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Growth Performance, Carcass Characteristics and Economic Efficiency of Using Graded Levels of Moringa Leaf Meal in Feeding Weaner Pigs

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Authors' contributions

This work was carried out in collaboration between all authors. Author ADOO, JKKA and FRKB designed the study, wrote the protocol, managed the analyses of the study and wrote the manuscript. Author SYA reviewed the experimental design and performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

A study was conducted to evaluate the feeding value of *Moringa oleifera* leaf meal (MOLM) as part of feed ingredient on the growth performance, carcass characteristics, and economic efficiency of weaner pigs. A total of forty-five (45) weaner pigs of mixed sexes of age 7-8 weeks old were allocated to five dietary treatments and nine replicates in a randomized complete block design. The treatments were: diet 1 designated as 0% MOLM had no moringa in the diet and was the control, diets 2, 3, 4, and 5 designated as 1% MOLM, 2.5% MOLM, 3.5% MOLM and 5% MOLM contained moringa leaf meal at 1%, 2.5%, 3.5% and 5% respectively. Data collected were subjected to analysis of variance with the aid of SAS (2008). The results obtained showed that feed intake and final body weight were not significantly ($p>0.05$) influenced by MOLM. The growth rate of pigs on 5% MOLM (0.54 kg/pig) was better ($p<0.05$) than those on the control and 2.5% MOLM diets and this reflected in the best feed conversion efficiency (0.3) for the pigs on 5% MOLM. Carcass parameters including slaughter weight, organ weight, carcass length, loin eye muscle area, ham and primal cuts of pork were not significantly ($p>0.05$) influenced by MOLM. Back fat thickness

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reduced ($p<0.05$) from 2.2 cm in the control to 1.7 cm as moringa inclusion increased to 5%. There were no differences in crude protein levels of the meat (20.2% to 24.6%), moisture content (69.1% to 71.3%), and the pH of the meat (5.3 to 6.0). The feed cost decreased as the level of MOLM inclusion in the dietary treatments increased from 0% MOLM to 5% MOLM. It was therefore concluded that MOLM could be used as a feed ingredient in the diet of pigs to reduce production cost. MOLM had no detrimental effect on the meat of pigs, and has the potential to reduce fat level in pork to produce leaner carcass.

Keywords: Moringa oleifera; pigs; growth performance; carcass characteristics; leaf meal.

1. INTRODUCTION

Pig production provides the means by which rapid transformation of animal protein consumption can be achieved in Ghana. Although pigs are frequently maligned by some social and religious groups in Ghana, they have several good attributes including high prolificacy, high fecundity, short generation interval, early maturity, high feed conversion efficiency and a modest requirement with respect to housing and equipment [1]. Despite these advantages of pig production, high cost of feed increases the price of pork beyond the reach of the average Ghanaian. The urgent need to improving production efficiency, through lower production costs and supply of a product that meets consumers' expectations are key elements required for a profitable and viable pig production enterprise [2]. Lowering the feed cost demands the use of non-conventional feedstuffs that are readily available with good nutrient composition for use in pigs' diets.

Moringa oleifera Lam. (moringa) which is a promising non-leguminous multipurpose tree with high crude protein and lower tannins content [3,4,5] offers a good alternative source of protein to animals. Moringa is a fast-growing tree with fast regrowth after pruning [6] and has the capacity to produce high quantities of fresh biomass per square meter even at high planting densities. Moringa is a source of highly digestible protein (methionine and cystine), calcium, iron, ascorbic acid, and carotenoids [4,6,7]. In spite of these good attributes of moringa, there is scanty information regarding its use in pig diets.

This study was therefore undertaken to determine the optimum level at which *Moringa oliefera* leaf meal (MOLM) could be incorporated in the diets of weaner pigs to improve their growth performance, carcass characteristics and economic efficiency.

2. MATERIALS AND METHODS

2.1 Experimental Location

The experiment was carried out at the Piggery Section of the Department of Animal Science Education, University of Education, Winneba (UEW), Mampong-Ashanti. The experiment lasted for six months.

2.2 Experimental Pigs and Design

Forty-five (45) large white weaner pigs of age 7-8 weeks old and mixed sexes (30 females and 15 males) obtained from the Piggery Section of the Animal Science Farm, University of Education, Winneba, Mampong-Ashanti were used for the experiment. The animals were balanced by weight and allocated to five dietary treatments and nine replications in randomized complete block design. Each animal constituted a replicate. The five dietary treatments were: Diet 1, which was designated as 0% MOLM, was the control diet and contained soya bean meal and fish meal as the main protein source with no moringa leaf meal. Diet 2 designated as 1% MOLM, Diet 3 as 2.5% MOLM, Diet 4 as 3.5% MOLM and Diet 5 as 5% MOLM contained moringa leaf meal at the rate of 1%, 2.5%, 3.5% and 5%, respectively. The dietary treatments were iso-nitrogenous and iso-carloric. The proportion of the individual feed ingredients in the dietary treatments is presented in Table 1.

2.3 Housing and Feeding

Each animal was housed singly in a pen (194 cm x 160 cm) with concrete floor that had a feeder and a drinker. The experimental diets were offered *ad libitum* in separate concrete feeders in the morning (07.00 h). The diets were offered daily and the leftover feed weighed daily before feeding. Water was also provided *ad libitum.*

Table 1. Composition of experimental diets and calculated analysis

Feed ingredients	% Composition of ingredients per treatment (As Is)				
	0% MOLM	1% MOLM	2.5% MOLM	3.5% MOLM	5% MOLM
Maize (grain)	50	50	50	50	50
Anchovey fish meal	2.0	2.0	2.0	2.0	2.0
Tuna fish meal	5.5	5.0	5.5	4.0	5.0
Soybean meal	7.7	7.5	6.5	7.5	6.0
Wheat bran	34.3	34.5	33.5	33.0	32.0
Premix	0.5	0	0	0	0
Moringa leaf meal	0	1.0	2.5	3.5	5.0
Total	100	100	100	100	100
Calculated analyses					
Crude protein (%)	17.26	17.27	17.31	17.29	17.33
Crude fibre (%)	4.5	4.7	4.8	5.1	5.2
Ether extract (%)	3.88	3.87	3.91	3.91	3.98
DE ($MJKg^{-1}$)	13.1	13.1	13.2	13.0	12.9

MOLM- Moringa oleifera leaf meal, DE- Digestible Energy

**Vitamin premix provided the following per kilogram of diet: Fe 100 mg, Mn 110 mg, Cu 20 mg, Zn 100 mg, Se 0.2 mg, Co 0.6 mg, Senoquin 0.6 mg, retinal 2000 mg, cholecalciferol 25 mg, α- tocopherol 25 mg, menadione 1.33 mg, cobalamin 0.03 mg, thiamin 0.83 mg, riboflavin 2 mg, folic acid 0.33 mg, biotin 0.03 mg, pantothenic acid 3.75 mg, macin 23.3 mg, pyridoxine 1.33 mg*

2.4 Parameters Measured

Parameters measured included growth performance, carcass characteristics and economics of production using moringa based diets.

2.5 Data Analysis

Data obtained were subjected to analysis of variance with [8]. Differences among means were separated using least significant difference (LSD) at 5% significant level.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of Moringa Leaves

The MOLM contained a considerable quantity of crude protein, crude fibre, ash, and ether extract (Table 2). The MOLM used in this study had a crude protein content of 26.70% (Table 2) which was lower than 40.00%, 30.30% and 27.40% reported by [9-11] respectively but was higher than values of 16.00%, 22.42% and 23.27% obtained by [12-14] respectively. The crude fibre value of 14.63% obtained was lower than the 19.25% and 19.10% reported by [11] and [6] respectively. The ether extract value of 5.00% was lower than the 6.50% reported by [10] but similar to the 5.25% reported by [6]. The ash content of 9.00% was also lower than the 12.00% reported by [15] but the dry matter content of 88.75% was higher than the value of 76.53% reported by [11]. These variations in the nutrient contents of moringa in this study and others reported may be due to differences in agro-climatic conditions or to different ages of trees [6], age of cutting or harvesting, edaphic factors, agronomic practices as well as methods of processing and analysis of MOLM [16].

Table 2. Proximate composition (%) of moringa leaf meal

Parameters	Value (%)
Crude protein	26.70
Crude fibre	14.63
Ether extracts	5.00
Ash	9.00
Dry matter	88.75
Moisture	11.25
Nitrogen free extracts	33.42

3.2 Growth Performance of the Pigs

The growth performance of weaner pigs fed on the dietary treatments for the experimental period is shown in Table 3.

Initial body weights of the pigs were similar ($p>0.05$) at the start of the experiment. Daily feed intake was not influenced ($p>0.05$) by inclusion of MOLM in the diets. A major factor influencing feed intake in pig is the energy density of the diet when physiological and environmental factors are held constant [17,18]. The general similarities of feed intake observed in this study among the treatments indicated the iso-carloric nature of the dietary treatments (Table 1) as pigs ate to satisfy their energy requirements [17]. The growth rate of pigs on 5% MOLM was better (p<0.05) than those fed on the control diet and 2.5% MOLM diets but not significantly different from pigs on 1% MOLM and 3.5% MOLM. The final body weight was not influenced by dietary treatments. The feed conversion efficiency (FCE) was better (p<0.05) for pigs fed on 5% MOLM (0.30 kg wt/kg feed) as compared to the control and 2.5% MOLM (0.28kg wt/kg feed) but not different (p>0.05) from 1% MOLM and 3.5% MOLM. The variations in feed conversion efficiency are attributed to differences in the feed utilization by the animals, although diets were iso-nitrogenous. The observations made on growth rate and FCE further suggest that MOLM can be used in pig diets to obtain good growth performance without vitamin premix inclusion in the diet. One of the main constraints for the use of tropical foliages could be the high content of the fibre fractions and bulkiness [19]. These constraints did not adversely affect the growth performance of the pigs at 5% inclusion level and indicated potential higher levels of MOLM inclusion in the feed.

3.3 Carcass Characteristics

The mean carcass weight, organ weight and dressing percentage of pigs are presented in Table 4. Significant differences (P<0.05) were observed in the carcass dressed weights among dietary treatments and is consistent with observation made by [20]. Whereas carcass dress weight of 0% MOLM, 1% MOLM, 2.5% MOLM and 5% MOLM were similar (p>0.05) those pigs fed the diet that contained 3.5% MOLM had higher (p<0.05) dressed weight as compared with 0% MOLM and 2.5% MOLM. However, Dressed percentage was not influenced (P>0.05) by MOLM. Muscle score was significantly (p<0.05) better for 5% MOLM diet probably due to comparative nutrient availability and utilization by the animals. Carcass characters such as loin muscle area, carcass length, ham, and feet were not influenced significantly (P>0.05) by dietary treatments. This indicates that the use of MOLM in pig diets is not likely to adversely affect these carcass traits. Back fat thickness was lower (p<0.05) for pigs fed 5% MOLM (1.7 cm) as compared with the control (2.2 cm) and 1% MOLM (2.1 cm) but not 2.5% MOLM and 3.5% MOLM (2 cm) and has the advantage of producing lean carcass. The trend indicates an inverse relationship between the level of MOLM inclusion and back fat thickness. The reduction in back fat is attributed to the MOLM which possesses a potent hypocholesterolemic agent [21] that probably reduced the fat composition of the body. This further suggests that when pigs are fed on MOLM diet, it is likely to reduce the overall fat content of the resulting meat.

The weight of lungs, heart, spleen, intestines and kidneys was not significantly (p>0.05) influenced by MOLM in the diets (Table 4). The weight of the liver of pigs fed the control diet was higher (p<0.05) as compared with the 2.5% MOLM but not the other treatments. The comparative lower liver weight could be due to the hypocholesterolemic property of MOLM which might have reduced the fat built up in the liver. These results indicate that MOLM is not likely to cause any detrimental effect to the carcass traits or organs.

Table 3. Growth performance of weaner pigs fed moringa leaf meal in kg

Parameters	0% MOLM	1% MOLM	2.5% MOLM	3.5% MOLM	5% MOLM	LSD	SE
Initial body weight (kg/pig)	14.2	14.4	14.3	14.1	14.2	0.34	0.16
Daily feed intake (kg/pig)	1.79	1.77	1.75	1.77	1.77	0.06	0.03
Total feed intake (kg/pig)	164.9	162.8	161.5	162.3	162.8	10.78	5.02
Final body weight (kg/pig)	60.7	60.2	60.2	60.1	60.2	0.62	0.29
Total weight gain (kg/pig)	46.5	45.8	45.9	46.0	46.0	0.69	0.33
Daily growth rate (kg/day)	0.51^{b}	0.52^{ab}	0.50^{b}	0.52^{ab}	0.54^{a}	0.03	0.01
Feed conversion efficiency	0.28^{b}	0.29^{ab}	0.28^{b}	0.29^{ab}	0.30^{a}	0.02	0.01

Means bearing different superscript in the same row are significantly different (p<0.05)
MOLM = Moringa leaf meal; LSD=Least significant difference; SE =Standard error

Table 4. Effect of different levels of moringa leaf meal (MOLM) on the carcass components of pigs

Parameters	0% MOLM	1% MOLM	2.5% MOLM	3.5% MOLM	5% MOLM	LSD	SE
Slaughter weight (kg)	60.7	60.2	60.2	60.1	60.2	0.62	0.29
Dress weight (kg)	51.2^{b}	51.9^{ab}	50.9^{b}	55.1^{a}	54.2^{ab}	3.62	1.10
Dressing percentage (%)	84.3	86.2	84.5	91.6	90.0	0.36	2.0
Last rib fat thickness (cm)	2.0	1.4	2.2	2.0	1.5	1.11	0.34
Muscle score	2.0^{b}	2.0^{b}	2.0^{b}	2.0^{b}	3.0^{a}	0.0	0.0
Loin muscle area (cm^2)	17.0	17.5	18.0	16.6	16.3	1.31	0.40
Carcass length (cm)	61.7	63.0	59.0	63.0	67.0	8.22	2.52
Ham (kg)	7.9	6.9	7.6	7.7	8.2	1.82	0.55
Shoulder (kg)	7.0^{b}	7.3^{b}	7.3^{b}	8.1^{ab}	8.7^{a}	1.22	0.37
Back fat thickness (cm)	2.2^{a}	2.1^{a}	2.0^{ab}	2.0^{ab}	1.7^{b}	0.44	0.13
Feet (kg)	0.7	1.2	1.2	1.0	1.2	0.42	0.13
Full gastro intestinal tract (%LBW)	7.4	6.7	6.7	6.9	6.5	1.61	0.49
Empty gastro intestinal tract (%LBW)	3.6	3.4	3.7	3.7	3.7	1.18	0.36
Liver (%LBW)	1.9^{a}	1.7^{ab}	1.3^{b}	1.8^{ab}	1.7^{ab}	0.59	0.18
Lungs (%LBW)	0.8	0.9	1.2	0.8	0.7	0.55	0.16
Heart (%LBW)	0.4	0.4	0.4	0.4	0.3	0.18	0.05
Spleen (%LBW)	0.2	0.2	0.1	0.2	0.1	0.22	0.07
Kidney (%LBW)	0.3	0.3	0.3	0.4	0.3	0.21	0.06

Means bearing the same superscript in the same row are not significantly different (p>0.05)
LSD= Least significant difference; SE= Standard error
%LBW= Percentages of live body weight

3.4 Meat Characteristics

The protein, ether extract, moisture and pH of pork from the various treatments are indicated in Table 5.

The mean values for protein, ether extract, moisture and hydrogen potential were not influenced (p>0.05) by dietary treatments. The similar chemical composition of the meat observed could possibly be attributed to the fact that the protein content of the diets was iso-nitrogenous. Protein content of a diet is directly related to the moisture level of the carcass, which also affects the ether extract level [22]. This indicates that diets that contained MOLM were as good as the control. The ultimate pH is of particular importance to the meat industry because it directly influences the self-life, colour and eating quality of meat [23,24]. The desirable pH for meat ranges from 5.5 to 5.8 and it is associated with light-coloured and tender meat [25,26]. The pH of meat has a high influence on water holding capacity (WHC), which is closely related to product yield and pork quality. The pH of the meat obtained in this study 5.2, 5.3, 5.3 and 6.2 for 3.5% MOLM, 1% MOLM, 5% MOLM and 2.5% MOLM respectively were not within the recommended range but the control was within the accepted range. Low pH is usually associated with Pale, Soft and Exudative (PSE) pork and is not desirable. On the other hand, high meat pH (above 6.0 to 6.2) often causes dark, firm and dry (DFD) pork. The pH values obtained in this study could be attributed to pre-slaughter stress on the pigs.

3.5 Economic Efficiency of Using MOLM

Cost efficiency of using MOLM in pig diets is presented in Table 6. The per kg feed cost reduced as the MOLM inclusion increased. Total feed cost also decreased as the level of MOLM in the diets increased from 0% MOLM to 5% MOLM (Table 6). The diets containing 1% MOLM, 2.5% MOLM, 3.5% MOLM and 5% MOLM contained more of the less expensive MOLM and relatively less amounts of other protein ingredients (soya bean meal and fish meal) which are more expensive. This is consistent with observation made by [27]. At the time of the experiment, the production cost of MOLM was GH¢0.20 per kg while the prevailing market prices of soya bean meal and fish meal were GH ¢4.00 and GH¢ 2.00 per kg, respectively.

Table 5. Effect of different levels of MOLM on the carcass components of weaner pigs (dry matter)

Parameters	0% MOLM	1% MOLM	2.5% MOLM	3.5% MOLM	5% MOLM	LSD	SE
Protein (%)	20.2	21.9	23.3	24.6	22.8	11.36	4.20
Ether extract (%)	23.1	15.8	18.9	14.3	21.7	11.85	4.12
Moisture (%)	71.3	70.3	70.2	69.0	69.1	5.96	2.10
pH	5.5	5.3	6.2	5.2	5.3	4.29	4.80

Means bearing the same superscript in the same row are not significantly different (P>0.05)
LSD= Least significant difference, pH= Hydrogen potential, SE = Standard error of means

Table 6. Economic efficiency of using MOLM

Parameters	0% MOLM	1% MOLM	2.5% MOLM	3.5% MOLM	5% MOLM
Per kg feed cost (GH¢)	0.938	0.915	0.9015	0.899	0.883
Total feed intake (kg)	164.9	162.8	161.5	162.2	162.0
Total feed cost (GH¢)	154.6	148.9	145.6	145.8	143.0
Weight gain (kg)	46.5	45.7	45.8	46.0	46.0
Feed cost: weight gain (GH¢/kg)	3.32:1	3.26:1	3.18:1	3.17:1	3.10:1

The cost to gain ratio ranged from 3.10:1 to 3.32:1. Pigs fed diets containing 5% MOLM had the best feed cost to gain ratio of 3.10:1 whiles the poorest was the diet that had no moringa (0% MOLM- 3.32:1). Thus, diet containing 5% MOLM was more economical than any of the other dietary treatments and could be attributed to higher weight gain (46.0 kg) with respect to total feed cost (GH¢143.0). This indicates that the inclusion of MOLM in pig diets renders the production more economical.

4. CONCLUSION

The results of this study show that moringa leaf meal (MOLM) has good nutrient composition particularly protein which could be used as a feed ingredient among others for feeding weaner pigs. The growth performance and general carcass parameters were not adversely affected by the inclusion of MOLM in pigs' diet. It is apparent that MOLM has a potential to reduce back fat thickness of pigs. It was more economical to produce pigs especially at 5% inclusion level. Further research is needed to establish the effect of MOLM on sensory analysis and haematological indices of the pigs.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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