class of non-ruminant herbivores and are able to utilize household waste which can provide food security, reduce poverty and meet protein demands (Okon *et al*., 2023a; Christopher *et al*., 2023). Pork, the meat from pigs, although not generally accepted in many Islamic countries of the world and states in Nigeria, can be eaten in processed forms such as smoked pork, ham, bacon, and sausages. The meat is highly digestible and comparable to rabbit meat (Sam *et al.* 2020). It is high in protein and rich in many vitamins and minerals. Lean pork can be an excellent addition to a healthy diet (Holness, 2005). The pig industry though loaded with benefits faces a pressing need to reduce its ecological footprint and enhance resource efficiency. Feeding alone in livestock industry, including pigs, accounts for over 75% of the total production for maximum productivity (Ekpo and Okon, 2022). Traditional feed sources have limitations in terms of sustainability, cost and nutritional balance. Smallholder livestock and pig farmers therefore rely on non-conventional feed resources to sustain production (Essien *et al*., 2022; Lekule and Kyvsgaard, 2003). One of such potentially viable alternative feed resource is avocado seed meal. Avocado fruit itself according to NASS (2022), upon ripening can be used in preparing salads in homes, and as a flavour in ice cream and milk shakes. The fruit has potentials of helping diabetic patients to maintain optimal blood sugar levels (Dabas *et al.,* 2013). The seed, which is discarded after human consumption of the flesh, can be considered an important source of energy for animals (Grageola *et al.*, 2010; Van Ryssen *et al.,* 2013). Tugiyanti *et al.* (2019) in a study on Japanese quails reported that avocado seed powder supplements improved meat quality as well as internal organs of the birds. Studies into the proximate composition of the seed meal reveals about 49.03 g, 17.90 g, 15.55 g, 2.26 g, 15.10 g of carbohydrate, lipid, protein, ash and moisture respectively (Adegoke *et al*., 2012). It is also reported to have a high phytochemical profile including tannin, oxalate, saponin, flavonoid, glycoside cyanogenic, alkaloid, phenol, steroids, and phytic acid (Indumathi and Vijayalakshmi, 2015). It is also rich in polyphenols which have antioxidative and antimicrobial properties (Adegoke *et al*., 2012), carotenoids, minerals, phenolics, vitamins, and fatty acids (Tabeshpour *et al.*, 2017). Despite the enormous potential of avocado seed meal, there is paucity of information on its use on the carcass and sensory characteristics of grower pigs. Carcass characteristics is key and pivotal in the determination of quality and marketability of pork products. Sensory evaluation of pork products on the other hand is crucial, as it bridges the gap between production practices and consumer satisfaction. These two meat attributes must not be played down on. This study therefore aims at investigating the impact of incorporating processed avocado seed meal into the diet of grower pigs on their carcass characteristics and the sensory attributes of pork, with emphasis on the potential of a sustainable and nutritious feed alternatives in pig farming.

2.0 Materials and Methods

2.1 Experimental Site

This experiment was carried out at the Piggery Unit of the Teaching and Research Farm of Akwa Ibom State University, Obio Akpa Campus. Obio Akpa is located between latitude $4^{o}30'$N and $5^{o}00'$N and longitude $7^{o}30'$E and $8^{o}00$E with an annual rainfall ranging from 3500 to 5000 mm, average monthly temperature of 25°C, and relative humidity between 60 to 90% (AKSU-MET, 2021).

2.2 Sourcing and Processing of Test Materials

The seeds of avocado (*Persea americana)* were sourced from food and fruit processing outlets in some villages in Oruk Anam Local government area of Akwa Ibom State. The seeds, after extraction from the fruits were cleaned by washing in clean water, and chopped with a kitchen knife into sizeable portions. The chopped seeds were thereafter subjected to heating for 25 minutes in boiling water at 60^{o}C. Air drying was carried out for a day after which the dried seeds were ground to form a meal using a grinding machine.

2.3 Proximate and Phytochemical Analysis of Tested Ingredient

Proximate and phytochemical analysis was carried out on the tested ingredient. Parameters assessed include; Moisture, dry matter, ether extract, crude fibre, ash, crude protein and carbohydrate. Likewise, tannin, oxalate, phytic acid, saponin, flavonoids and alkaloids compositions were assayed in the seed meal. This was carried out in line with the procedure described by AOAC (2005) and Harborne (1973) and Sofowora (1993).

2.4 Experimental Diet and Animals Management

Conventional feed ingredients (wheat offal, maize, palm kernel cake, soybean and bone meal) were used to formulate pig diet while avocado seed meal (ASM) was included to replace maize at 0% (T_1), 2.5% (T_2), 5% (T_3) and 7.5% (T_4) respectively. Each treatment group comprised of six pigs which was further replicated three times with two pigs making a replicate. A total of twenty-four (24) growing pigs of mixed sexes were acquired from the piggery unit of the Department of Animal Science, Akwa Ibom State University, Obio Akpa Campus for the experiment. The pigs were weighed at the start of the trial to obtain initial body weight and thereafter on weekly basis. Feed and water were offered *ad libitum* and the trial lasted for 70 days.

2.5 Carcass Evaluation

At the end of the feeding trial which lasted 10 weeks (70 days), a total of eight pigs (2 per treatment) were randomly selected, starved for 12 hours, and weighed. They were thereafter stunned and slaughtered by severing the jugular vein. This was followed by evisceration and removal of gut. The dressed carcass was weighed and used to calculate the dressing percentage, as the ratio of dressed weight to liveweight multiplied by 100. Each of the organ (heart, liver, kidney and lungs) as well as the abdominal fat were removed and weighed. Organ weights were expressed as percentages of live weight. The dressed carcass was dissected into different primal cuts (breast, thick rib chop, rib chop, loin, chump chop, leg fillet and leg shank end) and weighed using electronic scale (AS3101). The thigh was used to determine meat to bone ratio. The carcass evaluation was carried out as reported by Ekpo and Okon (2023).

2.6 Sensory Evaluation

Fresh meat sample (200 g) for sensory evaluation were taken from the right thigh and cooked before being subjected to sensory evaluation. A 9-point hedonic scale (1 = dislike extremely to 9 = like extremely) was used for the sensory assessment to score the cooked meat samples based on colour, flavour, tenderness, juiciness, and overall acceptability (Eke *et al*., 2013). A 24-member pre-trained taste panel was set up to carry out the sensory evaluation. The panelists were given orientation about the sensory parameters evaluated.

2.7 Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA) in a completely randomized design using SPSS version 20.0 for windows. Where significant difference between treatment means occurred, they were separated using Duncan's Multiple Range Test (Duncan, 1955).

3.0 Results and Discussion

The proximate and phytochemical composition of avocado seed is presented in Table 1. The proximate analysis of the seeds of avocado for dry matter, ether extract, crude fibre, ash, crude protein and total carbohydrates were 82.23, 7.7, 8.87, 2.99, 10.53 and 60.36%, respectively. The seed profile showed a high moisture content of 17.77% which was higher than the values (15.10 %, 13.09 %) reported by Ejiofor *et al*. (2018) and Egbuonu *et al*. (2018) respectively. This suggests that the seed has poor storability potential and is subject to oxidation and spoilage. Values (82.23 %) reported for dry matter in this study was close to those (86.91 %, 94.88 %) reported for avocado pear seed flour and water melon seed by Egbuonu *et al*. (2018) and Egbuonu (2015) respectively. This is indicative of the high nutrient content in the seed of avocado pear. Protein content (10.53) reported in this study was higher than values (2.64 and 2.19 %) reported by Egbuonu *et al*. (2018) and Vinha *et al*. (2013) respectively for avocado pear but close to values (7.75 %) reported by Mahawan *et al*. (2015). Ash content values (2.99 %) compared favourably with the values (2.40 %) reported by Bahru *et al.* (2019). The low ash value obtained in this study indicates a low mineral content in the seed. Crude fibre values (8.87 %) were higher than the values (7.10 %) reported by Bahru *et al.* (2019) indicating that the seeds of avocado could serve as a good source of dietary fibre, providing appetite satisfactory functions by helping in bowel movement through the digestive system. Fibre also lowers cholesterol levels and prevent plague formation in the blood vessels by improving the absorption and re-absorption of cholesterol and bile acids (Edem *et al*., 2019; Erhirhie and Ekene, 2013). Value obtained for ether extract (7.70 %) was higher than the value range (2.02 – 3.10 %) reported by Bahru *et al.* (2019) and Uzama *et al*. (2015). The carbohydrate content of avocado seed (60.36 %) was higher than that (56.70) reported by Ejimofor *et al*. (2023). This observation, could be a pointer that avocado pear seed could serve as a high carbohydrate source, supplying the energy needed as a feedstuff for livestock.

The phytochemical (mg/100g) concentration as shown on Table 1 were in this order: Saponin (7.25 mg/100g) > oxalate (6.21 mg/100g) > tannin (5.65 mg/100g) > phytic acid (3.84 mg/100g) > alkaloid (1.93 mg/100g) > flavonoids (1.20 mg/100g). The values reported for tannin, saponin, flavonoids, and alkaloids in this study (5.65, 7.25, 1.20, 1.93 mg/100g) respectively, is close to values (1.41, 4.44, 1.81, 2.14 mg/100g) reported by Bahru *et al.* (2019). The differences in

proximate and phytochemical composition of the avocado seed in this study compared to previous studies may be influenced by the soil characteristics and climatic condition in the area the plant was cultivated, genetics, and variation in analytical procedures employed (Okon *et al*., 2022).

Table 3.1: Proximate and phytochemical composition of avocado seed

Proximate	Values (%)	Phytochemical	Concentration (mg/100g)
Moisture	17.77	Tannin	5.65
Dry matter	82.23	Oxalate	6.21
Ether extract	7.70	Phytic acid	3.84
Crude fibre	8.87	Saponin	7.25
Ash	2.99	Flavonoids	1.20
Crude protein	10.53	Alkaloids	1.93
Carbohydrate	60.36	-	-

Results obtained indicate the pre-slaughter weight with respect to treatments 1 (0 %), 2 (2.5 %), 3 (5 %) and 4 (7.5 %) were 35.50 kg, 40.00 kg, 42.00 kg and 38.00 kg respectively. There were significant ($p<0.05$) differences as T_3 showed significant weight gain ($p<0.05$) followed by T_2 and T_4 while T_1 was the least. The values for dressed weight were 21.00 kg, 25.00 kg, 28.50 kg and 23.00 kg for T_1, T_2, T_3 and T_4 respectively. T_3 recorded the highest significant ($p<0.05$) dressed weight while T_1 recorded the least. These values could have been influenced by the pre-slaughter weights of the animals in the different treatments. Similarly, values of dressing percentage for the different treatments were T_1 (59.15 %), T_2 (62.50 %), T_3 (67.85 %) and T_4 (60.52 %). Pigs in T_3 group recorded the highest significant ($p<0.05$) value while the lowest value was recorded by the animals in the control (T_1) group. The increase in values for the pigs fed the treatment diets could be attributed to their increased dressed weights earlier observed. The values for breast obtained, indicated 1.30 kg, 1.40 kg, 1.50 kg and 1.30 kg for T_1, T_2, T_3, and T_4 respectively. These values were close to earlier values (2.76, 3.26, 4.25, and 3.86 kg) obtained by Ekpo *et al*. (2020). Animals in T_3 group had the highest significant ($p<0.05$) value for breast cut followed by T_2 while T_1 and T_4 which recorded the least were not significantly different ($p>0.05$). The same trend was observed in belly, thick rib chop and rib chop. Values obtained for loin were 0.80 kg, 1.40 kg,1.45 kg and1.09 kg for T_1, T_2, T_3, and T_4 respectively. Pigs in T_2 and T_3 group recorded the highest value and was followed by T_4 while T_1 had the least value. The same trend was observed for Leg fillet end. However, Leg shank end indicated significant increase ($p<0.05$) in T_3 and was different from T_1, T_2 and T_4. Pigs in T_4 group however, recorded the least leg shank end value. Weight of the organs (kidney, lungs, liver, spleen, heart) showed no significant ($p>0.05$) difference among the treatment groups. Abdominal fat values obtained were: 10.90 g, 4.03 g, 2.50 g and 1.60 g for T_1, T_2, T_3, and T_4 respectively. The least value was recorded in T_4. This implies that fat reduced significantly ($p<0.05$) in pigs fed diets in treatments 2, 3 and 4 compared to the control (T_1). This may be attributed to the presence of antioxidants in the seeds of avocado which served as the test ingredient, as well as the increased fibre content of the feed given to the animals in the fourth treatment (T_4). Stringer *et al.* (2009) in a study highlighted that the fat in the muscle of grain-fed animals is more susceptible to lipid oxidation compared to those from grass-fed animals. This is attributed to the low antioxidants profile in

grains. Generally, antioxidants are known to protect against oxidation of fatty acids. De Evan *et al*. (2020) reported that herbs and other plant products such as avocado pear are known sources of linoleic, linolenic acids and antioxidants. He also revealed in his study that including 30% of avocado seed on a wet basis reduced intramuscular fat content in fattened pigs. Result of meat to bone ratio indicated higher significant ($p<0.05$) value for pigs fed different inclusion levels of the test ingredient compared to the control (T_1). This is a reflection of the dressing percentage and also implies that pigs fed avocado seed meal in T_3 and T_2 were able to convert the feed to muscle. The rich nutrient profile of avocado seed may also be a contributing factor to the variation in the values recorded. This is in agreement with Ekpo and Okon (2023).

Table 3.2: Carcass Characteristics of Pigs fed Experimental Diets

Parameters	T_1(0%ASM)	T_2 (2.5%ASM)	T_3(5%ASM)	T_4(7.5%ASM)	SEM
Pre-slaughter (kg)	35.50	40.00	42.00	38.00	1.67
Dressed weight (kg)	21.00^{d}	25.00^{b}	28.50^{a}	22.00^{c}	1.49
Dressing %	59.15^{c}	62.50^{b}	67.85^{a}	60.52^{b}	1.29
Head % (kg)	3.10	3.50	3.60	2.80	1.10
Shank and trotter (kg)	0.30	0.60	0.50	0.30	0.27
Belly (kg)	1.40^{c}	1.70^{b}	1.80^{a}	1.40^{c}	0.05
Breast (kg)	1.30^{c}	1.40^{b}	1.50^{a}	1.30^{c}	0.05
Thick rib chop (kg)	1.20^{c}	2.00^{b}	3.00^{a}	1.70^{c}	0.30
Rib chop (kg)	1.10^{b}	1.00^{b}	1.30^{a}	0.90^{c}	0.04
Loin (kg)	0.80^{c}	1.40^{a}	1.45^{a}	1.09^{b}	0.16
Chump chop (kg)	0.90	0.80	0.80	0.90	0.18
Leg fillet end (kg)	1.00^{b}	1.20^{a}	1.30^{a}	1.10^{b}	0.11
Leg shank end (kg)	1.20^{b}	1.20^{b}	1.40^{a}	0.90^{c}	0.06
Kidney (% lw)	0.36	0.32	0.37	0.26	0.16
Lungs (% lw)	1.30	0.75	0.95	0.79	0.61
Liver (% lw)	2.25	1.75	1.70	1.57	0.69
Spleen (% lw)	0.34	0.17	0.24	0.16	0.13
Heart (% lw)	0.41	0.42	0.33	0.26	0.24
Abdominal fat (g)	10.90^{a}	4.03^{b}	2.50^{c}	1.60^{d}	0.20
Meat/Bone ratio (kg)	2.00^{d}	3.10^{b}	3.57^{a}	2.67^{c}	0.17

^{a,b,c,d} means on the same row with different superscripts are significantly ($P<0.05$) different
ASM = Avocado seed meal

Table 3 showed the sensory properties of pork fed different dietary inclusion levels of avocado seed. Sensory evaluation is important as it helps in the determination of the level of acceptability of meat products by consumers (Inusa and Muhammad, 2021). The result of this study shown in Table 3 indicated that the processed pork from the different treatments differed significantly ($p<0.05$) in all parameters assessed except colour. Hedrick *et al*. (1994), from a physiologically standpoint opined that meat flavour is a perception and detection of four composite sensations from the nerve endings on the surface of the tongue including bitterness, sourness, saltiness and sweetness. The various inclusion levels of avocado seed in the diets of the pigs were found to

greatly affect the flavour of pork used in this study. T_3 had the highest rating (8.29) for flavour and differed ($p<0.05$) significantly from the T_1, T_2, and T_4 which had ratings of 6.14, 7.86 and 6.43 respectively. The variation in values may be attributed to the rich flavonoid and phenols present in the seed. This is in consonance with the report of Tabeshpour *et al*. (2017) who reported a rich flavonoid, carotenoid and flavonoid in avocado pear seed.

Tenderness of meat is a trait which is intricately linked with juiciness. It causes tender meat to readily unleash its succulent juice when mastication commences. This moisture released during meat mastication explains the extent to which juiciness is achieved (Okon *et al*., 2023b). The result from this study indicates a significant ($p<0.05$) increase in both tenderness and juiciness values with T_3 recording the highest scores. There was no significant ($p>0.05$) difference in the colour across the different treatments. This is an indication that the seed meal from avocado did not adversely affect the colour of the meat. The overall acceptability showed significant ($p<0.05$) differences with the highest score recorded in T_3. This was followed by T_2 which did not differ significantly ($p>0.05$) from T_1 while T_4 scored the lowest and differed significantly from other treatments. This implies that pork in T_3 group with avocado seed meal at 5% inclusion level was more preferred by the panelists. This may be attributed to the interplay of flavour, juiciness and tenderness of the meat product. This agrees with the findings of Okon *et al.* (2023c) who reported a heightened overall acceptability for rabbits fed diets rich in phenolic compounds.

Table 3.3: Sensory Properties of meat from pig fed avocado seed meal

Parameters	T_1(0%ASM)	T_2 (2.5%ASM)	T_3(5%ASM)	T_4(7.5%ASM)	SEM
Flavour	6.14^{b}	7.86^{ab}	8.29^{a}	6.43^{ab}	0.36
Juiciness	6.86^{a}	6.57^{a}	7.57^{a}	4.86^{b}	0.34
Tenderness	6.43^{c}	7.14^{b}	7.86^{a}	7.14^{b}	0.27
Colour	7.14	7.71	7.71	7.00	0.24
Overall acceptability	7.86^{b}	8.00^{b}	8.57^{a}	6.00^{c}	0.28

^{a,b,c,d} means on the same row with different superscripts are significantly ($P<0.05$) different
ASM = Avocado seed meal

4.0 Conclusion and Recommendation

The findings of this study have demonstrated that the inclusion of avocado seed meal up to 5% in pig diets can improve carcass yield as well as sensory qualities of pork without any adverse effect. Since inclusion of avocado seed meal in pig diets improved carcass and sensory qualities, the 5% optimal level is therefore recommended. However, higher inclusion level is recommended for further research.

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