International Journal of Innovation Scientific Research and Review
Vol. 03, Issue, 04, pp.1129-1135, April, 2021
Available online at http://www.journalijisr.com

Research Article

ISSN: 2582-6131

EFFECT OF INCLUDING GRADED LEVELS OF MORINGA OLEIFERA LEAF(MOLM) IN FED DIETS ON CARCASS CHARACTERISTICS OF PIGS AND PORK QUALITY

***Affram David Yentumi**

Dambai College of Education, P.O Box 84, Dambai Krachi East Municipality, Oti Region Ghana.

Received 27th February 2021; Accepted 30th March 2021; Published online 28th April 2021

ABSTRACT

This experiment which lasted for 12 months used a total of 20 female pigs to investigate the dietary effect of *Moringa oleifera*leaf (MOLM) on the carcass characteristics of pigs and pork quality. The pigs which were 10-11 weeks of age and an average body weight of 11 kg were used. The pigs were randomly grouped into five treatments with each animal constituting a replicate in a randomized complete design and each treatment had four replicates (animals). The control diet contained no MOLM (0%), while Diets 2, 3, 4 and 5 contained (MOLM) at the rate of 5, 7.5, 10 and 12%, respectively. Data collected were subjected to the analysis of variance procedure of Statistical Analysis Systems (SAS 2010). There were no significant differences (P>0.05) in initial body weight. All the parameters measured for pork quality: moisture, protein, fat, ash, carbohydrate, pH and energy were significantly (P<0.05) different among treatments. Sows fed 0% (8.54) and 7.5 % (8.55) (MOLM) were significantly higher in fat than all the other MOLM treatment 5%, 10% and 12% for 8.38, 8.38 and 8.19 respectively. carcass with fur, dressing weight, dressing percentage, visceral fat weight, heart weight, lung weight, liver weight, spleen weight, kidney weight, visceral with content, visceral without content, stomach with content and back fat thickness measured for carcass characteristics were significantly (P<0.05) different. Back fat thickness for 0% MOLM (3.05) was significantly higher than all the MOLM treatments and reduced significantly as MOLM inclusion levels increased 2.78, 1.55, 1.25 and 1.00for 5, 7.5, 10 and 12% MOLM respectively. However, values for stomach without content did not (P>0.05) differ. It could be concluded that MOLM has no deleterious effect on pork quality and carcass characteristics of pigs. MOLM reduces fat in pock. Carbohydrate and energy levels in pork increases with increasing levels of MOLM. Visceral fat and back fat thickness reduces with increasing levels of MOLM. It is recommended that for pork quality, MOLM inclusion level should be at 5%.

Keywords: Moringa oleiferaleaf meal (MOLM), pig, carcass, dressing, pork quality, inclusion level.

INTRODUCTION

Naturally, the carcass characteristics and meat quality of animals are affected by the state and the type of ingredients used in feeding them (Aberle, Forrest, Gerrard, & Mills,2001). According to (Aberleet al. 2001) pigs fully fed on concentrate diet tend to produce more carcass fat and eventually are less efficient in converting feed to lean meat than pigs fed slightly below ad libitum energy intake. Meat is usually an important component of a well-balanced diet owing to its high-quality source of protein, high iron, essential fatty acids, and B-group vitamins (Biesalski, 2005). It is however, established by recent research that the consumption of fatty meat has a likely related increased risk of serious health challenges such as coronary-heart diseases and colorectal cancer (Ferguson, 2010). Particularly, saturated fatty acids (SFA) of animal have been noted to influence the pathogenesis of cancer associated diseases and heart failure. (Simopoulos & Cleland, 2003). It has also been establish that meat with a very low omega-6/omega-3 ratio is of a high benefit for human health (Flock & Kris-Etherton, 2013). Recent findings have established that moringa has the ability to improve carcass dress weight and also lower back fat thickness in pigs leading to meat quality improvement (Oduro-Owusu, Kagya-Agyemang, Annor & Bonsu, 2015) Moringa oleifera from the Moringaceae family is a fast growing plant widely available in the tropics and sub-tropics with several economic uses for both industrial and medicinal purposes (Richter, Siddhuraju, & Becker,2003). The edible parts of the Moringa tree are exceptionally nutritious (Teketay, 2001). The leaves are a promising source of food in the tropics because the tree is usually full of leaves during the dry season when other foods are typically scarce (Fahey, 2005). Despite the characteristic good nutritional value of Moringa, there is little information regarding its utilization in pig diet. Oduro-Owusuet al.(2015) used MOLM to investigate the growth performance and carcass characteristics of pigs. However, the present study seeks to determine the optimum level of (MOLM) that will have maximized effect on the carcass characteristics of pigs and pork quality.

***Corresponding Author: Affram David Yentumi,**
Dambai College of Education, P.O Box 84, Dambai Krachi East Municipality, Oti Region Ghana.

METHODOLOGY

Experimental design and management of animals

A total of twenty (20) Large White gilts were used for the experiment. The gilts were between 9-11 weeks of age and 10 Kg. The twenty gilts were balanced by body weight and randomly allocated to five (5) treatments with four replicates in a Completely Randomized Design (CRD). Each replicate had one animal. Each animal was housed in a single pen with concrete floor. A pig stall had the following dimension: Length 240cm Width 210cm and Height 120cm. Thus it had an area of 50, 400 cm^2. Feed and water troughs had the following dimensions: Length 45cm, Width 30cm and Height 16 cm giving an area of 1,350 cm^2. Water was offered *ad libitum* in concrete water trough. Feed however, was restricted and offered in concrete feed trough in the morning. Pigs were given 3.30% feed of their body weight as recommended by (Fasuyi, Ibitayo & Alo, 2013).A daily routine of cleaning the pig stalls was keenly observed. Prior to the experiment, the pig stalls were cleaned and later disinfected with quincide, a broad spectrum disinfectant. The pigs were also dewormed using Piperazine (Dorpharma B.V. Ltd., The Netherlands).

Table 1: Composition and analysis of experimental diets

INGREDIENTS	% COMPOSITION OF INGREDIENTS PER TREATMENT (AS IS)				
	0% MOLM	5% MOLM	7.5% MOLM	10% MOLM	12% MOLM
Maize	49	49	49	48	50
Tuna Fish Meal	6	6	6	5.5	5.5
Soybean Meal	8.5	8	7	6.5	6.5
Wheat Bran	35.5	31	29.5	29	25
Premix	0.5	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5	0.5
Molm	0	5	7.5	10	12
Total	100	100	100	100	100
Calculated Levels Of Some Nutrients And Energy					
Crudeprotein	17.17	17.31	17.14	17.03	17.17
Methionine	0.33	0.33	0.33	0.32	0.41
Lysine	0.93	0.91	0.90	0.98	0.83
Crude Fibre	4.61	4.95	5.08	5.3	5.43
De (Mj Kg^{-1})	12.78	12.67	12.57	12.42	12.48

The vitamin premixprovided 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 2000mg, cholecalciferol 25 mg, α- tocopherol 25 mg, menadione 1.33 mg, cobalamin 0.03 mg, thiamin 0.83 mg, riboflavin 2 mg, folicacid 0.33 mg, biotin 0.03 mg, pantothenicacid 3.75 mg, macin 23.3 mg, pyridoxine 1.33mg.

The DE energy was calculated using the DE values for the various ingredients as recommended by (National Research Council, 1998). The DE for the moringa which is the test ingredient was also calculated using the proximate values obtained after the analysis using the formula, DE (MJ/kg DM)= 17.47+0.0079CP+0.0158oil-0.0331ASH-0.0140NDF as recommended by (McDonald, Edwards & Greenhalgh, 1998).

Proximate and pH determination of pork

Samples of pork were taken from the ham of the various sampled animals. Proximate analyses and pH of the pork were carried out at the Kwame Nkrumah University of Science and Technology, Biochemistry Laboratory. The pH analysis were done by chopping samples of pork into smaller pieces after which 5 grams of each sample was weighed using a digital scale into a beaker. Twenty-five milliliters (25ml) of distilled water was then added to each sample and stirred for five (5) minutes. The samples were then left to stand for fifteen minutes after which the pH was measured with a digital pH meter. Proximate analysis of pork was also carried out on percentage protein, percentage fat, percentage moisture, percentage ash, carbohydrate percentage of meat and energy content of meat as recommended by (A.O.A.C, 1990).

Carcass characteristics

Three gilts per treatment were sampled for the carcass analysis. The sampled sows were slaughtered to assess and measure carcass characteristics. Before slaughtering, the pigs were starved overnight but had free access to water. After slaughtering, carcasses were gutted and weighed. Each carcass was halved and measurements taken from the left half as recommended by (Eusebio, 1980). The following were the carcass parameters that were studied: Live weight, dressing percentage, visceral fat, back fat thickness, weight of heart, weight of lungs, weight of liver, weight of spleen, weight of kidneys, visceral with content, visceral without content, stomach with content and stomach without content.

Evaluation Of Carcass

Slaughtering of pigs

Each of the fifteen sampled sows was slaughtered. The slaughtering was done at The Animal Farm of the University of Education, Winneba, Mampong Campus. A sharp knife was used to slit the anterior vena cava, jugular vein and the bicarotid trunk and the animal left to bleed. The animals were then scaled with hot water (80^0c) after bleeding. To determine the slaughter weight the sows were allowed to bleed after which the carcass was weighed. Dressing percentage: The dressed carcass weight was expressed as a percentage of the live weight. Back fat thickness: A straight cut was made at the back of the carcass from the neck region to the tail. A rule was used to measure the thickness of the fat at three points, the first rib, the last rib and the rump area. The average of the three measurements was taken as the back fat thickness (Eusebio, 1980). Visceral with content: The weight of the visceral with the content was weighed. Visceral without content: The visceral was emptied of its content and weighed. Stomach with content: The stomach was weighed with its content. Stomach without content: The stomach was emptied of its content and weighed. Visceral fat: visceral fat was weighed.

Weighing of some internal organs

The weights of heart, lung, liver, spleen and kidneys were measured separately using a digital scale.

RESULTS

Table 2: Effects of different levels of MOLM on pork quality of sows

Parameters	0% M	5% M	7.5% M	10% M	12% M	L S D	S E
Moisture (%)	68.70^{a}	68.37^{cd}	68.53^{b}	68.40^{c}	68.26^{d}	0.12	0.03
Protein (%)	18.83^{a}	18.62^{b}	18.42^{c}	18.45^{c}	18.40^{c}	0.17	0.04
Fat (%)	8.54^{a}	8.38^{b}	8.55^{a}	8.38^{b}	8.19^{c}	0.10	0.02
Ash (%)	0.84^{ab}	0.87^{a}	0.86^{a}	0.83^{b}	0.84^{ab}	0.04	0.01
Carbohydrate (%)	3.02^{d}	3.67^{bc}	3.55^{c}	3.93^{ab}	4.23^{a}	0.33	0.08
pH	7.27^{b}	7.39^{a}	7.30^{ab}	7.33^{ab}	7.32^{ab}	0.10	0.02
Energy (k/Cal)	685.44^{b}	688.58^{a}	689.91^{a}	690.29^{a}	685.22^{b}	2.81	0.74

Means bearing the same superscript in the same row are not significantly different (P>0.05).

LSD = Least significant difference
SE = Standard error of means
M = MOLM

The percentage of moisture in the pork was significantly (P<0.05) higher for pigs fed diets containing 0% MOLM than those fed diets containing the MOLM (5% to 12%). The values for moisture in the pork for pigs fed diets containing 7.5% MOLM were also significantly (P<0.05) higher than those fed diets containing 5%, 10% and 12% MOLM. The moisture values in the pork for pigs fed diets containing 10% MOLM were also significantly (P<0.05) higher than those fed diets containing 12% MOLM(Table 2).However, the values for moisture in the pork for pigs fed diets containing 5% and 10% MOLM did not differ. The trend observed indicates that moisture content in the pork generally decreased as MOLM inclusion levels increased (Table 2). Protein levels in the pork were significantly (P<0.05) higher for pigs fed diets containing 0% MOLM than the rest of the treatment means. Similarly, protein levels in the pork for pigs fed diets containing 5% MOLM were significantly (P<0.05) higher than those fed diets containing 7.5%, 10% and 12% MOLM which were similar (Table 2).It was observed that protein in the pork decreased slightly as MOLM inclusion levels increased. Fat in the pork for pigs fed diets containing 0% and 7.5% MOLM were significantly (P<0.05) higher than those fed diets containing 12% MOLM (Table 2). Ash content in the pork for pigs fed diets containing 5% and 7.5% were significantly (P<0.05) higher than those fed diets containing 10% MOLM but similar to those fed diets containing 0% and 12% MOLM (Table 2).Carbohydrate content in the pork for pigs fed diets containing 12% MOLM were significantly (P<0.05) higher than those fed diets containing 0%, 5% and 7.5% MOLM but similar to those fed diets containing10% MOLM. Further, carbohydrate content in the pork for pigs fed diets containing 0% MOLM were significantly (P<0.05) lower than those fed diets containing 5%, 7.5% and 10 % MOLM. Then those fed diets containing 7.5% MOLM were significantly (P<0.05) lower in carbohydrate content than those fed diets containing 10% MOLM. However, the carbohydrate content for pigs fed diets containing 5% and 7.5% MOLM were similar (Table 2).The pH in the pork for pigs fed diets containing 5% MOLM were significantly (P<0.05) higher than those fed diets containing 0% MOLM but similar to those fed diets containing 7.5%, 10% and 12% MOLM. similarly, pH for pigs fed diets containing 0%, 7.5%, 10% and 12% MOLM were similar (P>0.05) (Table 2). Energy levels in the pork for pigs fed diets containing 5%, 7.5% and 10% MOLM were similar but significantly (P<0.05) higher than those fed diets containing 0% and 12% MOLM which were also similar (Table 2).

Effect of different levels of MOLM on the carcass characteristics of sows

The effects of different levels of MOLM on the carcass characteristics of sows are shown in Table 3. Apart from the Dams Live Weight (D LW), all other figures for all the parameters were expressed as a percentage to the dams live weight.

Table 3:Effect of different levels of MOLM on the carcass characteristics of sows

Parameters	0% M	5% M	7.5% M	10% M	12% M	L S D	S E
D L W(kg)	65.^{ab}	72.5^{a}	59.5^{b}	68.5^{ab}	59.5^{b}	9.37	2.48
D P (%)	74^{a}	74^{a}	60.5^{b}	70.75^{a}	68.5^{a}	6.50	1.72
V F W (%)	0.51^{a}	0.19^{b}	0.20^{b}	0.20^{b}	0.16^{b}	0.14	0.11
H W (%)	0.31^{b}	0.42^{a}	0.30^{b}	0.42^{a}	0.34^{b}	0.07	0.01
L u W (%)	0.92^{a}	0.58^{ab}	0.59^{ab}	0.66^{ab}	0.54^{b}	0.35	0.09
L i W (%)	2.09^{a}	2.20^{a}	1.12^{bc}	0.96^{c}	1.87^{ab}	0.83	0.21
W S (%)	0.11^{bc}	0.18^{a}	0.08^{c}	0.14^{ab}	0.10^{bc}	0.05	0.01
K W (%)	0.49^{a}	0.23^{b}	0.22^{b}	0.28^{ab}	0.24^{b}	0.22	0.05
V + C (%)	13.49^{ab}	12.59^{b}	16.07^{ab}	14.65^{ab}	16.74^{a}	3.81	1.01
V – C (%)	4.18^{b}	3.54^{b}	7.08^{a}	4.88^{ab}	5.06^{ab}	2.46	0.65
S + C (%)	2.56^{d}	2.88^{cd}	5.79^{a}	4.13^{b}	3.87^{bc}	1.17	0.30
S – C (%)	0.93	1.33	0.74	1.77	1.26	1.06	0.27
B F T (mm)	3.05^{a}	2.78^{b}	1.55^{c}	1.25^{d}	1.00^{e}	0.11	0.02

Means bearing the same superscript in the same row are not significantly different (P>0.05)

LSD = Least significant difference
SE = Standard error of means
M = MOLM

D L W = Dams Live Weight. D P = Dressing percentage. V F W = Visceral Fat Weight. H W = Heart Weight. L u W = Lung Weight. L i W = Liver Weight. W S = Weight of Spleen. K W = Kidney Weight. V + C = Visceral with Content. V – C = Visceral without Content. S + C = Stomach with Content. S – C = Stomach without Content. B F T = Back Fat Thickness.

There were significant (P<0.05) differences among all the dietary treatments for carcass characteristics for the pigs except for stomach without content. Dams live weight for pigs fed diets containing 5% MOLM were significantly (P<0.05) higher than pigs fed diets containing 7.5% and 12% MOLM but similar to those fed diets containing 0% and 10% MOLM **(**Table 3). Visceral fat weight was significantly (P<0.05) higher for pigs fed diets containing 0% MOLM than all the pigs fed diets containing MOLM (5% to12%) which were similar. Heart weight for pigs fed diets containing 5% and 10% MOLM were similar but significantly (P<0.05) higher than those fed diets containing 0%, 7.5% and 12% MOLM which were also similar **(**Table 3). Lung weight for pigs fed diets containing 0% MOLM were significantly (P<0.05) higher than those fed diets containing 12% MOLM but similar to those fed diets containing 5%, 7.5% and 10% MOLM. Similarly, pigs fed diets containing 12% MOLM were similar to those fed diets containing 5%, 7.5% and 10% MOLM in lung weight **(**Table 3). Liver weights were significantly (P<0.05) higher for pigs fed diets containing 0% and 5% MOLM than those fed diets containing 7.5% and 10% MOLM but similar to those fed diets containing 12% MOLM. Again pigs fed diets containing 10% MOLM were significantly (P<0.05) lower in Liver weight than those fed diets containing 12% MOLM but similar to those fed diets containing 7.5% MOLM (Table 3). Weight of spleen for pigs fed diets containing 5% MOLM were similar to those fed diets containing 10% MOLM but significantly (P<0.05) higher than those fed diets containing 0%, 7.5% and 12% MOLM. Also, pigs fed diets containing 0%, 7.5% and 12% MOLM were similar in weight of spleen **(**Table 3). Kidney weight for pigs fed diets containing 0% MOLM were significantly (P<0.05) higher than those fed diets containing 5%, 7.5% and 12% MOLM but similar to those fed diets containing 10% MOLM (Table 3). Visceral with content weight for pigs fed diets containing 12% MOLM were significantly (P<0.05) higher than those fed diets containing 5% MOLM but similar to those fed diets containing 0%, 7.5% and 10% MOLM. The pigs fed diets containing 5% MOLM were also similar to those fed diets containing 0%, 7.5% and 10% MOLM in visceral with content weight (Table 3). Visceral without content weights were significantly (P<0.05) higher for pigs fed diets containing 7.5% MOLM than those fed diets containing 0% and 5% MOLM but similar to those fed diets containing 10% and 12% MOLM. Pigs fed diets containing 0% and 5% MOLM were also similar to those fed diets containing 10% and 12% MOLM (Table 3).Stomach with content weight for pigs fed diets containing 7.5% MOLM were significantly (P<0.05) higher than all the other treatment means. However, pigs fed diets containing 0% and 5% MOLM were similar. Those fed diets containing 10% and 12% MOLM were also similar. Then those fed diets containing 5% and 12% MOLM were also similar (Table 3).There was no significant (P>0.05) difference among the treatment means for stomach without content. The treatment means for back fat thickness for pigs fed diets containing 0% MOLM were significantly (P<0.05) higher than all the pigs fed diets containing MOLM (5% to 12%). Back fat thickness for pigs fed diets containing 5% MOLM were (P<0.05) higher than those fed diets containing 7.5%. Back fat thickness for pigs fed diets containing 7.5% MOLM were significantly (P<0.05) higher than those fed diets containing 10% MOLM. Those fed diets containing 10% MOLM were also significantly (P<0.05) higher than those fed diets containing 12% MOLM (Table 3). The pattern observed was that back fat thickness reduced significantly as MOLM inclusion levels increased.

DISCUSSION

Protein, fat, moisture, ash, carbohydrate, energy and pH of pork

The differences in moisture and protein levels in the pork could be attributed to the high fibre in the MOLM diets which probably affected protein availability to the sows. Díaz, González, & Ly, (1997) and Díaz, (1998) reported that high fibre results in poor availability of nutrients to monogastric since it affects digestibility. The range of protein content which was 18.40% to 18.83% for pork in this study was lower than 16.98% to 19.41% for pork reported by (FAO,1969). It was also below the range of 20.2% to 24.6% reported by (Oduro-Owusu *et al*. 2015). The protein levels in the pork in this study was lower than what was observed by (Oduro-Owusu *et al*. 2015) possibly because of the low levels of MOLM in that study which was from 1 to 5% MOLM compared to the MOLM levels in this experiment which was from 5 to 12% MOLM. It is therefore possible that the fibre in the diets in this study comparatively resulted in the low availability of protein to the sows which are directly correlated to the protein in the meat. The range of moisture content of pork obtained in this present study was from 68.26% to 68.70%. The result obtained for moisture content was higher relative to moisture level of pork 42% reported by (Singh & Ghosh, 2004) but below 75% observed by (Offer &Trinick, 1993). However, it was lower than the range of 69.0% to 71.3% moisture content of pork reported by (Oduro-Owusu *et al*. 2015).The differences observed in the fat content of the pork could be as a result of the anti-fat activity in moringa leaf which has the ability to reduce fat in pork to produce quality meat. According to (Ghasi, Nwobodo, & Ofili,2000) moringa juice extracted at relatively low doses of 1mg/g reduced cholesterol in the serum of Wister rats. The differences in the carbohydrate content of the pork could be attributed to the high fibre which pigs could convert at the hind gut into fatty acid (Bach & Jorgensen, 2001). In this present study, the pH of the meat ranged from 7.30% to 7.39% which were lower than the range of 5.5 to 6.3 reported by (Gardner, Kenny, Milton& Pethick,1999) and Educational Technology (EUTECT, 1997) as the preferred pH of meat. This could be as a result of the time frame within which the meat was analysed, thus in less than 24 hours as recommended by (Dransfield, 1994). After every slaughter, the pork was taken to the laboratory the same day for analysis to be done which was less than the recommended 24 hours. According to (Warriss, Brown, Francombe & Higgins, 1989) the pH in meat is dependent on the amount of glycogen available in the muscle at slaughter and this is normally attained when glycolysis ceases. The pH range of pork in this study was lower than 5.9 to 6.1 reported by (Mukumbo, Maphosa, Hugo, Nkukwana, Mabusela& Muchenje, 2014) when MOLM was fed to pig to evaluate meat quality, shelf life and fatty acid composition of pork. It was also lower than 5.2 to 6.2 of the pH range reported by (Oduro-Owusu *et al.* 2015) when MOLM was fed to pigs to evaluate their growth performance, blood chemistry and carcass characteristics. The pH in this study was lower than what was observed by (Oduro-Owusu *et al.* 2015) possibly because the analysis of the pH in this study was done in less than 24 hours as explained above. The difference in the energy of pork which was high for most of the MOLM treatments in this study could be attributed to the high carbohydrates and vitamins that are associated with MOLM. Fuglie, (2001) reported that *Moringa oleifera* is a good source of proteins, carbohydrates, vitamins and minerals with its essential amino acids considered quality. High carbohydrates feeds are associated with high energy. On a contrary note, 12% MOLM was lower in energy content than the other MOLM treatments possibly because at that inclusion level the fibre content was too high for the pigs (monogastric) to adequately utilize the feed. According to (Souffrant, 2001) dietary fibre dilutes dietary energy.

Effect of MOLM on the carcass characteristics of sows

The differences in dams live weight (DLW) could be attributed to the different weight at which the gilts attained puberty. This finding agrees with the findings reported by (Miller, McDonald & Asiedu, 2005) where in a related research, mulberry leaf meal was used to investigate the carcass characteristics of boars. The results showed that final body weight, hot carcass weight, fasted body weight and empty body weight were different. Oduro-Owusu *et al.*(2015) however, did not observe any difference in the final live weight of the pigs when MOLM was fed to pigs. The dressing percentage (DP) showed a difference, however, the difference did not follow any trend to give a base for assigning the differences to the MOLM or the control diet (0% MOLM)This finding is in agreement with what was reported by (Miller *et al.* 2005) when mulberry leaf meal was used to evaluate the carcass characteristics of boars. It was observed that the dressing percentage based on fasted body weight were significantly different. However, (Oduro-Owusu *et al.*2015) did not observe any difference in the dressing percentage of the pigs fed varying levels of MOLM diets. The differences in visceral fat weight and back fat thickness among the dietary treatments could be assigned to the anti-fat effect of MOLM which has the potential to reduce fat in pork to enhance its quality. (Ghasi *et al*. 2000) reported that juice extracts from moringa leaves was found to possess hypocholesterolemic agents. In a research conducted using Wister rats it was found that when moringa juice extracts was given at relatively low dose of 1mg/g, co-administered with a high fat diet daily for 30 days, cholesterol was found to reduce in the serum of the rats (Ghasi *et al*. 2000). This research was in agreement with the findings of (Oduro-Owusu *et al.*2015) whose finding revealed how back fat thickness in pork reduce with increasing levels of MOLM. (Gyebi, 2014) observed a similar trend such that visceral fat in rabbits fed varying levels of MOLM reduced with corresponding increase in MOLM levels. The differences in kidney and liver weights among dietary treatments which showed that sows on the control diets had comparatively higher kidney and liver weights was an indication that there were no toxic substances in the MOLM diets. Abdel-Wareth, Hammad & Ahmed, (2014) reported that the liver is responsible for deamination in the body and the kidney is also responsible for detoxification in the body and in an attempt to deaminate or detoxify the kidney and the liver increase in weight respectively. Ahamefule, Eduok, Usman, Amaefule, Obua & Oguike, (2006) reported that the weights of some internal organs like liver and kidney of animals could be used in animal feeding experiments as evidence of toxicity. In that report higher kidney and liver weights were observed. This was attributed to the under-processed soya which possibly retained some anti-nutritional factors. The anti-nutritional factor could have accounted for the higher weights of the kidney and the liver in an attempt to detoxify the anti-nutritional factors in the feed containing the soya bean meal. Abdel-Wareth *et al.* (2014) in a related experiment used *Khaya senegalensis* leaves to evaluate the performance, carcass traits, hematological and biochemical parameters in rabbits. Differences in weight were observed among the dietary treatment for liver and kidney. It was observed that at 35% of the leaf meal there was no deleterious effect on the animals. However, at 65% of the leaf meal there was deleterious effect on the liver. Oduro-Owusu *et al.*(2015) in an experiment observed no difference in the weights of liver and kidneys expressed as a percentage of the body weight of pigs when they were fed diets containing graded levels of MOLM. Olayeni, Farinu, Togun, Adedeji & Aderinola, (2006) also observed how the varying inclusion levels of wild sunflower leaf meal in the diets of weaner pigs showed no differences in the relative weights of liver, heart and spleen but kidney weight showed differences among dietary treatments. There were differences among the dietary treatment in heart, lung and weights of spleen. However, there were no particular trends for which these differences could be assigned to the MOLM or the 0% MOLM diet. In comparison, (Dougnon, Aboh, Kpodékon, Honvou & Youssao, 2012) and (Oduro-Owusu *et al.*2015) in their investigations observed no differences in the parameters mentioned above when MOLM was fed to rabbits and pigs respectively. Gyebi, (2014) and Nuhu, (2010) also in their investigations observed no difference in the weight of heart, lung and spleen when MOLM was fed to rabbits. The differences in visceral with content did not follow any particular trend upon which the differences could be attributed to either the control diet or the MOLM diets. This finding is in contrast to the findings reported by (Oduro-Owusu *et al.*2015) where no differences were observed in the weight of the full gastro intestinal tract taken as a percentage of the total carcass weight. Similarly, (Nuhu, 2010) in his investigation observed no significant difference in the weight of full caecum when rabbits were fed MOLM. There were differences among dietary treatments for visceral without content but without an apparent pattern for which to attribute the difference to the MOLM or the 0% MOLM diet. This finding is in contrast to the findings of (Oduro-Owusu *et al.*2015) who observed no differences in visceral without content when MOLM was fed to pigs. The differences in the weight of stomach with content revealed that the sows on the MOLM diets had higher stomach with content weight than sows on the control diet. This could be attributed to the bulky and fibrous nature of the MOLM. These led to the inability of the sows to digest the feed fully and to empty it before they were slaughtered. This resulted in the high weight of stomach with content for sows on the MOLM diets. Dietary fibre is a heterogeneous mixture of structural and non-structural polysaccharides and lignin and is not digested by endogenous secretions by the pig (Souffrant, 2001). Oduro-Owusu *et al.*(2015) however, observed no differences in the weight of the full gastro intestinal tract taken as a percentage of the total carcass weight.

Conclusions And Recommendations

The result that was obtained in this research investigation suggests that including moringa oleifera leaf meal (MOLM) has no deleterious effect on pork quality and carcass characteristics of pigs. Including MOLM in pig diet reduced fat in pock significantly as MOLM inclusion levels increased. MOLM modified energy levels highly at 7.5% MOLM inclusion and carbohydrate was highly improved at 12% MOLM inclusion level. However, protein reduced as MOLM inclusion level increased. Visceral fat and back fat thickness reduces with increasing levels of MOLM. It is recommended that for pork quality, MOLM inclusion level should be at 5% while inclusion levels of MOLM for carcass characteristics should be 7.5% MOLM.

Acknowledgments:

The author is most grateful to the University of Education Winneba, Department of Animal Science Education, College of Agriculture Education, for allowing me to use their facility to conduct the experiment. The author is also grateful to **Prof. j.k. kagya-agyemang** for the guidance he provided during the practical work.

REFERENCES

A.O.A.C., (1990), Association of Official Analytical Chemists, Official methods of Analysis.15th edition, Washington, D.C.

Abdel-Wareth, A.A.A., Hammad, S. and Ahmed, H. (2014).Effects of khayasenegalensis leaves on performance, carcass traits, hematological and biochemical parameters in rabbits. *Excli Journal. 13:* PP: 502-512.

Aberle, E.D., Forrest, J.C., Gerrard, D.E. and Mills, E.W. (2001).Principles of Meat Science. Fourth Edition, Kendall/Hunt Publishing Company, Iowa, USA. Pp. 63.

Ahamefule, F.O., Eduok, G.O., Usman, A., Amaefule, K.U., Obua, B.E. and Oguike, S.A. (2006). Blood Biochemistry and Hematology of weaner Rabbits Fed Sundried, Ensiled and Fermented cassava Peel based diets. *Pakistan Journal of Nutrition,* 5(3):248-253.

Bach, K.K.E. and Jorgensen, H. (2001). Intestinal degradation of dietary carbohydrates from birth to maturity. In: Lindberg, J.E. and Ogle, B. (Eds). Digestive Physiology of Pigs Proceedings of the 8th Symposium. CABI Publishing, Wallingford, UK. p.109 120.

Biesalski H.K. (2005): Meat as component of a healthy diet – are there any risks or benefits if meat is avoided in the diet? Meat Science, 70, 509–524.

Díaz I., González, C. and Ly, J. (1997). Determination of effect of inclusion of 3 levels of foliage of sweet potato (*Ipomoea batata* (L.) Lam.) on the speed of transitohasta the ileum. *ArchivosLatinoamericanos of Animal Production*, 5 (Supplement):291.

Díaz, I. (1998). Evaluation of cuatrometodos (faecal, ileal, in situ and in vitro) para determination digestion of foliage of sweet potato (*Ipomoeabatatas* L.) in pigs.MSc. Thesis. Faculty of Agronomy.Central University of Venezuela. Maracay.

Dougnon, T.J., Aboh, B.A., Kpodékon, T.M., Honvou, S. and Youssao, I. (2012). Effects of substitution of pellet of *Moringa oleifera* to commercial feed on rabbit's digestion, growth performance and carcass trait. *Journal of Applied Pharmaceutical Science, 2*(9):*015-019.*

Dransfield, E. (1994). Optimization of tenderization, ageing and tenderness. *Meat Science*, 36: 105- 120.

Educational Technology (EUTECH), (1997).Measuring the pH of Meat. Educational technology instruments, Pte Ltd. Pp.2-5.

Eusebio, J.A. (1980). Pig Production in the Tropics. Longman Group, Essex, UK.

FAO.(1969). Food and Agriculture Organization. Food Composition for use in Nigeria. Rome Italy. (21):89-92.

Fahey, J.W. (2005). *Moringa oleifera*: A Review of the Medical Evidence for Its Nutritional, Therapeutic, and Prophylactic Properties. Part1. A forum on beneficial trees and plants. *Trees for Life Journal*. 1:5. http://www.tfljournal.org.

Ferguson L.R. (2010): Meat and cancer. Meat Science, 84, 308–313.

Fasuyi, A.O., Ibitayo, F.J and Alo, S.O. (2013). Histopathology, haematology and serum chemistry of growing pigs fed varying levels of wild sunflower (Tithoniadiversifolia) leaf meal as protein supplements. Bionutritional evaluation Journal of Central European Agriculture, 9(1): 23-34

Flock M.R., Kris-Etherton P.M. (2013): Diverse physiological effects of long-chain saturated fatty acids: Implications for cardiovascular disease. Current Opinion in Clinical Nutrition and Metabolic Care, 16, 133–140.

Fuglie, L.J. (2001). Natural Nutrition for the Tropics. In: The Miracle Tree: The Multiple Attributes of Moringa. Fubalie, L.J. (ed). CTA Publication, Wageningen, The Netherlands, pp. 103-115.

Gardner, G.E., Kenny, L., Milton, J.T.B., and Pethick, D.W. (1999). Glycogen metabolism and ultimate pH in Merino, first cross and second cross with lambs as affected by stress before slaughter. Australian Journal of Agricultural Research, 50: 175-18.

Ghasi, S., Nwobodo, E. and Ofili, J.O. (2000). Hypocholesterolemic effects of crude extract of leaf of Moringa oleifera lam in high-fat diet fed Wister rats. Journal of Ethno pharmacology. 69: 21-25.

Gyebi, E. (2014). Growth, reproduction, blood profile and carcass characteristics of new Zealand white weaner rabbits (oryctolaguscuniculus) fed different levels of moringa oleifera leaf meal. M.Phil. Thesis. University of Education Winneba.

McDonald, P., Edwards, R.A. and Greenhalgh, J.F.D. (1998). Animal nutrition: 4th Edition. Produced by Longman Group (EE) Ltd. Hongkong. Pg. 8-320.

Miller, D., McDonald, D. and Asiedu, F. (2005).The effect of mulberry leaf meal on the growth performance of weaner goats in Jamaica. Bio Nutritional Evaluation Journal Centre. European Agriculture, 9(1): 23-34.

Mukumbo, F.E., Maphosa, V., Hugo, A., Nkukwana, T.T., Mabusela. T.P. and Muchenje, V. (2014).Effect of Moringa oleifera leaf meal on finisher pig growth performance, meat quality, shelf life and fatty acid composition of pork South African Journal of Animal Science. 44 (4).pp.92-98.

National Research Council (NRC, 1998).Nutrient requirement of swine, 9th Rev. Ed. National Acad. Press., Washington D.C. 3-127.

Nuhu, F. (2010).Effect of moringa leaf meal (MOLM) on nutrient digestibility, growth, carcass and blood indices of weaner rabbits. MSc. Thesis Kwame Nkrumah University of Science and Technology Kumasi.

Oduro-Owusu, A. D., Kagya-Agyemang, J. K., Annor, S. Y and Bonsu, F. R K. (2015) Growth performance, carcass characteristics and economic efficiency of using graded levels of moringa leaf meal in feeding weaner pigs. American Journal of Experimental Agriculture. 7(3): 190-196.

Offer, G.and Trinick, J. (1993). On the mechanism of the water holding capacity in meat: the swelling and shrinking of myofibrils. Meat Science 8:245-281

Olayeni, T.B., Farinu, G.O., Togun, V.A., Adedeji, S.O. and Aderinola, A.O. (2006). Performance and haematological characteristics of weaner pigs fed wild sunflower(TithoniadiversifoliaHemsl. A gray leaf meal. Journal of Animal and Veterinary Advances. 5(6): 499-502.

Richter, N., Siddhuraju, P. and Becker, K. (2003). Evaluation of nutritional quality of Moringa (Moringa oleifera Lam.) leaves as an alternative protein source for Nile tilapia. Aquaculture, 217: 599-611.

Singh, N.P. and Ghosh, S.K. (2004). Why eat Rabbit Meat. Indian Council of Agricultural Research. Tripura Centre, Lembucherra-West Tripura, Pp. 79-92.

Souffrant, W.B. (2001). Effect of dietary fibre on ileal digestibility and endogenous nitrogen losses in the pig. Animal Feed Science and Technology, 90: 93-102.

Warriss, P.D., Brown, S.N., Francombe, M.A. and Higgins, J.A. (1989). Effect of pre-slaughter fasting on characteristics of pig livers. International Journal of Food Science and Technology, 22:255.

Mukumbo, F.E., Maphosa, V., Hugo, A., Nkukwana, T.T., Mabusela. T.P. andMuchenje, V. (2014).Effect of *Moringa oleifera* leaf meal on finisher pig growth performance, meat quality, shelf life and fatty acid composition of pork *South African Journal of Animal Science.* 44 (4).pp.92-98.

Oduro-Owusu, A. D., Kagya-Agyemang, J. K., Annor, S. Y and Bonsu, F. R K. (2015) Growth performance, carcass characteristics and economic efficiency of using graded levels of moringa leaf meal in feeding weaner pigs. *American Journal of Experimental Agriculture.* 7(3): 190-196.

Richter, N., Siddhuraju, P. and Becker, K. (2003). Evaluation of nutritional quality of Moringa(*Moringa oleifera* Lam.) leaves as an alternative protein source for Nile tilapia. *Aquaculture,* 217: 599-611.

Simopoulos A.P., Cleland L.G. (eds) (2003): Omega-6/ Omega-3 Essential Fatty Acid Ratio: The Scientific Evidence. Karger, Basel, Switzerland.

Teketay, D. (2001). The Effect of Temperature on the Germination of *Moringa Setenopetala*: A Multi-purpose Tree. *Trees for Life Journal.* Vol. 1(1).

****