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<p>pii: S222877011400021-5</p> <p>Effect of weaning age and sex on bone development of pigs raised under intensive system and slaughtered at 70 kg body weight</p> 	<p style="text-align: center;">Original Research, D21 Ganelang B., Moreki J.C., Nsoso S.J., Tsopito C.M. <i>Online J. Anim. Feed Res.</i>, 4(5): 113-120, 2014.</p> <p>ABSTRACT: The aim of the study was to determine the effects of weaning age and sex on bone development of pigs raised under intensive system and slaughtered at 70 kg body weight. A total of 24 piglets were randomly assigned to 3 weaning ages: treatment 1 (21 days of age), treatment 2 (28 days of age) and treatment 3 (35 days of age). Feed and water were given ad libitum up to slaughter weight of 70 kg. Data were analysed as completely randomized design (CRD) using the General Linear Model (GLM) procedure of statistical analysis system, version 9.3. Weaning age did not have significant ($P > 0.05$) effect on bone length and width of pigs. However, pigs weaned at 35 days of age tended to have longer femur (17.4 ± 0.17 cm), tibia (16.0 ± 0.19 cm) and humerus (15.6 ± 0.17 cm) than those weaned at 21 and 28 days of age. A 28 days weaning age resulted in significantly heavier femur (239.0 ± 6.19 g vs. 216.8 ± 6.19 g), tibia (145.8 ± 4.02 g vs. 132.0 ± 4.02 g) and humerus (211.7 ± 4.91 g vs. 195.9 ± 4.91 g) compared to 21 day weaning age. Tibia ash percentage was significantly higher (52.3 ± 0.65 % in pigs weaned at 35 days of age compared to those weaned at 28 (47.6 ± 0.65 %) and 21 days (46.8 ± 0.65 %)). Pigs weaned at 35 days had significantly higher tibia Ca content (38.4 ± 0.36 %) compared to those weaned at 28 (37.2 ± 0.36 %) and 21 days (36.9 ± 0.36 %)). Phosphorus content of the tibia bone was significantly affected by weaning age while Mg content was not affected. Males had significantly heavier femurs (226.4 ± 3.89 g) than females (207.2 ± 3.89 g) pigs weaned at 21 days while tibia and humerus fresh weight of pigs weaned at 21 days was not affected by sex. Sex did not affect tibia mineral content at 21, 28 and 35 days weaning ages. Piglets can be weaned at 21 or 35 days of age without negatively affecting bone development. Twenty one days weaning age is recommended as pigs weaned at this age reach slaughter weight earlier than other weaning ages. Keywords: Bone Length, Bone Mineral Content, Bone Weight, Sex, Weaning Age.</p>	 
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	<p>bilurobin, potassium, sodium and chloride. In view of the above, up to 15% replacement of maize with banana peel meal has no adverse effect on performance and blood components of broiler chickens with concomitant reduction in feed cost N/kg and feed cost per kg gain.</p> <p>Keywords: Broiler Chicken, Banana Peel, Maize, Growth and Blood Components</p>	
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<p>pii: S222877011400024-4</p> <p>Prevalence of Salmonella species in stray cats in Mosul city, Iraq</p>  	<p>Original Research, D24 Mushgil Zenad M., Talib Al-Obaidi Q. and Abdul-Mohsen Al-Talibi M. <i>Online J. Anim. Feed Res.</i>, 4(5): 133-136, 2014.</p> <p>ABSTRACT: Stray carnivores are often exposed to intestinal infection with Salmonella species and might remain carriers for long period, so they have great possibilities for shedding these organisms; particularly the stray cats in cities are more than others because of their size and habits; thus they might contribute actively in contamination of environment. The aim of this study was to detect Salmonella species in stray cats and to access their role in spreading of salmonella infection. Rectal swabs from 59 apparently healthy cats were cultured, tetrathionate broth and Salmonella–Shigella agar were used. Euthanization and post mortem examinations were done later. Bacterial isolation from internal organs was carried out also. Morphological properties and biochemical tests were dependent for detection of Salmonella organisms. They were serotyped in Central Health Laboratory in Baghdad. A high isolation rate of Salmonellae (10.16%) was recorded (by rectal swabs). Various Salmonella serovars were observed: <i>S. anatum</i> (3.38%), <i>S. montevideo</i> (3.38%), <i>S. typhimurim</i> (1.69%) and <i>S. brennderup</i> (1.69%). The isolation rate from internal organs was lower (0.67%) than that from rectum, <i>S. typhimurim</i> (1.69%) and <i>S. montevideo</i> (1.69%) were isolated from small intestine and mesenteric lymph nodes respectively. Stray cats have great chances to get intestinal infection in comparison with the house cats due to their living style. In conclusion asymptomatic (carriers) stray cats were considered a dangerous source of infection with Salmonellae, besides their significant role in contamination of environment; they will threat public and animal health particularly in cities.</p> <p>Keywords: Salmonella, Cats, Enteric Infection in Mosul.</p>	 

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THE EFFECT OF FEEDING GRADED LEVELS OF ROASTED SUNFLOWER (*Helianthus Annuus* L.) SEED MEAL ON WEANER RABBITS

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ABSTRACT: The effects of feeding graded levels of roasted sunflower seed meal inclusion on the performance, nutrient digestibility and carcass characteristics of weaner rabbits were evaluated. Thirty six (Dutch x chinchilla) breeds of rabbit of mixed sexes were used for the experiment which lasted for nine weeks (63 days). They were matched for weight and randomly allotted to four treatments with nine rabbits per treatment and were replicated three times in a completely randomized block design. The levels of roasted sunflower seed meal were 0, 10, 20 and 30 % respectively. The diets and clean water were offered *ad libitum* throughout the experimental period. The productive performance results showed that rabbits on diet four consumed significantly ($P<0.05$) more feed than those on diets one (control), two and three, and the lowest feed intake were recorded in T₁ (control). The final body weight, total weight gain, daily weight gain and the feed conversion ratio significantly ($P<0.05$) revealed higher mean values in T₃ (20%) and T₄ (30%) inclusion of roasted sunflower seed meal than the T₁ (control). The feed cost (₦/Kg) and Total feed cost (₦) indicated significant ($P<0.05$) reduction among the treatment groups as the roasted sunflower seed meal levels inclusion in the diet increased. Significantly ($P<0.05$) better feed cost/Kg gain were obtained in T₄ than T₁ (control). The nutrient digestibility revealed significant ($P<0.05$) difference among the treatment groups in all the parameters, but the mean values were inferior in the T₁ (control) than the T₂, T₃ and T₄ respectively. The results of carcass characteristics revealed high significant ($P<0.05$) difference among the treatment groups except in the lungs, heart, small and large intestine, spleen and stomach. Based on these results, growing rabbits could tolerate up to 30 % roasted sunflower seed meal in their diets with no adverse effect.

Keywords: Rabbit, Sunflower seed, Performance and Carcass characteristics.

ORIGINAL ARTICLE
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INTRODUCTION

The increasing competition between man and his livestock for available gains and feed coupled with Nigeria neglect of Agriculture, has led to high cost of available feed resources. Agunbade et al. (2000) noted that apart from the fact that these are keenly competed for by humans, they are being imported into the country resulting in a situation that degenerate into a continuous rise in the cost of feed for human and animal feeding. Measures aimed at alleviating feed cost in animal production centered on the introduction of non-conventional feedstuffs. The non-conventional feed ingredient could be processed into a high quality feedstuff that can favourably supplement protein and energy sources which currently plays the dual note of feeding man and his livestock. Rabbits (*Oryctolagus caniculus*) have been recommended (Taiwo et al., 2005) as having the best productive advantage to utilize the non-conventional feed sources to bridge the protein gap.

In this respect, Taiwo et al. (2005) showed that sunflower seed has nutritive potentials as a feedstuff for livestock. The percent amino acid content was high and comparable to oil seeds such as soyabean, cotton seed and groundnut seed meal. A preliminary feeding trial conducted by Taiwo et al. (2005) using sunflower seed meal did not have adverse effect on the performance, nutrient digestibility and serum chemistry of rabbits. Sunflower is grown in many semi-arid regions of the world. It is tolerant of both low and high temperature (Putnam et al., 1990). NRC (1984) quoted sunflower seed meal figures 23.3 % protein, 31.6 % crude fibre, 1 % lysine, 0.5 % methionine and 1543 Kcal/Kg metabolizable energy. Reft (1997) reported that the major nutrient in sunflower seeds include protein, thiamine, vitamin E, iron, phosphorus, potassium, calcium and essential fatty acids such as linoleic and oleic acid. Sunflower seed also contained some anti-nutritional factors which include tannins and phytic acid (Khare, 2000; D'Mello, 2000 and Matyka et al., 1993). On this premise, this study was designed to measure the performance, nutrient digestibility and carcass characteristics of weaner rabbits fed rations with roasted sunflower seed meal (SSM) inclusion.



MATERIAL AND METHODS

Thirty six weaned rabbits (Dutch x chinchilla) breeds with age ranging from 5 to 6 weeks were randomly selected and assigned to four dietary treatment groups with nine rabbits per treatment and three per replicate in a completely randomized block design. Rabbit were housed in cages measuring 45 cm x 30 cm. the study lasted for nine weeks (63 days) with an initial one week adjustment period for the rabbits to get accustomed to the feed and confinement. Prior to the commencement the house together with the cages were thoroughly cleaned and disinfected. The rabbits were also pre-condition by de-worming them with Ivomec and administered prophylactic doses of coccidiostate for controlling coccidiosis respectively. The four experimental diets contain 0, 10, 20 and 30 % roasted sunflower seed meal in treatments T₁ (control), T₂, T₃ and T₄ respectively. The rabbits were fed in the morning daily. The quantity of feed supplied daily to them were weighed every morning from which the left over was removed to determine the daily feed intake. The rabbits were weighed at the beginning of the study and weekly thereafter while feed conversion ratio was calculated. Fresh clean drinking water was provided *ad libitum* daily. At the end of the 8th week of the experiment, three rabbits from each treatment were transferred into metabolic cages with facilities for separate collection of faeces over a period of seven days for nutrient digestibility studies.

At the end of the experiment three rabbits per treatment were randomly selected for carcass analysis. The rabbits were fasted for 12 hours before slaughtering and dressing was done by flaying dressed weights and gastrointestinal tract (GIT) weight were recorded immediately after evisceration. The different organs were carefully removed, weighed and expressed as a percentage of the live weight.

Processing of the sunflower seed meal

The sunflower seed were sand roasted; this involved the use of clean fine alluvial sand in a wide aluminium frying pan and heating the sand to the temperature of about 90°C. Sufficient quantity of batch of the raw seeds to cover about two-third of the area of sand was placed on the sand. The seeds and sand were mixed together by constant stirring with a wooden stick to prevent the burning of the seed coat and enhance even distribution of heat. The duration of the roasting was 2 – 3 minutes, the sand was then sieved from the seed and allowed to cool and then milled in hammer meal. The heat treated seed meal was used in compounding the experimental diet.

Statistical analysis

All data collected were subjected to analysis of variance (ANOVA) using completely randomized block design. Significant ($P < 0.05$) difference among treatment means were determined by the least significant difference (LSD), as outlined by Steel and Torrie (1990).

RESULTS AND DISCUSSION

Proximate Composition of Experimental Diets

The results of the proximate composition are shown in Table 1. The analyzed crude protein (CP) value is slightly lower than the calculated value. The lower crude protein in the diet might be attributed to the level of protein in sunflower seed meal as shown in Table 1. NRC (1984) reported that sunflower seed meal contains about 23.30 % crude protein. The values of the ether extract (EE) falls below (10 – 20 %) recommended by Benjamin (1986), but far above the 2 – 25 % for maintenance and 3 – 5% for lactation reported by Bivin et al. (1988). Relf (1997) reported that sunflower seed meal contains about 90% poly unsaturated oil. Sunflower is one of the oldest oil producing plants and its seed have the highest oil content (close to 55 %), Spore (2006). The crude fibre values (CF) increases with increase in the levels of sunflower seed meal. The crude fibre level (8.73 – 10.34 %) is below the recommended levels 14 – 20 % (Lebas, 1980; Champe and Maurice, 1983). The ash content ranges between 7.54 – 9.01 %, which is adequate for rabbit growth. The metabolizable energy (ME) levels of the diet ranged from 2689 – 2908 Kcal/Kg. the energy levels of the diet were within the levels 2500 – 2900 Kcal/Kg recommended by Aduku and Olukosi (1990) for weaner rabbits.

Growth performance

The results of the performance are shown in Table 2. The final body weight, total weight gain, daily weight gain, daily feed intake and feed conversion indicated high significant ($P < 0.05$) difference as influence by inclusion of roasted sunflower seed meal among the treatment groups. The result of the final body weight (1150.00 – 1625.99 g/rabbit) obtained at the end of the experiment was within the range (1140.11 – 1178.76 g/rabbit) reported by Onifade and Tewe (1993) for rabbits of similar ages. Rabbits on diet 4 (30 % sunflower seed meal) inclusion significantly ($P < 0.05$) gained more weight than those on the other treatment groups. However, the mean daily weight gain (10.65 – 18.25 g/day) falls within the range of 10 – 20 g/day observed in most rabbits reared in tropical environment (Cheeke, 1987). The daily weight gain showed significant ($P < 0.05$) difference among the treatments and is similar to the values 15 – 20 g/day reported by Schiere (1999) and 11.37 – 19.11 g/day reported by Njidda and Igwebuikwe (2006) for rabbits. The performance by rabbits in this study was significantly higher ($P < 0.05$) than 10 g/day and 7.8 g/day reported by Abu and Ekpeyoung (1993) but lower than 25.50 g/day reported by De-Blas and Garvey (1975) for rabbits under temperate conditions. The higher daily weight gain observed in T₄ (18.25 g/day) may be attributed to the high feed intake observed in T₄. It has been reported that adding fat to the diet increase growth rate of rabbit (Besidina, 1977) and that rabbit can tolerate up to 20 – 25 % fat in the diet depending on their ages (Aduku and Olukosi, 1990). Inclusion of sunflower seed meal up to 30 % in



this study is observed to increase live weight of rabbits. The daily feed intake was significantly higher ($P < 0.05$) in T_4 (58.95 g/day) and lowest in T_1 (46.70 g/day). Minson (1983) reported that animal intake is directly related to dry matter digestibility (DMD). From the result, it clearly shows that the DMD of T_4 was better than the other treatment groups followed by T_2 (66.17 %) and T_3 (63.42 %) respectively. The daily feed intake for T_2 , T_3 and T_4 were figuratively higher than the T_1 (control) group though there were no significant ($P > 0.05$) difference between T_1 and T_2 . The feed conversion ratio (FCR) ranges from (2.79 - 4.38). The best feed conversion ratio (FCR) was observed in T_4 (2.79). The feed conversion ratio (FCR) was lower than 6.91 - 7.30 reported by Abu and Ekpeyoung (1991). The differences observed in the feed conversion ratio (FCR) may be attributed to the composition of the diet. Relatively all the rabbits receiving sunflower seed meal in the diets recorded better FCR than the control (0 % sunflower seed meal). The feed cost (₦/Kg), total feed cost (₦) and feed cost / Kg gain indicated significant ($P < 0.05$) difference among all the inclusion levels. The feed cost (₦/Kg) and total feed cost (₦) decreased with increasing level of roasted sunflower seed meal up to 30 %. The highest feed cost (₦/Kg) and total feed cost (₦) was recorded in T_1 (control) and the least was in T_4 (30%) inclusion of roasted sunflower seed meal. While the feed cost per Kg gain, decreased with increasing level of roasted sunflower seed meal in the diet. The result obtained in this study was desirable in rabbit diet because the inclusion of roasted sunflower seed meal decreased the feed cost and gave better returns in terms of feed cost per Kg gain. This observation agreed with the report of Apata and Ojo (2000) that the high cost of feed was largely due to the exorbitant price and scarcity of conventional feed ingredients. Similarly, Smith *et al.* (1981) also observed that unconventional plant protein sources drastically reduced feed cost (₦/Kg) and these gave better feed cost per Kg gain.

Table 1 - Ingredient and chemical composition of experimental diet

Ingredients	T_1 (control)	T_2 10%	T_3 20%	T_4 30%		
Maize	32	22	14	5		
Soyabean (full-fat)	19	16	12	9		
Sunflower meal	0	10	20	30		
Groundnut haulms	15	18	20	22		
Maize offal	30	30	30	30		
Bone meal	3	3	3	3		
Salt	0.5	0.5	0.5	0.5		
Min./Vit. premix*	0.5	0.5	0.5	0.5		
Total	100	100	100	100		
Calculated analyses						
Crude protein	16.00	16.00	16.00	16.00		
Energy (Kcal/kg)	2689	2752	2830	2908		
Lysine (%)	0.66	0.65	0.61	0.60		
Methionine + cystine (%)	0.50	0.53	0.55	0.58		
Calcium (%)	1.20	1.22	1.23	1.24		
Phosphorus (%)	0.77	0.79	0.80	0.82		
Chemical Analyses						
Dry matter	95.43	95.91	95.29	96.13	Raw	Roasted
Crude protein	16.12	16.12	16.10	15.68	90.00	98.40
Crude fibre	8.73	8.96	9.25	10.34	23.50	29.10
Crude fat	5.09	6.73	7.59	8.82	22.10	30.74
Ash	7.54	8.79	8.63	9.01	44.00	39.00
					4.70	10.50

* Premix (Agricare-mix®) supplied per kg of diet; Vitamin A 20,000IU; Vitamin D 4,000IU; Vitamin E 39.96IU; Vitamin K 5.99 mg; Riboflavin 12 mg; Vitamin B₁₂ 0.1 mg; Pyridoxine HCl 7 mg; Cal-D-Panthenate 30 mg Nicotinic acid 70 mg; Folic acid 2 mg; Biotin 0.2 mg; Potassium 0.41 %; Sodium 0.30 %; Copper 24 mg; Manganese 110 mg; Zinc 100 mg; Iron 110 mg; Selenium 0.3 mg; Calcium 0.22 mg; Iodine 3 mg; Choline 1000 mg; Butylated hydroxytoluene (BHT) 140 mg and Zeolox 50 mg.

Table 2 - Performance of rabbit fed graded levels of sunflower seed meal

Parameters	T_1 (control)	T_2 10%	T_3 20%	T_4 30%	SEM
Initial body weight (g)	478.82	474.10	477.30	475.40	0.200
Final body weight (g)	1150.00 ^b	1200.11 ^b	1500.15 ^a	1625.19 ^a	123.500*
Total weight gain (g)	671.18 ^d	726.01 ^c	1022.85 ^b	1149.79 ^a	104.830*
Daily weight gain (g)	10.65 ^c	11.52 ^c	16.34 ^b	18.25 ^a	1.820*
Daily feed intake (g)	46.70 ^c	47.34 ^c	54.48 ^b	58.95 ^a	0.40*
Feed conversion ratio	4.38 ^a	4.17 ^a	3.33 ^b	2.79 ^c	0.013*
Mortality	0.00	0.00	0.00	0.00	--
Feed cost (₦/kg)	64.30 ^a	61.10 ^a	57.90 ^c	54.10 ^c	6.340*
Total feed cost (₦)	196.13 ^a	196.13 ^a	189.17 ^b	172.66 ^c	10.130*
Feed cost/kg gain	167.50 ^c	184.51 ^b	188.08 ^b	237.95 ^a	11.460*

a,b,c,d Mean within the same row with different superscripts significantly ($P < 0.05$) different; * = significant ($P < 0.05$) different; SEM = Standard Error of Means



Nutrient digestibility

The result of the nutrient digestibility is shown in Table 3. There were high significant ($P<0.05$) differences among treatments for dry matter digestibility (DMD), crude protein digestibility (CPD), crude fibre digestibility (CFD) and ether extract digestibility (EED). The dry matter of T₁ (control) is significantly ($P<0.05$) inferior to groups on roasted sunflower seed meal based diets while the highest was recorded in T₄ in all parameters. The effects of fat on digestibility of the diet are equivocal.

Benjamin (1986) reported that the addition of vegetable oil to a ration did not have any effect on digestion of dry matter, ether extract and crude protein. On the contrary, a decrease in digestibility of dry matter, organic matter and energy was reported by Lebas (1975) on addition of oil. The crude fibre digestibility (CFD) range between (52.33 – 59.32 %). The treatment groups on roasted sunflower seed meal diet perform better than the T₁ (control) group, though the crude fibre digestibility was not adversely affected. The crude fibre digestibility shows slight depression than the other nutrient digestibility except for ash. Variations exist in the coefficient for the most commonly used feedstuffs. Variation in fibre digestibility is especially wide, making interpretation difficult (Pairet *et al.*, 1986). A possible explanation in the discrepancies may lie in the failure to include the composition of soft faeces in the calculation. In germ free rabbits, which do not practices coprophagy, digestibility coefficient of fat and protein are increased and carbohydrate and fibre decrease (De-Blas and Gidenne, 1998). This could be the possible explanation observed in the decrease of the crude fibre digestibility. The crude protein digestibility (CPD) were significantly higher ($P<0.05$) in all the treatment groups with the highest in T₄ (84.39 %) and lowest in T₁ (76.32 %). The digestibility of crude protein increases as the dietary crude protein level rises, but becomes markedly depressed by an increase in crude fibre content of a diet (Lang, 1981). It shows that crude fibre (CF) content of the feed (Table 1) was higher, that might be the possible cause of depression in crude protein digestibility (CPU) of T₁ (control). Lang (1981) also reported that the digestibility of most nutrients has been shown to increase as protein level rises. The result of the ether extract digestibility (EED) shows that the ether extract digestibility (EED) increases with increase in the level of roasted sunflower seed meal. The ether extract digestibility (EED) ranges from (62.86 – 81.23 %) with the highest in T₄ (30 %) roasted sunflower seed meal inclusion. Sirato-Yasumoto *et al.* (2001) suggested that the presence of saponified fat which is not detected by ether extraction may have resulted in seriously high nutrient digestibility of fat been quoted in many experiments. The ash digestibility ranges from (32.00 – 73.33 %) with the highest value in T₄ (73.33 %) and lowest in T₁ (32.00 %). The ash digestibility (AD) is shown to increase with increase in the levels of roasted sunflower seed meal.

Table 3 - Nutrient Digestibility of Rabbits fed Graded Levels of Sunflower Seed Meal

Nutrient (%)	T ₁ (control)	T ₂ 10%	T ₃ 20%	T ₄ 30%	SEM
Dry matter (DM)	60.13 ^c	66.17 ^b	63.42 ^b	81.68 ^a	1.210*
Crude protein (CP)	76.32 ^d	78.32 ^c	80.13 ^b	84.39 ^a	0.030*
Ether Extract (EE)	62.86 ^b	71.72 ^b	78.63 ^a	81.23 ^a	1.140*
Crude fibre (CF)	52.33 ^c	55.23 ^b	56.72 ^b	59.32 ^a	0.310*
Ash	32.00 ^d	52.50 ^c	67.57 ^a	73.33 ^b	2.410*

^{a,b,c,d} Mean within the same row with different superscripts significantly ($P<0.05$) different; * = significant ($P<0.05$) different; SEM = Standard Error of Means

Carcass characteristics

The results of carcass measurement are shown in Table 4. There were high significant ($P<0.05$) treatment effects on slaughter weight, carcass weight and dressing percentage, the highest mean values were revealed in rabbits fed T₄ containing 30% roasted sunflower seed meal and the lowest in T₁ (control). The higher dressing percentage range from 43.28 – 70.78 % obtained may be related to the higher fat content recorded with carcass. This is similar to the report of Fielding (1991) who reported dressing percentage of 50 – 56 % and tends to be greater if the rabbits are fully grown. This was also observed in this study where T₄ having the highest percentage (70.78%) also had highest abdominal fat (11.25%), while T₁ (control) having the lowest (43.28%) dressing percentage had the lowest abdominal fat (7.35%). The study revealed that there was a relationship between dressing percentage and abdominal fat of carcass. Significant ($P<0.05$) difference in T₄ with 30% roasted sunflower seed meal were however observed for some of the organs which include liver, kidney, back and caecum while lungs, heart, small and large intestine, spleen and stomach indicated no significant ($P>0.05$) difference among the treatment groups.

The finding in this study concur with the report of Epo *et al.* (2009) and Alciček *et al.* (2005) who fed cassava tuber meals and 20% sunflower seed meal to rabbits but did not showed any significant ($P<0.05$) difference among treatments for heart, lungs, spleen, liver and stomach. It is a common practice in feeding trials to use weights of some internal organs like liver and kidneys as indicators of toxicity. Bone (1979) reported that if there is any toxic elements in the feed, abnormalities in weights of liver and kidney would be observed. The abnormalities arise because of increased metabolic rate of the organ in attempt to reduce these toxic elements or anti-nutritional factors to non-toxic metabolites. The observations in this study suggest that the test diets did not contain any appreciable toxin.



Table 2 - Carcass Characteristics of Rabbits fed Graded Levels of Sunflower Seed Meal

Parameters	T ₁ (control)	T ₂ 10%	T ₃ 20%	T ₄ 30%	SEM
Slaughter weight	1000.04 ^b	1033.11 ^b	1234.62 ^a	1318.22 ^a	123.500*
Carcass weight	497.70 ^b	509.85 ^b	689.35 ^a	727.65 ^a	164.890*
Dressing percentage	43.28 ^c	45.49 ^c	57.96 ^b	70.78 ^a	12.470*
Liver	40.35 ^d	45.10 ^c	44.70 ^b	57.05 ^a	9.750*
Lungs	10.35	10.48	11.24	10.22	1.010
Heart	3.00	2.95	3.16	3.99	1.620
Kidney	8.30 ^b	8.50 ^b	10.70 ^a	10.90 ^a	2.670*
Back	77.01 ^c	93.76 ^b	95.21 ^b	105.72 ^a	18.001*
Small intestine	89.60	87.25	90.80	88.80	3.280
Large intestine	105.55	103.45	107.95	108.91	5.390
Caecum	24.70 ^c	24.90 ^c	20.50 ^b	30.50 ^a	4.676*
Spleen	1.10	1.45	1.00	1.80	1.340
Stomach	90.75	92.35	91.20	90.65	2.440
Abdominal fat	7.35 ^b	8.89 ^b	10.85 ^a	11.25 ^a	1.340*

^{a,b,c,d} Mean within the same row with different superscripts significantly (P<0.05) different; * = significant (P<0.05) different; SEM = Standard Error of Means

CONCLUSION

Based on the results obtained, it appears that the inclusion of roasted sunflower seed meal into the diets of rabbits up to 30% has no negative effect on the performance, nutrient digestibility and carcass characteristics of weaner rabbits.

REFERENCES

- Abu OA and Ekpeyoung TE (1993) Utilization of dried palm oil mill effluent by young growing rabbit. *World Rabbit Science* 1(1):11-15.
- Aduku AO and Olukosi JO (1990). Rabbit management in the tropics. Living Books Service, G. U. Publication, Abuja FCT.
- Agunbade JA, Adeyemi OA, Fasina OE and Bagbe SA (2000). Fortification of cassava peel in balanced diets for rabbits. *Journal of Animal Production*. 28(2):167-173.
- Alciceek A, Bozkurt M and Cabuk M (2005). The effect of essential oil combination derived from selected herbs growing wild in Turkey on broiler performance. *South African Journal of Animal Science*. 33:89-94.
- Apata DF and Ojo U (2000). Efficiency of the *Trichoderma viride* enzymes complex in broiler starter fed cowpea testa based diet. In: Ukachukwu, S. N., Ibeauchi, J A., Ibe, S. N., Ezekwe, A. G. and Abasiokong, S. F. (eds). *Animal Production in the New Millennium Challenges and Options*. In: Book of Proceeding of the 25th Annual NSAP Conference. Pp. 132-134.
- Basedina GG (1977). Fat supplement in the diet for rabbits. *Nutrition Abstract Review*. (Series) B. 47:836
- Benjamin JC (1986). Rabbit digestion and blood composition after fat and oil addition to the feed. *Journal of Applied Rabbit Research*. 38:221-229.
- Bivin S, Murray KA and Holsen G (1988). Healthy rabbits under primitive conditions. *Christian Vet. Mission Scattle*. Washington D. C. 91833. USA.
- Bone FJ (1979). *Anatomy and Physiology of Farm Animals*. Reston, USA.
- Champe, K. R. and Maurice, D. V. (1983). Research review on response of early weaned rabbits to sources and level of dietary fibre. *Journal of Applied Rabbits Research*. 6(2):64-67.
- Cheeke PR (1987). *Rabbit Feeding and Nutrition*. Academic Press Inc. Orlando, Florida, USA. Pp 376.
- De-Blas JC and Garvey JB (1975). A note on the retention of energy and nitrogen in rabbits. *Journal of Animal Production*. 21:347.
- De-Blas E and Gidenne T (1998). Digestion of starch and sugars. In: de-Blass, E., Wiseman J, eds. *The nutrition of rabbits*. Wallingford. CABI Publishing: 17-38.
- D'Mello JPF (2000). Anti-nutritional factors and mycotoxins. In: *Farm animal metabolism and nutrition*. CAB International Walling Ford, U. K. pp 383-403.
- Ekpo JS, Solomon IP, Isaac IJ, Ekpo KO and Leo OO (2009). Carcass characteristics and economic benefits of weaner rabbits fed cassava tuber meals. *Asian Journal of Animal and Veterinary Advances*. 4(4):214-218.
- Fielding D (1991). *Rabbits: The Tropical Agriculture Series*. K. Macmillan Education Ltd. London, UK.
- Khare SK (2000). Application of immobilized enzymes in soyabean processing. The third International soyabean processing and utilization conference (ISPCRC).110: 2000 of the Innovation era for soyabean. 15-20, October, 2000, Tsukuba, Ibaraka, Japan, pp. 381-382.



- Lang J (1981). The nutrition of commercial rabbits, Part 1. Physiology, digestibility and nutrient requirement. *Nutrition Abstract Review (Series B)* 5(4):197-225.
- Lebas F (1975). Effect of energy level in food on growth and performance of the rabbit. *Annual Zoo Technology*. 24:281-288.
- Lebas F (1980). Nutrient requirement and feeding of meat rabbit. *Journal of Applied Rabbit Research*. 3(2):15-22.
- Matyka S, Bogusz G and Korol W (1993). Phytate content in cereal grains, legume and rape seeds. *Biuletyn Informacyjny Pozemyslu Paszowedo. Poland*. 32(1):37-43.
- Minson DJ (1983). Forage quantity assessing the plant animal complex in proceeding of the 14th International Grassland Congress Lexington, K Y, USA. Pp 23-29.
- Njidda AA and Igwebuikue JU (2006). Growth performance and apparent nutrient digestibility of weaning rabbits fed graded levels of molasses. *Global Journal of Agricultural Science*. 5(2):167-172.
- NRC (1984). Nutrient requirement of poultry 8th ed. Washington, D.C. National Academy of Science.
- Onifade AA and Tewe OO (1993). Alternative tropical energy feed resources in rabbit diet. Growth performance, Diets digestibility and Blood composition, *World Rabbits Science* 1(1):17-24.
- Pairat M, Bouyssou T and Ruckesbuseh Y (1986). Colonic formation of soft faeces in rabbits: a role for endogenous prostaglandins. *Animal Journal of Physiology*. 250:302-308.
- Putnamett DH, Oplinger ES, Hicks DR, Durgan BR, Noetzel DM, Meronuk RA, Doll JD and Schulte EE (1990). Sunflower: Alternative field crops manual. <http://www.hort.purdue.edu/newcrop/afcm/index.html>.
- Relf D (1997). Sunflower, *The Virginia Gardener. Newsletter* 8(8):1-2. <http://www.ext.vt.edu/index.html>.
- Schiere JB (1999). Backyard rabbit farming in the tropics. Agrodock Publications, Co-Publishing with CTA. Macmillan Education Ltd. London. Pp 40-41.
- Sirato-Yasumoto S, Katsuta M and Okuyama Y (2001). Effect of Sesame seeds rich in sesamin and sesamol on fatty acid oxidation in rat liver. *Journal of Agriculture and Food Chemistry*. 49(5):2647-2651.
- Smith RL, Jensen LS, Hooveland CSI and Hanna WW (1981). The use of plant protein source in broiler chicken diets. *Journal of Agriculture*. 3:78-82.
- Spore (2006). Oiling the future. *Sesame: Past and Future*. Pp 3-5.
- Steel RGD and Torries JH (1990). *Principles and Procedures of Statistics*. Mc Graw-Hill Book Company. New York.
- Taiwo AA, Adejuyigbe AD, Adebomale EA, Oshotan JS and David OO (2005). Performance of nutrient digestibility of weaned rabbits fed forages supplemented with concentrate. *Nigerian Journal of Animal Production*, 32(1): 74 – 78.



EFFECT OF WEANING AGE AND SEX ON BONE DEVELOPMENT OF PIGS RAISED UNDER INTENSIVE SYSTEM AND SLAUGHTERED AT 70 KG BODY WEIGHT

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ABSTRACT: The aim of the study was to determine the effects of weaning age and sex on bone development of pigs raised under intensive system and slaughtered at 70 kg body weight. A total of 24 piglets were randomly assigned to 3 weaning ages: treatment 1 (21 days of age), treatment 2 (28 days of age) and treatment 3 (35 days of age). Feed and water were given *ad libitum* up to slaughter weight of 70 kg. Data were analysed as completely randomized design (CRD) using the General Linear Model (GLM) procedure of statistical analysis system, version 9.3. Weaning age did not have significant ($P > 0.05$) effect on bone length and width of pigs. However, pigs weaned at 35 days of age tended to have longer femur (17.4 ± 0.17 cm), tibia (16.0 ± 0.19 cm) and humerus (15.6 ± 0.17 cm) than those weaned at 21 and 28 days of age. A 28 days weaning age resulted in significantly heavier femur (239.0 ± 6.19 g vs. 216.8 ± 6.19 g), tibia (145.8 ± 4.02 g vs. 132.0 ± 4.02 g) and humerus (211.7 ± 4.91 g vs. 195.9 ± 4.91 g) compared to 21 day weaning age. Tibia ash percentage was significantly higher (52.3 ± 0.65 % in pigs weaned at 35 days of age compared to those weaned at 28 (47.6 ± 0.65 %) and 21 days (46.8 ± 0.65 %)). Pigs weaned at 35 days had significantly higher tibia Ca content (38.4 ± 0.36 %) compared to those weaned at 28 (37.2 ± 0.36 %) and 21 days (36.9 ± 0.36 %). Phosphorus content of the tibia bone was significantly affected by weaning age while Mg content was not affected. Males had significantly heavier femurs (226.4 ± 3.89 g) than females (207.2 ± 3.89 g) pigs weaned at 21 days while tibia and humerus fresh weight of pigs weaned at 21 days was not affected by sex. Sex did not affect tibia mineral content at 21, 28 and 35 days weaning ages. Piglets can be weaned at 21 or 35 days of age without negatively affecting bone development. Twenty one days weaning age is recommended as pigs weaned at this age reach slaughter weight earlier than other weaning ages.

Keywords: Bone Length, Bone Mineral Content, Bone Weight, Sex, Weaning Age.

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INTRODUCTION

In conventional pig farming, weaning involves separation of piglets from the sow and littermates, often mixing piglets with unknown peers and the loss of milk which is the main source of nutrition, thus exposing young piglets to several stressors (Hotzel et al., 2010). Pigs are weaned at around 30 days of age and then raised to market weight, often in the same buildings which can serve as breeding areas for pathogens leading to reinfection of the whole population of pigs in the farm (Whiting and Pasma, 2008). In the past decade, segregated- and medicated-early-weaning practices have been used by swine producers to optimize the health of their piglets to increase feed efficiency and growth performance which improve economic efficiency (Johnson et al., 2012). Biological changes in metabolism, immune system, and intestinal functions occur during and immediately after weaning that may have both short and long-term effects on pig growth and health, regardless of age of pig at weaning (Campbell et al., 2013).

Some of the benefits of early weaning age (≤ 21 days) include increased facility utilisation, increased numbers of litters per sow per year and a reduction in the spread of diseases (Worobec, 1997). However, early weaning is stressful because the piglet must quickly adapt to dramatic changes in its social and physical environment. These combined stressors have a significant impact on post weaning pig health and welfare through reductions in feed intake and performance, development of behavioural vices, and increased susceptibility to disease (Moeser et al., 2007; Colson, 2006). However, special diets and management schemes have been developed to overcome nutritional problems associated with early weaning. On the other hand, late weaning reduces stress, increases post-weaning feed intake but does not improve intestinal functionality; hence it is economically not sustainable (van der Meulen et al., 2010). Most of the differences between early-weaned and late-weaned pigs are evident soon after weaning but they disappear before slaughter (Hohenshell et al., 2000).

There is still much debate about what age piglets should be weaned (Shipka, 2011; King, 2013) as both early weaning and late weaning have advantages and disadvantages. Therefore, it is important to identify age at weaning suitable for Botswana conditions that would promote growth, performance, welfare of animals and economic



viability of piggeries. Therefore, this study was carried out to determine the effect of weaning age and sex on bone development of pigs raised under intensive system and slaughtered at 70 kg body weight.

MATERIAL AND METHODS

The experiment was carried out at Chemae Farm, near Matebeleng village in Kgatleng District from May to November 2013. The site is situated on 24° 32' 54.12" S 26° 1' 3.55" E, at an altitude of 980 m above sea level. The area had average daily temperature of 15 °C in winter (May to July) and 29 °C in summer (August to November).

Animal management

Forty eight piglets [(Landrace x Large white) x Topigs (Tempo x Topigs 40) x Topigs] cross were randomly assigned to 3 treatments. There were 4 replicates in each treatment and each replicate had 4 pigs (2 males and 2 females). Treatment 1 was for piglets weaned at 21 days, treatment 2 at 28 days and treatment 3 at 35 days. Twenty-eight day weaning period served as a control. Teeth and tail cutting were carried out when piglets were 1 day old while iron injection and castration were done at 3 days of age. Iron injection was administered intramuscularly on the neck. Castration was performed surgically using sharp and disinfected blades.

Pigs were not vaccinated against any disease but were treated for internal parasites using piperazine (active ingredient: piperazine adipate 100%) at 1.2 g/10 kg body weight. Triatix pour on (active ingredient: amitraz 2% m/v) was used to control external parasites. Cosumix Plus (active ingredients: sulphachlorpyridazine sodium and trimethoprim) and sulfazine 33 1/3 % (active ingredient: sulphadimidine) were used to treat pigs for diarrhoea. The pigs were raised in 12 pens each measuring 2.2 m x 2.2 m in a naturally ventilated house with concrete floor and corrugated iron roofing. Wheat straw was used as bedding material and was replaced every fortnight. During cold days, heating was provided to the piglets using coal.

Diets

The pigs in all treatments were fed commercial diets that complied with Botswana Bureau of Standards pig feeds specification (BOS 190:2006). From 10 to 35 days of age, piglets were offered creep feed, weaner diet from 35 to 70 days of age and thereafter grower diet up to slaughter weight of 70 kg. Feed and water were provided *ad libitum* throughout the study period. The analysed nutritive composition of the diets expressed in g/kg is shown in Table 1.

Table 1. Nutrient composition of diets offered to pigs raised under intensive system

Nutrient (g/kg)	Creep diet	Weaner diet	Grower diet
Crude protein	185.1 ± 0.34	156.7 ± 7.15	148.5 ± 0.84
Moisture	85.2 ± 0.53	72.9 ± 0.58	76.8 ± 0.18
Crude fibre	14.9 ± 0.006	22.4 ± 1.33	64.0 ± 9.66
Crude fat	10.9 ± 0.27	17.4 ± 0.37	19.1 ± 0.35
Calcium	7.3 ± 0.07	5.5 ± 0.04	4.5 ± 0.03
Phosphorus	4.5 ± 0.06	3.3 ± 0.08	4.5 ± 0.05

Ante mortem treatment

At 70 kg body weight, pigs were transported early in the morning (i.e., 0700 hr.) in an open vehicle with rails to a local abattoir in Gaborone for slaughter. Upon arrival at the abattoir, the pigs were held in lairage for 12 hr. with free access to water until slaughter the following morning. The animals were slaughtered humanely by electrical stunning (240 V, 0.5 A, 5s), exsanguinated, scalded, dehaired and eviscerated (Serrano et al., 2009). After slaughter, the carcasses were hanged so that blood drains away. *Ante mortem* and *post-mortem* inspections were carried out by meat inspectors in accordance with Livestock and Meat Industries Act of 2007. After inspection, the carcasses were chilled at 7 °C for 24 hr.

Data collection

After 24 hr. in the chiller, the carcasses were dissected into two halves: left and right. The right half was deboned manually using knives so that bone measurements could be carried out. After deboning, all the bones were frozen at -20°C until analysis. Tibia, femurs and humeri were removed and measured for bone length, wide bone shaft width (Kanakov et al., 2004). Bone lengths and bone shaft widths were measured using digital calliper with accuracy of 0.001 mm (Chiripasi et al., 2013). Fresh weights of bones were measured immediately after deboning of the carcasses while dry weights were measured after drying the bones at 110 °C for 24 hr. (Alexander et al., 2010).

Tibia bone ash %, Ca %, P % and Mg % was determined after drying the bones. Bone marrow was physically removed from each bone using steel teaspoon. After drying, ash % was determined by ashing bones in a muffle furnace at 550 °C for 24 hr. Calcium, P and Mg were determined by dissolving 1 g of ash into 10 ml 3M hydrochloric acid and boiled for 10 minutes in a 100 ml beaker and allowed to cool for 30 minutes (AOAC, 1996). Thereafter, 1 ml of the sample was put into 200 ml volumetric flask and topped to the mark using distilled water.



Calcium and Mg were determined using flame atomic absorption spectrophotometer (make: Varian Australia PTY Ltd, model: 220 FS) while P was determined using ultra violet spectrophotometer (make: Shimadzu, model: UV - 1800).

Statistical analysis

Data were analysed as completely randomized design (CRD) using the General Linear Model (GLM) procedure of Statistical Analysis System, version 9.3 (SAS Institute, 2010). The reported least squares means were separated using least significant difference (t test). The significance level considered for all the statistical tests was $P < 0.05$. The following statistical model was used for the analysis:

$$Y_{ijk} = \mu + W_i + S_j + (WS)_{ij} + \beta(\text{AGE}_{ijk} - \text{AGE}) + \epsilon_{ijk}$$

where Y_{ijk} = response variable (bone development: bone length, width, fresh weight, dry weight, ash %, Ca %, P %, Mg %)

μ = general mean,

W_i = effect of weaning age at level i (21 days, 28 days, 35 days),

S_j = effect of sex at level j (male, female),

$(WS)_{ij}$ = effect of interaction WS at level ij ,

β = linear regression coefficient of AGE_{ijk} on age at slaughter,

AGE = mean age of animals at slaughter,

AGE_{ijk} = age of individual animals at slaughter,

ϵ_{ijk} = random error.

RESULTS AND DISCUSSION

Bone length

Weaning age did not have significant effect on bone length of pigs slaughtered at 70 kg body weight (Table 2). Pigs weaned at 35 days tended to have longer femur (17.4 vs.17.1 cm), tibia (16.0 vs.15.8 cm) and humerus (15.6 vs.15.2 cm) than those weaned at 28 days. Pigs weaned at 21 days of age had 17.0, 15.9 and 15.3 cm for femur, tibia and humerus lengths, respectively. The current results are consistent with Richmond and Berg (1972) who reported 15.52 cm, 17.10 cm, 16.25 cm for humerus, femur and tibia lengths, respectively for pigs weaned at 21 days and slaughtered at 68 kg. Chaudhary and Price (1987) reported femur and humerus length of 16.9 and 16.0 cm, respectively for pigs weaned at 21 days and slaughtered at 179.5 days of age. Furthermore, Liu et al. (1999) reported shorter humerus (13.04±0.58 cm), femur (14.11±0.64 cm) and tibia (12.95±0.63 cm) for pigs slaughtered at 84 days of age. According to Mao et al. (2008), studies in mice and chickens have shown that the limb bone lengths are strongly controlled by genes. Therefore, environmental factors like weaning age are unlikely to have significant effect on bone length.

As expected, pigs weaned at 35 days had numerically longer bones compared to 21 and 28 day weaning ages. Hohenshell et al. (2000) observed an improvement in average daily gain of early-weaned pigs compared with late-weaned pigs. It was suggested by Do (2012) that increasing weaning age up to 32 days can be an effective production strategy to improve growth rate which is consistent with current results.

Bone width

Weaning age did not have significant effect on bone width (Table 2). Femur width remained the same (23.0 mm) in all the weaning ages. Carter and Cromwell (1998) reported femur width of 26.90 mm which is greater than 23.0 mm found in the current study. In this study, pigs were slaughtered at 70 kg while in the study by Carter and Cromwell (1998) they were slaughtered at 114 kg body weight. Tibia and humerus were numerically wider for pigs weaned at 21 days than those weaned at 28 days. Compared to 28 day weaning age, 35 day weaning age had numerically narrower tibia (20.8 mm) and wider humerus (26.2 mm). These slight variations in bone widths could be due to differences in genetics and level of bone mineralization.

Bone weight

Fresh weight: Bone fresh weight was significantly ($P < 0.05$) influenced by weaning age (Table 2). At 21 days weaning age resulted in lighter femur (216.8 g), tibia (132.0 g) and humerus (195.9 g) compared to 28 day weaning age. The current results are consistent with Richmond et al. (1972) who recorded weights of 207.7 g, 227.74 g and 160.48 g for humerus, femur and tibia, respectively of pigs weaned at 21 days and slaughtered at 68 kg. Similarly, Chaudhary and Price (1987) reported femur and humerus fresh weights of 243.0 and 226.0 g, respectively for pigs weaned at 21 days and slaughtered at 179.5 days of age. Narayanan et al. (2008) stated that pigs weaned at 21 days require more days to reach market weight, and hence recommended 28 day weaning age. In the current study, there was significant difference in tibia fresh weight for pigs weaned at 28 and 35 days. The tibia fresh weight of pigs weaned at 28 days was 145.8 g while it was 132.9 g for pigs weaned at 35 days. However, there was no significant difference in bone fresh weight for pigs weaned at 21 and 35 days although 35 day weaning age tended to have higher numerical values (Table 2). These findings disagree with Danko and Bilkei (2004) who found that early weaned pigs were heavier at slaughter than late weaned ones. Variations in bone weight could be attributable to bone tissue deposition and resorption that continuously occur in the body of a living animal (Hanagriff, 2012).



Table 2. Means and standard errors of lengths, widths, weights and mineral content of bones of pigs raised under intensive system, weaned at different ages and slaughtered at 70 kg body weight

Variable	21 days	28 days	35 days	SEM	LSD	P value
Bone length (cm)						
Femur	17.0 ^a	17.1 ^a	17.4 ^a	0.17	0.50	0.36
Tibia	15.9 ^a	15.8 ^a	16.0 ^a	0.19	0.56	0.71
Humerus	15.3 ^a	15.2 ^a	15.6 ^a	0.17	0.52	0.51
Bone width (mm)						
Femur	23.0 ^a	23.0 ^a	23.0 ^a	0.41	1.22	0.96
Tibia	21.3 ^a	21.1 ^a	20.8 ^a	0.46	1.37	0.23
Humerus	25.9 ^a	25.5 ^a	26.2 ^a	0.34	1.00	0.10
Bone fresh weight (g)						
Femur	216.8 ^a	239.0 ^b	223.8 ^{ab}	6.19	18.40	0.04
Tibia	132.0 ^a	145.8 ^b	132.9 ^a	4.02	11.93	0.04
Humerus	195.9 ^a	211.7 ^b	204.2 ^{ab}	4.91	14.60	0.01
Bone dry weight (g)						
Femur	122.9 ^a	142.4 ^b	128.7 ^a	4.47	13.29	0.02
Tibia	76.9 ^a	89.0 ^b	80.4 ^a	2.63	7.80	0.01
Humerus	115.2 ^a	127.6 ^b	118.6 ^{ab}	3.26	9.68	0.04
Slaughter age (days)	130.8 ^a	134.6 ^{ab}	137.0 ^b	1.59	4.72	0.04

SEM = Standard error of means. LSD = Least Significant Difference; ^{a,b} Means within the same row having different letters differ significantly; P < 0.05

Dry weight

Bone dry weight was significantly higher in pigs weaned at 28 day of age compared to other weaning ages. Pigs weaned at 28 days tended to have heavier dry humerus (127.6 g) than those weaned at 35 days (118.6 g). No significant difference in bone dry weights from pigs weaned 21 and 35 days weaning ages was observed although 35 day weaning age tended to have heavier bones (Table 2). The heavier bones from pigs weaned at 35 days could be due to the fact that pigs were on sow's milk longer than other weaning ages. Petrovič et al. (2009) stated that the characteristic feature of the suckling period of piglets is an extremely rapid development of bones enabled by unique milk nutrition with a high fat content provided by the dam.

Slaughter age

Weaning age had significant (P<0.05) influence on slaughter age (Table 2). In this study, pigs weaned at 35 days of age took a longer time (137 days) to reach market weight (70 kg) compared to those weaned at 21 days of age (130.8 days). However, there was no significant difference in slaughter age between 28 day weaning age and other weaning ages. These results agree with Danko and Bilkei (2004) who found that days to slaughter do not differ between the early or late weaned pigs.

Bone mineral content

Tibia ash was significantly higher at 35 days weaning age (52.3%) compared to 21 days (46.8%) and 28 days (47.6%) weaning ages (Table 3). However, weaning age did not have significant influence on ash content of pigs weaned at 21 and 28 days. The ash content of 47.6% in the present study is lower than the ash contents of 53.5 to 61.1% reported by Crenshaw et al. (1981) in pigs weaned at 28 days. It is also lower than 57.6% reported by Kornegay et al. (1973). The ash content of tibia in the current study is higher than 37.4% for pigs weaned at 17 days of age reported by Jolliff and Mahan (2012). The variation in the ash contents could be due to the young age (56 days) at which the pigs were slaughtered in the study by Jolliff and Mahan (2012) compared to the slaughter age of 130.8 days in the current study. Previous study by Field (2000) found that bone ash content increases with age.

There was significant difference in Ca content between 35 day weaning age and other weaning ages (Table 3). However, the Ca content of tibia bone was not significantly (P>0.05) different between 21 and 28 day weaning ages. Pigs weaned at 35 days had the highest Ca content (38.4%) and those weaned at 21 days the lowest Ca content (36.9%). There was no significant difference in P content between 28 and 35 day weaning ages although 28 weaning age tended to have higher P content (18.3%) compared to 35 days (17.4%). Phosphorus content was significantly less (16.9%) for pigs weaned at 21 days compared to those weaned at 28 days (18.3%). The current results are consistent with Field (2000) who reported Ca and P contents of bones of mammals of 37% and 17%, respectively. Varley et al. (2010) reported lower P (8.59%) and Ca (18.19%) contents in metacarpal bones. According to Saraiva et al. (2011), bone resorption occurs in order to maintain P and Ca ratio resulting in a decrease of bone mineral content. In the current study, weaning age did not have significant (P > 0.05) effect on Mg content of tibia bone although pigs weaned at 21 days tended to have higher content of Mg (0.54%) (Table 3).

Influence of sex on bone development

Bone length: Sex had no significant (P>0.05) effect on bone length of pigs weaned at 21, 28 and 35 days (Tables 4 to 6). The current results are consistent with Tataru et al. (2012) who found no significant difference between sexes in the length of femur of pigs. In the current study, females had longer tibia (16.0 cm) than males (15.7 cm). Similarly, Richmond and Berg (1972) found no significant difference in length of humerus in male and female pigs. On the contrary, Richmond and Berg (1972) reported significantly longer femur and tibia in males than



female pigs weaned at 21 days and slaughtered at 68 kg. Essien and Fetuga (1988) also found significant difference in the lengths of femur, tibia and humerus between male and female pigs.

Table 3. Means and standard errors of mineral composition of tibia bone of pigs raised under intensive system, weaned at different ages and slaughtered at 70 kg body weight

Variable	21 days	28 days	35 days	SEM	LSD	P value
Ash %	46.8 ^a	47.6 ^a	52.3 ^b	0.65	1.92	< 0.0001
Ca%	36.9 ^a	37.2 ^a	38.4 ^b	0.36	1.06	0.03
P%	16.9 ^a	18.3 ^b	17.4 ^{ab}	0.45	1.35	0.01
Mg%	0.54 ^a	0.48 ^a	0.44 ^a	0.08	0.21	0.29

SEM = standard error of the means; LSD = Least Significant Difference; ^{a,b} Means within the same row having different letters differ significantly; P < 0.05

Table 4. Means and standard errors of lengths, widths, weights and mineral content of bones of pigs weaned at 21 days of age, raised under intensive system and slaughtered at 70 kg body weight

Variable	Male	Female	SEM	LSD	P value
Bone length (cm)					
Femur	17.0 ^a	17.0 ^a	0.18	0.67	0.88
Tibia	15.7 ^a	16.0 ^a	0.25	0.90	0.46
Humerus	15.3 ^a	15.3 ^a	0.28	1.01	0.97
Bone width (mm)					
Femur	23.0 ^a	23.1 ^a	0.50	1.80	0.93
Tibia	21.6 ^a	20.9 ^a	0.59	2.15	0.42
Humerus	26.0 ^a	25.7 ^a	0.36	1.32	0.60
Bone fresh weight (g)					
Femur	226.4 ^a	207.2 ^b	3.89	14.14	0.02
Tibia	133.9 ^a	130.2 ^a	4.98	18.10	0.62
Humerus	199.5 ^a	192.2 ^a	3.77	13.72	0.23
Bone dry weight (g)					
Femur	128.3 ^a	117.4 ^b	2.71	9.84	0.04
Tibia	79.8 ^a	74.0 ^a	2.83	10.29	0.21
Humerus	117.7 ^a	112.7 ^b	0.87	3.17	0.01
Tibia mineral content					
Ash %	46.6 ^a	47.0 ^a	0.64	2.34	0.66
Ca%	37.2 ^a	36.6 ^a	0.59	2.16	0.51
P%	16.3 ^a	17.6 ^a	0.61	2.23	0.21
Mg%	0.56 ^a	0.52 ^a	0.13	0.48	0.88
Slaughter age (days)	130.75 ^a	130.75 ^a	1.49	3.67	1.00

SEM = Standard error of means. LSD = Least Significant Difference; ^{a,b} Means within the same row having different letters differ significantly; P < 0.05

Table 5. Means and standard errors of lengths, widths, weights and mineral content of bones of pigs weaned at 28 days of age, raised under intensive system and slaughtered at 70 kg body weight

Variable	Male	Female	SEM	LSD	P value
Bone length (cm)					
Femur	17.1 ^a	17.2 ^a	0.27	0.98	0.86
Tibia	15.7 ^a	15.9 ^a	0.28	1.00	0.74
Humerus	14.9 ^a	15.4 ^a	0.28	0.99	0.36
Bone width (mm)					
Femur	22.6 ^a	23.4 ^a	0.68	2.42	0.67
Tibia	20.2 ^a	22.0 ^a	0.96	3.41	0.26
Humerus	25.1 ^a	26.0 ^a	0.50	1.77	0.23
Bone fresh weight (g)					
Femur	236.2 ^a	241.9 ^a	10.86	38.73	0.88
Tibia	141.7 ^a	149.9 ^a	8.39	29.94	0.61
Humerus	207.3 ^a	216.1 ^a	8.69	31.00	0.61
Bone dry weight (g)					
Femur	144.7 ^a	140.2 ^a	7.90	28.17	0.39
Tibia	89.4 ^a	88.5 ^a	5.51	19.67	0.75
Humerus	129.3 ^a	125.9 ^a	6.10	21.77	0.50
Tibia mineral content					
Ash %	48.4 ^a	46.7 ^a	0.63	2.23	0.11
Ca%	37.8 ^a	36.7 ^a	0.51	1.81	0.19
P%	18.1 ^a	18.5 ^a	0.66	2.34	0.61
Mg%	0.44 ^a	0.52 ^a	0.13	0.45	0.76
Slaughter age (days)	133.75 ^a	135.50 ^a	1.82	3.83	0.52

SEM = Standard error of means. LSD = Least Significant Difference; ^{a,b} Means within the same row having different letters differ significantly; P < 0.05



Table 6. Means and standard errors of lengths, widths, weights and mineral content of bones of pigs weaned at 35 days of age, raised under intensive system and slaughtered at 70 kg body weight

Variable	Male	Female	SEM	LSD	P value
Bone length (cm)					
Femur	17.1 ^a	17.8 ^a	0.32	1.03	0.32
Tibia	15.8 ^a	16.2 ^a	0.35	1.14	0.34
Humerus	15.6 ^a	15.6 ^a	0.25	0.79	0.80
Bone width (mm)					
Femur	23.2 ^a	22.9 ^a	0.42	1.36	0.34
Tibia	20.0 ^a	21.6 ^a	0.48	1.54	0.06
Humerus	25.3 ^a	27.1 ^a	0.66	2.12	0.09
Bone fresh weight (g)					
Femur	216.5 ^a	231.1 ^a	8.74	28.10	0.34
Tibia	129.9 ^a	136.0 ^a	4.40	14.15	0.51
Humerus	195.3 ^a	213.1 ^a	10.11	32.51	0.26
Bone dry weight (g)					
Femur	124.7 ^a	132.7 ^a	5.53	17.78	0.62
Tibia	77.1 ^a	83.7 ^a	2.38	7.65	0.35
Humerus	113.8 ^a	123.5 ^a	5.85	18.81	0.39
Tibia mineral content					
Ash %	51.7 ^a	52.9 ^a	1.42	4.55	0.52
Ca%	38.2 ^a	38.5 ^a	0.51	1.66	0.43
P%	17.3 ^a	17.4 ^a	0.85	2.72	0.78
Mg%	0.43 ^a	0.44 ^a	0.14	0.46	0.81
Slaughter age (days)	133.0 ^a	141.0 ^a	3.10	2.87	0.18

SEM = Standard error of means. LSD = Least Significant Difference; ^{a,b} Means within the same row having different letters differ significantly; P < 0.05

Bone width

Sex had no significant ($P > 0.05$) effect on bone width of pigs weaned at 21, 28 and 35 days of age (Tables 4 to 6). These results agree with Wiseman (2006) who found that femur thickness was not significantly affected by sex. However, in the current study, males tended to have wider tibia (21.6 mm) than females (20.9 mm) for pigs weaned at 21 days. Similarly, males tended to have wider humeri (26.0 mm) than females (25.7 mm) but narrower femurs (23.0 mm) than females (23.1 mm). Dikić et al. (2007) found the diameter of humeri and femurs to be 27.7 mm and 25.6 mm respectively for Swedish Landrace pigs. In the current study, females that were weaned at 28 days tended to have wider femur, tibia and humerus than males. In addition, female pigs that were weaned at 35 days of age tended to have wider tibia and humerus than males (Table 6).

Bone weight

Fresh weight: Sex had significant effect ($P < 0.05$) on fresh weight of femur from pigs weaned at 21 days of age (Table 4). Females had significantly heavier femur (226.4 g) compared to males (207.2 g). However, tibia and humerus fresh weight of pigs weaned at 21 days was not affected by sex. The current results on tibia and humerus fresh weight disagree with Essien and Fetuga (1988) who reported significant difference in the weights of tibia and humerus between male and female pigs. The present results on tibia and humerus are partially consistent with Richmond et al. (1972) who reported no significant influence of sex on fresh weight of femur, humerus and tibia of pigs weaned at 21 days and slaughtered at 68 kg. In the current study, sex had no significant influence on fresh weight of bones of pigs weaned at 28 and 35 days of age although females tended to have heavier bones than males. This variation in bone weights could be due to the differences in stage of skeletal maturity between the pigs at time of slaughter (Richmond et al., 1979).

Dry weight: Sex had significant ($P < 0.05$) effect on dry weight of femur and humerus for pigs weaned at 21 days of age (Table 4). Males had significantly heavier femur (128.3 g) and humerus (117.7 g) compared to females. The current results agree with Richmond et al. (1979) who found significant difference in the weights of individual bones of male and female pigs. However, bone dry weight in the present study was not influenced by sex in pigs weaned at 28 and 35 days of age. However, males from pigs weaned at 28 days tended to have heavier dry bones while females from pigs weaned at 35 days of age tended to have heavier dry bones (Tables 5 to 6).

Bone mineral content

Sex did not significantly affect tibia mineral content at 21, 28 and 35 days weaning ages (Tables 4 to 6). However, males tended to have higher Ca and Mg contents than females for pigs weaned at 21 days. Females weaned at 28 days tended to have higher P and Mg contents while males tended to have lower content of ash, Ca, P and Mg (Tables 3 and 4). These results disagree with Bollen et al. (2006) who found that bone Ca, P, and Mg were significantly different between sexes, with females expressing higher values than males.



Slaughter age

Sex did not significantly ($P > 0.05$) influence slaughter age (Tables 4 to 6). However, females took more days to reach slaughter weight (70 kg) compared to males. These findings disagree with Serrano et al. (2009) who found females to be superior in growth performance to their castrated male counterparts. Latorre et al. (2003), Morales et al. (2011) and Piao et al. (2004) argued that males consume more feed and hence grow faster than their female counterparts.

CONCLUSION

Weaning age and sex did not affect bone length, width, weight and mineral composition of pigs raised under intensive system. Piglets can be weaned at 21, 28 or 35 days of age under intensive system without negatively affecting bone development. Twenty one days weaning age is recommended as pigs weaned at this age reach slaughter weight earlier than other weaning ages.

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REFERENCES

- Alexander LS, Qu A, Cutler SA, Mahajan A, Rothschild MF, Cai W, Dekkers JC and Stahl CH (2010). A calcitonin receptor (CALCR) single nucleotide polymorphism is associated with growth performance and bone integrity in response to dietary phosphorus deficiency. *Journal of Animal Science*. 88: 1009-1016.
- AOAC (1996). Official Methods of Analysis. Association of Analytical Chemists, Washington, D.C. Page 31.
- Bollen PJA, Lemmens AG, Beynen AC, Meyer O and Ritskes-Hoitinga J (2006). Bone composition in male and female Göttingen minipigs fed variously restrictedly and near *ad libitum*. *Scandinavian Journal of Laboratory Animal Science*. 33(3): 149-158.
- Livestock and Meat Industries Act of 2007. Gaborone, Botswana.
- Campbell JM, Crenshaw JD and Polo J (2013). The biological stress of early weaned piglets. *Journal of Animal Science and Biotechnology*. 4: 19.
- Carter SD and Cromwell GL (1998). Influence of porcine somatotropin on the phosphorus requirement of finishing pigs: performance and bone characteristics. *Journal of Animal Science*. 76: 584-595.
- Chaudhary ZI and Price MA (1987). Effects of castration and exogenous estradiol or testosterone on limb bone growth and some performance traits in young male pigs. *Canadian Journal of Animal Science*. 67: 681-688.
- Chiripasi SC, Moreki JC, Nsoso SJ and Letso M (2013). Effect of feeding yellow maize, white sorghum and pearl millet as energy sources on mineral intake, retention and utilisation by guinea fowl under intensive management system. *ARPN Journal of Animal Science and Technology*. 3(1): 124-137.
- Colson V, Orgeur P, Foury A and Morme`de P (2006). Consequences of weaning piglets at 21 and 28 days on growth, behaviour and hormonal responses. *Applied Animal Behaviour Science*. 98: 70-88.
- Crenshaw TD, Peo Jr. ER, Lewis AJ, Moser BD and Olson D (1981). Influence of sex, age and calcium and phosphorus levels on the mechanical properties of various bones of swine. *Journal of Animal Science*. 52: 1319-1329.
- Danko P and Bilkei G (2004). Effect of early weaning and outdoor production on growth performance of pigs. *Pig Journal*. 54. (Abstract)
- Dikić M, Salajpal K, Karolyi D, Dikić D, Pavić M and Jurić I (2007). Characteristics of femur and humerus in turopolje pig - an autochthonous Croatian breed. Available online at <http://www.hrca.hr/file/24421>
- Do CH (2012). Estimation of weaning age effects on growth performance in Berkshire pigs. Available online at <http://www.thefreelibrary.com/Estimation+of+weaning+age+effects+on+growth+performance+in+Berkshire...-a0276186765>
- Essien AI and Fetuga BL (1988). Bone growth in the indigenous Nigerian pigs as a function of age, sex and body weight. *The Journal of Agricultural Science*. 110(03): 597-604.
- Field RA (2000). Ash and calcium as measures of bone in meat and bone mixtures. *Meat Science*. 55: 255-264.
- Hohenshell LM, Cunnick JE, Ford SP, Kattesh HG, Zimmerman DR, Wilson ME, Matteri RL, Carroll JA and Jay DC (2000). Few differences found between early- and late-weaned pigs raised in the same environment. *Journal of Animal Science*. 78:38-49.
- Hanagriff R (2012). Animal growth and development. Available online at <http://myimsservices.com/docs/Animal%20Growth%20&%20Development%20-%20Class%20Notes%20-%20Key.pdf>
- Hotzel MJ, Filho LCPM, Irgang R and Filho LA (2010). Short-term behavioural effects of weaning age in outdoor-reared piglets. *Animal*. 4(1): 102-107.



- Johnson AK, McGlone JJ and Gentry-Carter JG (2012). How does weaning age affect the welfare of the nursery pig? Available online at <http://www.porkgateway.org/FileLibrary/PIGLibrary/Factsheets/a6764v1-0.pdf>
- Kanakov D, Petkov P and Stojanchev K (2004). Changes of bone parameters of growing pigs to different phosphorus levels in the diet. *Trakia Journal of Sciences*. 2(1): 58-63.
- King G (2013). Considerations at weaning time. Available online at http://www.aps.uoguelph.ca/~gking/Ag_2350/wean.htm
- Latorre MA, Lazaro R, Gracia MI, Nieto M and Mateos GG (2003). Effect of sex and terminal sire genotype on performance, carcass characteristics, and meat quality of pigs slaughtered at 117 kg body weight. *Meat Science*. 65: 1369-1377.
- Liu MF, He P, Aherne FX and Berg RT (1999). Postnatal limb bone growth in relation to live weight in pigs from birth to 84 days of age. *Journal of Animal Science*. 77(7): 1693-701.
- Mao H, Guo Y, Yang G, Yang B, Ren J, Liu S, Ai H, Ma J, Brenig B and Huang L (2008). A genome-wide scan for quantitative trait loci affecting limb bone lengths and areal bone mineral density of the distal femur in a White Duroc × Erhualian F₂ population. *BMC Genetics*. 9: 63.
- Moeser AJ, Ryan KA, Nighot PK, Anthony T and Blikslager AT (2007). Gastrointestinal dysfunction induced by early weaning is attenuated by delayed weaning and mast cell blockade in pigs. *American Journal of Physiology - Gastrointestinal and Liver Physiology*. 293: 413-421.
- Morales JI, Cámara L, Berrocoso JD, López JP, Mateos GG and Serrano MP (2011). Influence of sex and castration on growth performance and carcass quality of crossbred pigs from 2 Large White sire lines. *Journal of Animal Science*. 89(11): 3481-3489.
- Narayanan R, Ronald BSM, Baegan S and Prabakaran R (2008). Effect of age at weaning on growth performance of large white Yorkshire. *Tamilnadu Journal of Veterinary and Animal Sciences*. 4(6): 237-239.
- Petrovič V, Novotný J, Hisira V, Link R, Leng L, Kováč G (2009). The Impact of Suckling and Post-weaning Period on Blood Chemistry of Piglets. *Acta Veterinaria*, 78: 365-371.
- Piao JR, Tian JZ, Kim BG, Choi YI, Kim YY and Han IK (2004). Effects of sex and market weight on performance, carcass characteristics and pork quality of market hogs. *Asian-Australian Journal of Animal Science*. 17(10): 1452-1458.
- Richmond RJ and Berg RT (1972). Bone growth and distribution in swine as influence by liveweight, breed, sex and ration. *Canadian Journal of Animal Science*. 52: 47-56.
- Richmond RJ, Jones SDM, Price MA and Berg RT (1979). Effects of breed and sex on the relative growth and distribution of bone in pigs. *Canadian Journal of Animal Science*. 59(3): 471-479.
- Saraiva A, Donzele JL, de Oliveira RFM, de Abreu MLT, Silva FCO, Vianna RA and Lima AL (2011). Available phosphorus levels in diets for 30 to 60 kg female pigs selected for meat deposition by maintaining calcium and available phosphorus ratio. *Revista Brasileira de Zootecnia*. 40(3). Available online at http://www.scielo.br/scielo.php?pid=S151635982011000300017&script=sci_arttext&lng=en
- Serrano MP, Valencia DG, Fuentetaja A, Lázaro R and Mateos GG (2009). Effect of castration on productive performance, carcass characteristics and meat quality of Iberian pig females reared under intensive management systems. *Livestock Science*. 123: 147-153.
- Serrano MP, Valencia DG, Fuentetaja A, Lázaro R and Mateos GG (2009). Influence of feed restriction and sex on growth performance and carcass and meat quality of Iberian pigs reared indoors. *Journal of Animal Science*. 87(5): 1676-1685.
- Shipka M (2011). Recommended practices for raising pigs from birth to weaning. Available online at <http://www.uaf.edu/files/ces/publications-db/catalog/anr/LPM-00845.pdf>
- Tatara MR, Krupski W, Tymczyna B and Łuszczewska-Sierakowska I (2012). Biochemical bone metabolism markers and morphometric, densitometric and biomechanical properties of femur and tibia in female and gonadectomised male Polish Landrace pigs. *Journal of Pre-Clinical and Clinical Research*. 6(1): 14-19.
- van der Meulen J, Koopmans SJ, Dekker RA and Hoogendoorn A (2010). Increasing weaning age of piglets from 4 to 7 weeks reduces stress, increases post-weaning feed intake but does not improve intestinal functionality. *Animal*. 4(10): 1653-1661.
- Varley PF, Sweeney T, Ryan MT and O'Doherty JV (2011). The effect of phosphorus restriction during the weaner-grower phase on compensatory growth, serum osteocalcin and bone mineralization in gilts. *Livestock Science*. 135: 282-288.
- Whiting TL and Pasma T (2008). Isolated weaning technology: Humane benefits and concerns in the production of pork. *Canadian Veterinary Journal*. 49(3): 293-301.
- Wiseman TG (2006). Genetic and gender influences on the changing phenotypic, total body and body component mineral compositions of pigs from 20 to 125 kilogram body weight. Available online at https://etd.ohiolink.edu/ap:0:0:APPLICATION_PROCESS=DOWNLOAD_ETD_SUB_DOC_ACCNUM:::F1501_ID:osu1141655387.attachment
- Worobec EKS (1997). Early weaning in swine: a behavioural assessment. Available online at <http://www.collectionscanada.gc.ca/obj/s4/f2/dsk2/ftp04/mq24520.pdf>

GROWTH, HAEMATOLOGICAL AND SERUM BIOCHEMICAL INDICES OF BROILER CHICKENS FED BANANA PEEL MEAL AS REPLACEMENT FOR MAIZE IN THE SEMI-ARID ZONE OF NIGERIA

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ABSTRACT: An experiment was conducted to investigate the replacement of maize with banana peel meal in broiler diets. One hundred and twenty (120) Anak 2000 broiler chicken were used for the study. Four diets were formulated using banana peel meal at 0%, 5%, 10%, and 15% levels in the respected diets. The birds were randomly allotted to dietary treatments in a completely randomized design. Each treatment consists of thirty birds with ten birds per replicate. The experiment lasted for eight weeks; feed and water were given *ad libitum*. The productive performance results indicated high significant ($P<0.05$) difference in final weight, daily weight gain and feed conversion ratio among the treatment group at different levels of replacement. Haematological indices and serum biochemical indices also followed similar pattern as the productive performance by revealing high significant ($P<0.05$) difference at different levels of maize replacement with banana peel meal in Packed cell volume (PCV), Red blood cell (RBC), Haemoglobin (Hb), White blood cell (WBC), Mean corpuscular volume (MCV), Mean corpuscular Haemoglobin (MCH), Haemoglobin concentration (Hb), Heterophils and Lymphocytes. The serum biochemical indices revealed high significant ($P<0.05$) difference in total protein, albumen, glucose, total bilirubin, potassium, sodium and chloride. In view of the above, up to 15% replacement of maize with banana peel meal has no adverse effect on performance and blood components of broiler chickens with concomitant reduction in feed cost ₦/kg and feed cost per kg gain.

Keywords: Broiler Chicken, Banana Peel, Maize, Growth and Blood Components

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INTRODUCTION

Nigeria like many other developing countries is currently faced with the shortage and high cost of conventional feed for poultry. Payne (1990) observed that the increasing worldwide need for energy and protein sources for ration formulation for poultry may in the long run delay or even halt the complete industrialization of the poultry industry. It is in light of this that efforts are geared towards investigation into the utilization of some cheap and readily available alternative sources of some energy and protein feed stuffs for monogastric animals. This has been the main focus of animal nutritionist in the country. The search was precipitated by high cost of most conventional feedstuffs which have always been in high demand by humans.

The poultry industry fall short of its own aim of self-sufficiency in animal protein consumption in the country that is 5 g/caput per day which is below recommended level of 35 g/caput per day (FAO, 2010). Constraints which include low level of income, poor management, high mortality rate and poor chicks quality is still believed to be responsible for the shortfall in production (Adesimi and Awoyomi, 1989; Aihonsu and Sunmola, 1999; Alimi, 2001 and Geidam *et al.*, 2006). However, the biggest impediment to livestock production in developing countries is high cost of feed ingredient (El-Deek *et al.*, 2009). In Poultry enterprise feed cost represents 65 – 75% of its production cost (Kekeocha, 1984).

Banana peels are outer covers of banana fruit and by-product of household consumption and banana processing factories. The proportion which is wasted as peel is 18 -20% (Dividich *et al.*, 1976). The peel contains 0.9% crude protein, 1.7% crude fat, 59.0% carbohydrate and 31.70% crude fibre, and if properly processed, it could be a high quality and cheap source of carbohydrate and minerals for livestock (Ahwange, 2008). Tartrakoon *et al.* (1999) also reported that the peel has high energy content but low in protein. However, anti-nutritional factors such as hydro-cyanide, oxalate, phytate and saponins have been reported in banana peels by Ahwange (2008) which affect their utilization in poultry. This experiment was carried out to investigate the effect of replacing maize with graded levels of banana peel meal on the growth, haematological and serum biochemical indices of broiler chickens.



MATERIAL AND METHODS

Experimental Stock and Management

One hundred and twenty day old mixed sex Anak 2000 broiler chicks were brooded for seven days. At one week of age, the chicks were randomly assigned to four dietary treatments of 30 birds with 10 birds per replicate in a completely randomized design. Each group was given one of the experimental diets and clean drinking water was given *ad libitum* throughout the 8 weeks experimental period. The birds were vaccinated against the common poultry diseases in the area. Gomboru vaccine at 2 and 5 weeks of age and Newcastle vaccine (Lasota) at 3 weeks of age.

Experimental diet

The banana peels were sourced locally within Maiduguri metropolis. They were cleaned, sun dried, milled and incorporated into the experimental diets. Four experimental diets (starter and finisher mashes) were formulated (Tables 1 and 2) to contain 0% (control), 5%, 10%, and 15% levels of banana peel meal as a replacement for maize in the diets.

Table 1 - Composition of the Experimental Broiler Starter Diets

Ingredient	Levels of inclusion of the banana peel meal			
	T ₁ (control)	T ₂ (5%)	T ₃ (10%)	T ₄ (15%)
Maize	35.36	30.36	25.36	20.36
Banana peel meal	0.00	5.00	10.00	15.00
Wheat Offal	8.84	8.84	8.84	8.84
FullFat Soybean	51.89	51.89	51.89	51.89
Bone Meal	3.0	3.0	3.0	3.0
Limestone	0.10	0.10	0.10	0.10
Salt	0.35	0.35	0.35	0.35
Methionine	0.20	0.20	0.20	0.20
Premix*	0.25	0.25	0.25	0.25
Total	100	100	100	100
Proximate Composition				
Dry Matter (DM)	91.50	90.40	90.20	88.80
Crude Protein (CP)	24.02	23.85	23.69	23.53
Crude Fibre (CF)	3.90	4.40	4.90	5.40
Ether Extract (EE)	11.21	11.74	12.27	12.79
Energy (kcal/kg)	3173	3127	3108	3055
Ash (%)	3.41	4.08	4.74	5.40
Nitrogen free extract (NFE)	48.90	46.33	44.60	41.68

*Bio-mix starter supplied/kg: Vit.A=10000IU, Vit.D3=2000IU, Vit.E=23000mg, Vit.K3=2000mg, Vit.B1=1800mg, Vit.B2=5500mg, Niacin=27,500mg, Panthothenic Acid=7500mg, Vit.B6=3000mg, Vit.B12=15mg, Folic Acid=750mg, Biotin H2=60mg, Choline chloride=300000mg, Cobalt=200mg, Copper=3000mg, iodine=1000mg, Iron=20000mg, Manganese=40000mg, Zinc=30000mg, Selenium=200mg, Anti-oxidant= 1250mg.

Table 2 - Composition of the Experimental Broiler Finisher Diets

Ingredient	Levels of inclusion of the banana peel meal			
	T ₁ (control)	T ₂ (5%)	T ₃ (10%)	T ₄ (15%)
Maize	46.45	41.45	36.45	31.45
Banana peel meal	0.00	5.00	10.00	15.00
Wheat Offal	11.61	11.61	11.61	11.61
Full Fat Soybean	37.44	37.44	37.44	37.44
Bone Meal	3.50	3.50	3.50	3.50
Limestone	0.20	0.20	0.20	0.20
Salt	0.35	0.35	0.35	0.35
Methionine	0.20	0.20	0.20	0.20
Premix*	0.25	0.25	0.25	0.25
Total	100	100	100	100
Proximate Composition				
Dry Matter (DM)	90.40	91.10	90.70	81.60
Crude Protein (CP)	20.07	19.90	19.03	18.00
Crude Fibre (CF)	3.89	4.49	4.88	5.38
Ether Extract (EE)	9.19	9.72	10.25	10.78
Energy (kcal/kg)	3050	3084	3034	3017
Ash (%)	4.19	3.73	5.38	5.06
Nitrogen free extract (NFE)	53.06	53.26	51.16	50.38

*Bio-mix finisher supplied/kg: Vit.A=8500IU, Vit.D3=1500IU, Vit.E=10000mg, Vit.K3=2000mg, Vit.B1=1500mg, Vit.B2=1600mg, Niacin=4000mg, Panthothenic Acid=20000mg, Vit.B6=5000mg, Vit.B12=1500mg, Folic Acid=10mg, Biotin H2=500mg, Choline chloride=175000mg, Cobalt=200mg, Copper=3000mg, iodine=1000mg, Iron= 20000mg, Manganese=40000mg, Zinc=30000mg, Selenium=200mg, Anti-oxidant= 1250mg.



Data Collection

Performance parameters: Individual body weight of the birds was obtained to the nearest 0.1 g on the first day of the study and weekly thereafter. Feed intake was measured on daily basis while feed conversion ratio was calculated as the ratio of the feed intake to the body weight gain.

Blood collection and analysis: At the end of week eight, blood samples were collected from three birds in each group (i.e. 1 bird per replicate) for determination of haematological and serum biochemical indices. The birds were fasted overnight and blood samples were collected early the next morning via the wing-vein by means of sterile disposable (21-gauge) syringe and needle, and then placed into sets of sample bottles. One set contained diapotassium salts of ethylene diamine tetra-acetic acid (EDTA) and the samples were used for haematological study; the other samples in anticoagulant-free bottles were used for the determination of serum biochemical indices. Packed cell volumes (PCV), red blood cell (RBC), white blood cell (WBC) and haemoglobin concentration (Hb) were analyzed according to the methods outlined by Bush (1975). Mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated by the formula of Schalm *et al.* (1985). The serum biochemical indices measured were the level of total protein, albumin, glucose, cholesterol, chlorine, sodium, potassium, creatinine total bilirubin, and urea were analyzed according to the methods outlined by Bush (1975) and WHO (1980). Proximate composition of the experimental diets was carried out according to the methods of AOAC (1980).

Statistical Analysis

All data collected were subjected to analysis of variance using Statistix (2003) and where means differed, they were separated using the least significant difference (LSD).

RESULTS AND DISCUSSION

The crude protein values for the broiler starter and finisher are within the range of 22 – 24% and 19 – 20% reported by Olomu (1995), Kekeocha (1984) and Williamson and Payne (1978), who also stated that maximum weight gain in broiler chickens was not only a function of the birds good management and housing, but also a function of the feed given to the chickens.

The ether extract (EE) values reported in this study were lower than the values of (22.30%) reported by Samy (1999) for plant protein sources. And the ash was within the reported values by NIS (1989). The range of values (4.60 – 5.06%) obtained in this study was adequate to provide the necessary mineral such as calcium and phosphorus needed for development of bones. The energy values were slightly higher than the values of 2800 Kcal/kg and 3000 Kcal/kg recommended by Olomu (1995) for the starter and finisher respectively which may be as a result of banana peel meal carbohydrate content (59.00%) reported by Ahwange (2008).

The productive performances of broiler chickens fed varying levels of banana peel meal are presented in Table 3. The final body weight revealed significant ($P<0.05$) difference among the treatment group in the (control), but the range obtained in this research is lower than the value 2495 g/bird reported by Olomu (1995). The significantly ($P<0.05$) lower body weight obtained in the birds fed 15% banana peel meal, may be related to the poor feed conversion ratio (FCR) of the birds as the banana peel meal inclusion level increased in the diets. This observation concurs with the work of Tewe (1983) who reported that broiler chickens fed banana peel meal beyond 7.5% level showed significant ($P<0.05$) reduction in body weight gain. Same author also reported that broiler chickens fed 30% banana peel meal gained the least weight and have the poorest feed conversion ratio. Similarly, Gohl (1982) reported that level of banana peel meal above 10% is detrimental to growth and feed efficiency of broiler chicken.

Table 3 - Productive performance of broilers fed graded levels of banana peel meal (BPM)

Parameters	Inclusion levels BPM				SEM ±
	T ₁ (control)	T ₂ (5%)	T ₃ (10%)	T ₄ (15%)	
Initial Weight (g/bird)	66.40	66.66	66.55	66.51	11.710
Final Weight (g/bird)	1548.00 ^a	1154.40 ^b	1190.00 ^b	981.70 ^c	33.222*
Daily Feed Intake (g/bird)	82.99	80.90	80.56	80.77	0.667
Daily Weight Gain (g/bird)	41.78 ^a	33.45 ^{ab}	41.60 ^a	25.67 ^c	0.595*
Feed Conversion Ratio	1.99 ^a	2.42 ^b	1.94 ^a	3.15 ^c	0.210*
Mortality (%)	16.67	15.00	13.33	33.33	NA
Feed Cost ₦/kg	87.01	85.30	83.64	81.89	NA
Feed Cost / kg gain	99.36	89.84	85.06	69.36	NA

^{a, b, c} Means within the same row bearing different superscripts differ significantly ($P<0.05$); * = significant ($P<0.05$); NA = Not Statistically Analyzed; SEM = standard error of mean

The feed intake indicated no significant ($P>0.05$) difference among the treatment group. This observation tallies with the report of Tewe (1983) who reported that as the banana peel meal levels increases in the diet of broiler chicken, there was reduction in growth, feed intake and feed efficiency. The result of this study also did not



tally with the values of up to 160 g/bird/day feed intake reported by Olomu (1995). This may be attributed to the anti-nutritional factor (Tannins) in banana peel which may affect its utilization by poultry (Ahwange, 2008) and Kumar (1991). Though the tannins content was not analysed in this study, but it was reported by Bressani et al. (1982) and Jansman (1993) that unconventional plant feed sources contained tannins which is build up for resistance of pest.

The daily weight gain indicated high significant ($P < 0.05$) difference in the control group and 10% replacement of maize with banana peel meal, the finding is similar to the report of Calvent (1978) and Hunter (1981) who observed that high fibre feed in the diets of animal depressed growth. The significant ($P < 0.05$) difference obtained in the daily weight gain among the replacement levels could be attributed to levels of the limiting amino acids in soyabean meal. These levels were adequate to meet the amino acid need of the birds. The methionine level in all the diets probably improved the biological value of the feeds (Abasiokong and Tyokpat, 2000)

The feed conversion ratio showed high significant ($P < 0.05$) difference among the treatment group in the control (0%) and 10% levels of replacement with similar pattern to final body weight and daily weight gain. The result of the feed conversion ratio in this study is contrary to the report of Tewe (1983) who reported that banana peel meal beyond 7.5% indicated poor feed conversion efficiency. Similarly Dividich et al. (1976) reported 31.70% crude fibre content for banana peel, but if processed properly, they could be a high quality and cheap source of carbohydrate and mineral for livestock. The significantly ($P < 0.05$) lower feed conversion ratio indicated in 15% replacement of maize with banana peel meal may be as a result of high crude fibre in the banana peel meal and anti-nutritional factors such as hydrocyanide, phytate and saponin which were not affected by processing as reported by Dividich et al. (1976) and tannin by Ahwange (2008).

The mortality record was high at 15% replacement of maize with banana peel meal compared to the (control) group. Post - mortem result showed no evidence of any disease. The chickens' death may be attributed to anti-nutritional factors in banana peel as reported by Ahwange (2008), and heat prostration as a result of high ambient temperature (40 - 43°C) during the study period. Similarly, Compose et al. (1981) observed that mortality rate was high when temperature was changed from 18.3 to 37.8°C.

The feed cost ₦/kg and feed cost/kg gain was not statistically analyzed but it was observed that there was reduction in the feed cost ₦/kg and feed cost/kg gain, as the level of banana peel meal increased in the diets. This observation agreed with the report of Apata and Ojo (2000) that the high cost of feed was largely due to the exorbitant price and scarcity of conventional ingredient and that this could be lowered by using non-conventional feed ingredients.

The haematological parameters (Table 4) showed significant ($P < 0.05$) difference in all the blood components at different inclusion levels of the banana peel meals except in monocytes, eosinophils and basophils. The PCV values are similar to the range of 30 - 33% reported by Swenson (1970) which indicated that the birds were neither dehydrated nor anaemic. The RBC, WBC, and Hb values obtained in this study were within the range of $2.5 - 3.2 \times 10^6 / \text{mm}^3$, $9 - 31 \times 10^3 / \text{mm}^3$ and 6.5 - 9 g/dl reported by Swenson (1970) and CCAC (1980). The MCV, MCH and MCHC range of values observed were within the values reported by Swenson (1970). The herophils and lymphocytes values were within the normal range of 25 - 30% and 55 - 60% reported by Swenson (1977). It has been observed by Esonu et al. (2001) that hematological constituents reflect the responsiveness of the animal to its internal and external environments which include feed and feeding.

The monocytes, eosinophills and basophills showed no significant ($P > 0.05$) difference among the treatment group, but the range of values observed were similar to the range of values reported by Swenson (1977). This is an indication of adequate production of anti-bodies and no bacterial infection or allergic condition among the bird as observed in this study. The observation concurs with the report of Dukes (1975) and CCAC (1980).

Table 4 - Haematological Parameters of Broiler Chicken fed Graded Levels of Banana peel Meal (BPM)

Parameters	Inclusion levels BPM				SEM
	T ₁ (control)	T ₂ (5%)	T ₃ (10%)	T ₄ (15%)	
Packed cell volume (%)	30.69 ^a	27.67 ^{ab}	24.67 ^b	30.00 ^a	1.472*
Heamoglobin (g/l)	8.10 ^a	7.10 ^a	5.70 ^b	7.60 ^a	0.449*
Red blood cells ($10^6 / \text{mm}^3$)	3.17 ^a	2.75 ^b	2.13	3.06 ^{ab}	0.172*
White blood cells ($10^3 / \text{mm}^3$)	18.50 ^a	17.33 ^{ab}	16.83 ^b	18.00 ^{ab}	0.527*
Mean corpuscular volume (fl)	96.67 ^b	100.83 ^b	115.27 ^a	97.90 ^b	1.820*
Mean corpuscular haemoglobin (pg)	25.70 ^{ab}	25.80 ^{ab}	26.80 ^a	24.77 ^a	0.804*
Mean haemoglobin conc. (g/dl)	26.37 ^a	25.60 ^a	23.27 ^b	25.30 ^a	0.744*
Heterophils (%)	28.33 ^c	25.67 ^d	38.33 ^a	34.00 ^b	0.913*
Lymphocytes (%)	63.00 ^a	66.67 ^a	54.67 ^b	58.00 ^b	1.616*
Monocytes (%)	4.33	3.33	3.00	4.67	1.155 ^{NS}
Eosinophils (%)	4.33	4.33	3.67	3.33	0.745 ^{NS}
Basophils (%)	0.00	0.00	0.33	0.00	0.236 ^{NS}

^{a, b, c} Means within the same row bearing different superscripts differ significantly ($P < 0.05$); * = significant ($P < 0.05$); NA = Not Statistically Analyzed; SEM = standard error of mean



The serum biochemical indices observed in (Table 5) were all within normal ranges reported by Dukes (1975) and Swenson (1970) for broiler chickens. The biochemical indices were not adversely affected by including 15% banana peel meals in broiler diets.

Table 5 - Serum Biochemical Indices of Broiler Chickens fed Graded Levels of Banana Peel Meal (BPM)

Parameters	Inclusion levels BPM				SEM
	T ₁ (control)	T ₂ (5%)	T ₃ (10%)	T ₄ (15%)	
Total protein (g/l)	12.00 ^a	8.00 ^b	9.50 ^{ab}	8.67 ^{ab}	1.548*
Albumin (g/l)	10.33 ^a	7.00 ^b	8.50 ^b	7.67 ^b	1.569*
Glucose (mmol/l)	7.70 ^c	9.00 ^a	9.15 ^a	8.67 ^b	0.149*
Total cholesterol (mmol/l)	1.37	0.90	1.00	1.13	0.217 ^{NS}
Urea (mmol/l)	2.67	2.67	2.95	2.70	0.144 ^{NS}
Total bilirubin (µmol/l)	9.33 ^a	8.67 ^{ab}	8.00 ^{ab}	6.67 ^b	3.324*
Potassium (mmol/l)	2.83 ^b	3.00 ^b	4.25 ^a	3.00 ^b	0.334*
Sodium (mmol/l)	108.67 ^{ab}	110.00 ^{ab}	123.00 ^a	104.00 ^b	6.449*
Chloride (mmol/l)	91.33 ^d	95.33 ^c	103.00 ^a	99.33 ^b	5.033*

^{a, b, c} Means within the same row bearing different superscripts differ significantly (P<0.05); * = significant (P<0.05); NA = Not Statistically Analyzed; SEM = standard error of mean

CONCLUSION

It was concluded that maize can be replaced by up to 10% banana peel meal without any adverse effects on the growth and health of broiler chickens.

REFERENCES

- Abasiekong SF and Tyokpat Y (2000). Effect of supplementary methionine and lysine on broiler chickens fed refermented brewers spent sorghum (*Sorghum Vulgare L.*) as chief dietary protein source. In Ukachuku, S. N., Ibeauchi, J. A., Ibe, S. N., Ezekwe, A. G. and Abasiekong, S. F. (eds), *Animal Production in the New Millenium: Challenges and options. Proceeding of the 25th Annual Conference of Nigeria Society of Animal Production*, Micheal Okpara University of Agriculture, Umudike, Nigeria. 19 – 23 March, 2000. Pp 184 – 187.
- Adesimi AA and Awoyomi B (1989). Potentials of poultry insurance as a risk management technique for Nigerian Farmers. *IFE Journal of Agriculture* 11: 76 – 84.
- Aihonsu JOY and Sunmola MA (1999). Optimal laying period for profitability and sustainable egg production. *IFE Journal of Agriculture*. 20: 67 – 80.
- Alimi T (2001). Economic Rational of Integration in Poultry Production System. *Lesotho Society of Science*, 7: 138 – 156.
- Ahwange BA (2008). Chemical Composition of *Musa Sapientum* (Banana) peels. *Journal of Food Technology*. 6(6): 263 – 266.
- AOAC (1980). *Official method of analysis*. 13th Edition. Herwitz, W. Washinton D. C. Association of Official Analytical Chemists. 1018p.
- Apata DF and Ojo U (2000). Efficiency of the *Trichoderma viride* enzymes complex in broiler starter fed cowpea testa based diet. In: Ukachukwu, S. N., Ibeauchi, J. A., Ibe, S. N., Ezekwe, A. G. and Abasiekong, S. F. (eds), *Animal Production in the New Millenium: Challenges and options. Proceeding of the 25th Annual NSAP conference*. Pp 132 – 134.
- Bressani R, Elias LG and Braham JE (1982). Reduction of digestibility of legume proteins by tannins. *Journal of Plant Foods*. 4:43 – 55.
- Bush BM (1975). *Veterinary laboratory manual*. William Heineman Medical Book Ltd. London, U. K. 447p.
- Calvent CC (1978). Decrease absorption of Ca, Mg, Zn, and Pb by Human due as wheat bran. *Journal of Nutrition* 3(2):106 – 493.
- Compose AC, Wilcox FH and Shaffner CS (1981). The influence of fast and low raises ambient temperature. *Poultry Science Journal*. 39 : 119 – 129.
- CCAC (1980). *Guide to the care and use of experimental animal vol. 1*. Ottawa, Ontario, Canada, Canadian Council on Animals care. Pp. 85 – 90.
- Dividich JL, Geoffrey F, Canope L and Chnost M (1976). Using waste banana as animal feed. *World Animal Review*. 67:123 – 132.
- Dukes HH (1975). *Physiology of domestic animal*, 18th Edn. 2nd Printing. (Melvin J Swenson Edition) Cornell University press limited. U.K.
- El-Deek AA, Asar MA, Hamdey SM and Abdalla AA (2009). Utilization of guava by-products in broiler finisher diets. *Egypt. Poultry Science Journal*, 29: 53-79



- Esonu BO, Emenalom OO, Udebibie ABI, Herbert U, Ekpo CF, Okoli IC and Iheukwumere FC (2001). Performance and blood chemistry of weaner pig fed raw mucuna (velvet bean) meal. *Tropical Journal of Animal Production and Investigation* 4:49-55.
- FAO (2010). Paper 1: Livestock Research in Nigeria . www.fao.org
- Geidam YA, Bukar MM and Ambaly AO (2006). Chick quality control: A key to sustainable poultry production in Nigeria. *Nigerian Veterinary Journal* 27:1-6.
- Gohl B (1982). *Musa Paraclisiaca L.* Banana plantain or cooking banana. *Tropical feeds. Feed information summaries and nutritive values.* FAO, Rome.
- Hunter JE (1981). Iron availability and absorption in rats fed sodium phytate. *Journal of Nutrition.* 3:841-850.
- Jansman AJM (1993). Tannins in feed stuff for simple-stomached animals. *Nutritional Research Review.* 6:209 – 236.
- Kekeocha CC (1984). *Pfizer poultry production handouts.* Pfizer Corporation, Nairobi, Kenya. 165 – 166.
- Kumar R (1991). Anti-nutritional factors, the potential risk of toxicity and method to alleviate them. *Proceeding of FAO expert consultation held at the Malaysian Agricultural Research development Institution.* Kuala Lumpur. Malaysia. Pp 14-18.
- NIS (1989). *Standard on specification for poultry diets.* Standard organization of Nigeria. Nigeria Industrial Standard. Federal Secretariat, Ikoyi, Lagos. Pp 10-12.
- Olomu JM (1995). *Monogastric Animal Nutrition Principles and Practice.* A Jackem Publication, Benin City, Nigeria. Pp 19-118.
- Payne WHJ (1990). *An introduction to animal husbandry in the tropics.* Longman Group limited U. K. pp 87-137.
- Samy JC (1999). Proximate Analysis. In Christie, B. R. (ed). *The Handbook of plant science in Agriculture.* CRC Press, Inc, Boca Raton, Florida.
- Schalm OW, Jain NC and Carroll EJ (1985). *Veterinary Haematology* (3rd Eds). Philadelphia, U.S.A. pp 807.
- Statistix (2003). Statistix 8: user's manual Analytical software.
- Swenson MJ, (1970). Physiological properties, cellular and chemical constituents of blood. In: *Duke's physiology of Domestic Animals.* 8th Edn. (M. J. Swenson Edition). Con-stock publishing associates. Cornell University press. Thaca and London.
- Swenson MJ (1977). *Duke's Physiology of Domestic Animals.* 9th edition. Constock publishing associates a division of Cornell University press. Thaca and London. Pp 14-34.
- Tartrakoon T, Chalearmsan N, Vearasil PT and Menlen UT (1999). The nutritive value of banana peel (*Musa sapientum*) in growing pigs. Deutcher Tropentag, Berlin.
- Tewe OO (1983). Replacing maize with plantain peels in the diet of broiler. *Nutrition Reports International* 28(1):23-29.
- Williamson G and Payne WJA. (1978). *An introduction to animal husbandry in the tropics.* 2nd ed. Longman Group Ltd. U. K., 87 – 137.
- World Health Organization (WHO). (1980). *Manual of Basic techniques for health laboratory.* WHO, Geneva, Switzerland. Pp 175-434.

INFLUENCE OF PRE-TREATMENT METHODS AND LEVELS OF INCLUSION OF CASSAVA PEEL /BLOOD MEAL MIXTURES ON NUTRIENT UTILIZATION AND RELATIVE ORGAN WEIGHTS OF RABBIT DOES

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ABSTRACT: A 12 weeks feeding trial was conducted to investigate the effects of pre-treatment methods and levels of inclusion of cassava peel/blood meal mixtures (3:2) on nutrient digestibility and relative organ weights of rabbits does. Ten diets were formulated with diet 1 serving as the control without cassava peel/blood meal mixture. Diets 2, 5 and 8 had 10% cassava peel+blood meal mixture, Diets 3, 6 and 9 had 20% cassava peel+blood meal mixture while Diets 4, 7 and 10 had 30% cassava peel+blood meal mixture. For diets 2, 3 and 4 cassava peels were ash-treated (ATD/BM), for diets 5, 6 and 7 the cassava peels were parboiled (PAB/BM) and for diets 8, 9 and 10 the cassava peels were sun dried (SUD/BM). The rabbits were divided into 10 treatment groups of six rabbits each and assigned randomly to the ten diets. Each rabbit served as a replicate in a randomized complete block design experiment in a factorial arrangement. The digestibility of nutrients was affected ($P < 0.05$) by pre-treatments methods as well as levels of inclusion levels. Although the digestibility of the various nutrients differs ($P < 0.05$) and did not follow a specific pattern, both the pre-treatment methods as well the levels of inclusion did not affect ($P > 0.05$) the final live weight of the rabbits. Pre-treatment methods as well as the level of inclusion affected ($P < 0.05$) the relative organ weights of the spleen and kidney. From the results these non-conventional feed ingredients can be included in growing rabbit diet up to 30% level since performance especially final live weights were not affected.

Keywords: Pre-treatment, Cassava Peels, Rabbit, Digestibility, Organ Weights

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INTRODUCTION

Livestock plays an integral role in the livelihood of poor farmers by providing economic, social food security (FAO, 2011) It is one of the fastest growing agricultural subsectors in the developing countries, but there is considerable shortage of feed availability in most of these developing countries (Wadhwa and Bakshi, 2013). In an attempt to solve the challenging animal protein inadequacy in Nigeria, series of livestock development drive have been embarked on by the government. Two major identified areas of focus are the production of animals that are fast growing and reduction of the production cost to make the meat and other animal products available and affordable. The potentials of rabbit in combating the animal protein inadequacy had earlier been highlighted by Ojebiyi et al., 2006. Daudu et al. (2009) reported that non-conventional feedstuff (NCF) offer the best alternative for the reduction of feed cost which will ultimately lead to reduction in the price of meat and other animal products. However for these NCFs to play these roles they must be available all year round and easy to procure and processed if need be. Cassava peel is among other by-products that are readily available in Nigeria and have no direct dietary value in human diets. This is because during cassava processing into human food, the peels which accounts for between 10-13 % of the tuber weight is often left to rot away at various processing sites. The peel is characterized by high fibre, low protein and high hydrogen cyanide content (an anti-nutritional factor) and requires some form of processing to appreciably reduce the cyanide content to acceptable or tolerant level thus improving the utilization. Tewe (1991), suggested that the processing techniques to be used for reduction of cyanide must consider the labour costs and the effect of the processing on the nutrient profile. Blood meal is one of the waste products from abattoir in Nigeria. Although it is rich in crude protein and most amino acids particularly lysine, it is low in isoleucine and poor in calcium and phosphorus (Rahjhan, 2001) and when processed could be appreciably incorporated to animal feed. According to Daudu et al. (2009), the best way in assessing the suitability of a feed ingredient for rabbit nutrition is to include graded levels in the diet and ensuring that all nutrients required by the animal are supplied while performance is measured to know the optimum inclusion level.

The present study is aimed at evaluating the effect of different pre-treatment methods and levels of inclusion of peel/blood meal mixtures on nutrient digestibility and relative organ weights of rabbit does.

MATERIAL AND METHODS

The experiment was carried out at the Rabbitary Unit of the Teaching and Research Farm, Ladoko Akintola University of Technology, Ogbomoso Oyo State Nigeria. Ogbomoso is in the derived savannah zone of Nigeria.

Test Ingredients:

The cassava peels used in this study were processed in three ways: these are ash treatment, parboiling and sun drying. The collection and processing is as described by Ojebiyi et al. (2008).

Formulation of Experimental diets:

Cassava peel-blood meal mixtures was prepared by combining each of the ash treated, parboiled and sundried cassava peels and blood meal in ratio 3:2. Ten diets were formulated, diet one which served as the control contained no cassava peel+blood meal mixture; diets 2, 3 and 4 contained either 10, 20 or 30% ash treated cassava peel+blood meal; diets 5, 6, and 7 contained either 10, 20 or 30% parboiled cassava peel+blood meal mixture while diets 8, 9 and 10 contained either 10, 20 or 30% sun dried cassava peel+blood meal mixture. The composition of the diet is shown in Table 1.

Table 1 - Percentage composition of experimental diets

Ingredients	Percentage Composition									
	Control	AA			PP			SS		
		10	20	30	10	20	30	10	20	30
Maize	12.25	12.25	12.25	12.25	12.25	12.25	12.25	12.25	12.25	12.25
Corn meal	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
GNC	14.50	8.00	3.00	0.00	8.00	3.00	0.00	8.00	3.00	0.00
PKC	27.0	23.50	18.50	11.50	23.50	18.50	11.50	23.50	18.50	11.50
Fish meal	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Cassava peel / Blood Meal	0.00	10.00	20.00	30.00	10.00	20.00	30.00	10.00	20.00	30.00
Molasses	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Premix ¹	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Total	100	100	100	100	100	100	100	100	100	100
Energy (kcal/kg)	2454.02	2342.25	2437.46	2441.97	2342.25	2437.46	2441.17	2442.25	2437.25	2441.97

¹Premix composition; content per 1kg diet: Vitamin A 3,200,000iu; Vitamin D₃ 1,200iu; Vitamin E 3,200iu; Vitamin K₃ 800mg; Vitamin B₁ 400mg; Vitamin B₂ 2000mg; Vitamin B₁₂ 2000mg; Niacin 400mg; Selenite (Se) 40mg; manganese (Mn) 3200mg; Pantothenic acid 2000mg; Folic acid 200mg; Chlorine (Cl) 60,000mg; Iron (Fe) 8,000mg; Copper (Cu) 3,200mg; Zinc (zn) 2,000mg; Cobalt (Co) 90mg; Iodine (I).

Experimental Animals and Management:

A total of 60-cross bred (New Zealand white × Chinchilla) female weaned rabbits of 5-7 weeks of age with mean weight of between 609.90 - 612.710 g were used for the study. They were divided into 10 treatment groups of 6 rabbits with each rabbit serving as a replicate in a completely randomized block design experiment in a factorial arrangement. The rabbits were housed individually in wood-wire cages with dimensions of 44×34×44cm. The drinking and feeding troughs were earthen pot re-enforced with cement to prevent tipping off. A total of 100g feed divided into two rations of 50g in the morning (8:00hr) and 50g in the evening (16:00hr) were supplied to each rabbit per day. The cages were designed in such a way that allows easy collection of faeces, urine and left over feeds to avoid buildup of odour and pathogens. At the commencement of the experiment the rabbits were weight-balanced such that the difference in weight between treatments was less than ± 3.00g.

Data collection

Feed Intake: Weighed quantity of feed was given to each animal and the left over was collected daily and weighed to evaluate the feed intake of each animal.

Digestibility trial: During the 12th week, daily faecal output was collected from each animal for 5 days, sun-dried, weighed and stored in plastic bags. The sample was bulked together ground and sub sample taken for proximate analysis.

Carcass and organ weights: At the end of the experiment the rabbits were tagged and starved for 12 hours before being slaughtered. After bleeding the rabbits were eviscerated to remove the internal organs for measurement. The dressed carcasses as well as the organ weights were expressed as a percentage of body weight.

Laboratory Analysis

The experimental diets, tests ingredients as well as the faecal samples were analyzed for proximate composition by the methods of AOAC (2005).

Statistical Analysis

The data collected were subjected to Analysis of variance using General Linear Model procedure (GLM) of SAS (2000) and means were compared using Duncan multiple Range Test option of the same statistical package.

RESULTS AND DISCUSSION

The proximate composition of the experimental diets revealed that the protein content ranged between 16.74-18.16% while the calculated metabolizable energy ranged between 2342.25-2454.02 kcal/kg (Table 2). The crude protein values are similar to that of Okeke et al. (2009) but lower than that of Alu et al. (2009). However the values fall within the range recommended by Lebas (1979) and NRC (1984) for growing rabbits. Nutrient digestibility as influenced by the pre-treatments methods is presented in Table 3. This shows that the pre-treatment methods did not have any significant ($P>0.05$) effect on dry matter digestibility, crude fat digestibility, and ash digestibility. However crude protein, crude fibre and Nitrogen free extract digestibilities were significantly ($P<0.05$) affected by dietary treatments.

Table 2 - Proximate composition of the Experimental diets

Nutrient	CC	AA			PP			SS		
		10	20	30	10	20	30	10	20	30
DM (%)	89.09	89.58	89.01	89.04	89.45	89.11	89.24	89.44	89.28	89.39
CP (%)	18.27	16.74	16.92	18.16	17.95	17.87	18.03	17.12	17.68	17.48
CFAT (%)	4.13	3.69	3.73	3.78	3.89	4.04	3.95	3.86	3.93	4.07
ASH (%)	7.32	6.82	6.94	7.13	7.18	7.24	7.08	6.97	6.94	6.86
CF (%)	8.87	7.87	8.14	8.04	8.09	7.98	8.54	8.94	8.69	8.75
NFE (%)	68.73	71.7	71.21	70.02	70.07	70.11	69.48	70.08	69.7	69.7
ENERGY (kcal/kg)	2454.02	2342.25	2437.46	2441.97	2342.25	2437.46	2441.17	2442.25	2437.25	2441.97

CC = Control diet (0% cassava peel/ blood meal), AA = Ash treated cassava peel meal, PP = Parboiled cassava peel meal, SS = Sundried cassava peel meal, DM = Percentage dry matter, CP = Percentage crude protein, CFAT = Percentage crude fat, CF = Percentage crude fibre, NFE = Percentage nitrogen free extract, G.E (kcal/g) = Gross energy kilocalorie per gram.

Table 3 - Main effect of pre-treatment method on performance of rabbit does fed diet containing treated cassava peel/blood meal mixtures

Parameters	Treatments				SEM
	Control	ATD/BM	PAB/BM	SUD/BM	
Initial weight	609.90	610.00	610.70	612.70	139.00
Final weight	1363.39	1277.5	1314.4	1323.3	269.00
Digestibility					
Dry Matter Digestibility (%)	61.17	63.4	54.75	57.47	15.05
Crude Protein Digestibility (%)	57.23 ^{ab}	61.96 ^a	52.39 ^b	52.16 ^b	16.12
Crude Fibre Digestibility (%)	32.97 ^b	38.91 ^a	41.91 ^a	41.65 ^a	6.05
Crude Fat Digestibility (%)	84.83	85.42	83.18	83.91	15.88
Crude Ash Digestibility (%)	72.83	70.54	64.41	63.38	12.39
Nitrogen Free Extract Digestibility (%)	83.83 ^a	77.88 ^b	72.77 ^b	75.15 ^b	10.49

^{ab} Means along the same row with different superscripts are significantly different ($P<0.05$). ATD/BM = Ash treated cassava peel+blood meal mixtures, PAB/BM=parboiled cassava peel+blood meal mixtures, SUD/BM=sun dried cassava peel+blood meal mixtures, SEM=standard error of mean.

The values obtained in crude protein digestibility of the rabbits that were fed cassava peel blood meal mixtures were comparable with the control irrespective of the processing method employed for cassava peel. A slight higher but insignificant value was observed for ash treated cassava peel when compared with the control. This may be due to the partial digestion of cellulose and enzyme secreted by microbes during the 24 hours soaking in ash thus making it easy for digestion by the rabbits. This observation is similar to the report of Adejinmi et al. (2007). Digestibility of crude fibre was higher ($P<0.05$) in the rabbits that received treated cassava peel compared with control. However, digestibility of Nitrogen free extract was significantly ($P<0.05$) lower in the rabbits that were fed treated cassava peel. This may be attributed to the fact that various processing applied enhanced the nutrient utilization.

The main effect of levels of inclusion of cassava peel/blood meal mixtures is presented in Table 4. The final live weights, and digestibility of dry matter, crude protein, crude fibre and ash were not significantly ($P>0.05$) affected by levels of inclusion of cassava peel+blood meal mixture in the diets. However digestibility coefficients of crude fat and nitrogen free extract were affected ($P<0.05$). The 30% inclusion levels had significantly ($P<0.05$) depressing effect on fat digestibility. Although the values obtained for crude fibre digestibility were not significantly ($P<0.05$) affected across the treatments the trend shows that it decrease linearly as the level of inclusion increases. This may mean that as the level of inclusion of cassava peel/blood meal increased there is the possibility of

increase fibre and cyanide which is an anti-nutritional factor. According to Merck (1988), most toxicant including methylxanthine interfere with enzyme system by denaturing enzyme protein and binding to the enzyme molecule thus inhibiting the digestive potential of animals. Cheeke (1987), had earlier reported that fibre is poorly digested in rabbit as this is rapidly propelled through the colon and excreted as hard faeces. This observation is confirmed in this study because across the treatments crude fibre digestibility is comparatively lower than other nutrients. However, the performance in terms of final Live weight were not significantly ($P>0.05$) affected in spite of the variations in the digestibility coefficients.

The main effects of pre-treatment methods on organ characteristics of rabbit does is presented in Table 5. Final live weight, eviscerated weight, dressing percentage, heart weight, lung weight, spleen weight, kidney weight and liver weight of the rabbits in this experiment were not affected ($P>0.05$) by the pre-treatment method of cassava peel/blood meal.

Table 4 - Main effect of level of inclusion of treated cassava peel/blood meal mixtures on performance of rabbit does

Parameters	Inclusion levels (%)				SEM
	0	10	20	30	
Initial weight	609.90	612.30	613.60	611.10	139.00
Final weight	1363.39	1334.06	1312.31	1312.50	269.00
Digestibility					
Dry Matter Digestibility (%)	61.17	65.04	64.24	64.16	15.05
Crude Protein Digestibility (%)	67.23	61.99	61.59	61.20	16.12
Crude Fibre Digestibility (%)	32.97	32.92	29.02	28.39	6.05
Crude Fat Digestibility (%)	84.83 ^a	86.62 ^a	86.09 ^a	79.12 ^b	15.88
Crude Ash Digestibility (%)	72.83	75.59	71.12	71.57	12.39
Nitrogen Free Extract Digestibility (%)	83.83 ^a	63.41 ^b	76.81 ^a	77.01 ^a	10.49

^{ab} Means along the same row with different superscripts are significantly different ($P<0.05$); SEM= Standard error of Mean.

Table 5 - effect of pre-treatment method on organ characteristics of rabbit does fed diet containing cassava peel/blood meal mixture

Parameter	CC	Treatment		
		AA	PP	SS
Final live weight (g)	1363.30	1298.88	1326.63	1333.00
Eviscerated weight (g)	678.18	695.95	664.19	649.23
Dressing Percentage (%)	49.7	53.48	50.00	48.65
Heart weight (g)	2.93	3.14	2.98	3.16
Lung weight (g)	6.20	5.97	6.76	6.44
Spleen weight (g)	0.95	0.72	0.84	0.73
Kidney weight (g)	7.40	7.91	8.31	8.36
Liver weight (g)	37.95	33.24	36.98	36.38

CC = Control diet (0% cassava peel/ blood meal), AA = Ash treated cassava peel meal, PP = Parboiled cassava peel meal, SS = Sundried cassava peel meal.

This may be indication of the effectiveness of the methods used in treating cassava peels in this study. The main effects of levels of inclusion are presented in Table 6. The inclusion levels of cassava peel+blood meal mixture did not affect ($P>0.05$) the final body, eviscerated weights, the dressing percentage, the relative heart, lungs, and liver weights. The relative spleen weights of rabbits in treatments 1(0%), and 2(10%) are similar ($P>0.05$) but lower ($P<0.05$) than weights of those rabbits placed on 20% and 30% levels. The weights increased linearly with increased level of cassava peel+blood meal mixture in the diet.

Table 6 - the main effect of level of inclusion of cassava peel/blood meal mixture on organ characteristics of rabbit does.

Parameter	CC (0%)	Level 10%	of Inclusion 20%	30%
Final Life Weight (g)	1363.30	1324.3	1294.3	1295.6
Eviscerated Weight (g)	678.18	693.01	654.88	653.08
Dressing Percentage (%)	49.7	52.40	50.20	50.53
Heart weight (g)	2.93	3.10	2.98	3.35
Lung Weight (g)	6.20	6.33	6.24	6.79
Spleen Weight (g)	0.66 ^b	0.68 ^b	0.78 ^a	0.95 ^a
Kidney Weight (g)	7.40 ^b	7.67 ^b	7.87 ^b	9.40 ^a
Liver Weight (g)	37.95	33.68	33.63	36.87

^{ab}Means along the same row with different superscripts are significantly different ($P<0.05$). CC=control

The relative spleen weights obtained in this study however falls within the value reported by Dairo et al. (2002) but lower than the value reported by Omole and Sonaiya (1981). This may be due to difference in the content of the feeds and management practices. The spleen is one of the reticulo-endothelial organs which function to destroy worn out red corpuscles releasing the iron from the haemoglobin for re-use by the body and also forming pigments which are then collected by the liver. According to Frandson (1981), many lymphocytes and monocytes are formed in the spleen, and it is probably associated with anti-body production. The results also shows that rabbit on the 30% inclusion had

the highest value (9.40g) for relative kidney weights when compared with the control (7.40), 10% (7.67g), and 20% (7.87g). These values are lower than the values reported by Ijaiya (2002). This may be due to difference in feed composition (Agunbiade et al., 1999). Kidney enlargement has been attributed to high deposition of uric acid related compounds (Opstevdt, 1988; Idowu and Eruvbetine, 2005). The swelling and enlargement of these vital organs may be due to toxic degenerative factors (Synder, 1990; Mitchell and Cotran, 2003). The incriminating factor in this study could be the residual HCN in the diet.

CONCLUSION

The study seems to suggest that rabbit does can tolerate up to 30% cassava peel+blood meal mixture without any adverse effect on body weight. When viewed in terms of nutrient utilization it can also be concluded the ash treatment of cassava peel is more effective than parboiling and sun drying before preparing the cassava peel+blood meal mixture. The test ingredients are easy to acquire and are of low value in human nutrition, consequently their inclusion in rabbit diets will lead to increase rabbit production, higher inclusion level as well as fortification with growth promoters will be focus of further studies.

REFERENCES

- Adejinmi OO, Babatunde BB, Olupora JA, Oyadeyi OS, Alphonso O, Adeniyi B (2003). Proc. 28th Ann. Conf. Nig. Soc. Ani. Prod. (NSAP), 16-20th March, Institute of Agric. Res. and Training, Moor Plantation, Ibadan, Nigeria. 385-388.
- Agunbiade JA, Adeyemi OA, Fasina OE, Ashorobi BO, Adebajo MO, Waide OA (1999). Cassava peels and leaves in the diet of Rabbits. Effect on performance characteristics. Nig. J. Ani. Prod. 26: 29-34
- Alu SE, Ruma RS, Umbugadu AAU, Makinde OJ (2009). The effect of different dietary fibres on the growth performance and carcass characteristics of growing rabbits. Proc. 14th Ann. Conf. Ani. Sci. Ass. Nig. (ASAN). September 14th -17th, LAUTECH, Ogbomoso. Nigeria, 390-392.
- AOAC (2005). Association of official Analytical Chemists. Official Method of Analysis 16th Edition. Washing D.C pg 69:88.
- Cheeke PR (1987). Rabbit feeding and Nutrition. Academic Pres, New York London – Sydney – Tokyo page 96–105.
- Dairo FAS, Aina O, Asafa AR (2002). The performance of growing rabbits fed ration containing Rumen content. Proc. 7th Ann. Conf. Ani. Sci. Ass. Nig., September 16-19, University of Agriculture, Abeokuta, Nig. 131-133.
- Daudu OM, Orunmuyi M, Joktham GE (2009). Use of non-conventional feeds: potentials and constraints for rabbit production in Nigeria. Proc. 34th Ann. Conf. Nig. Soc. Ani. Prod. (NSAP). March 15th -18th, University of Uyo, Uyo, Nig. 198-201.
- FAO (2011). World Livestock 2011- Livestock in food security Rome, FAO, Italy.
- Frandsen RW (1981). Anatomy and Physiology of Farm Animals, 2nd ed. Lea Febiger Publishers Philadelphia.
- Iduwo OMO, Eruvbetine D (2005). Performance, digestibility and carcass yield of broiler chickens fed diets containing two types of fish meal. Nig. J. Anim. Prod. 32(2): 204-214.
- Ijaiya A.T., Fasanya OA, Ayanwole BA (2002). Performance of breeding rabbit does fed maize and fermented cassava peel meal. Proc. 27th Ann. Conf. Nig. Soc. Ani. Prod. (NSAP), March 17-21, Federal University of Technology, Akure, Nig. 161-163.
- Lebas F (1979). Nutrition et alimentation du lapin. 2nd part. Alimentation – Les besoins. Cuniculture, 6:207-208
- Merck Veterinary Manual (1988). Merck and co Inc. Rahway, New Jersey U.S.A. page 2018 – 2019.
- Mitchell RN, Cotran RS (2003). Cell injury adaptation and death. In: Kumar, V., Cotran, R. S. and Robbins S.L. Ed. Robbins Basic Pathology 7th ed., Saunders, Philadelphia page 3 -31.
- Nutrition Research Council (1984). Nutrient requirements of Domestic Animals. Nutrient requirement of rabbits 2nd revised (eds). National Academy of Science, Washington D. C.
- Ojebiyi OO, Farinu GO, Babatunde GM, Aderinola OA (2008). Evaluation of the nutritive potential of cassava (*Manihot esculenta* Crantz) peels-blood meal mixture on the performance characteristics of female growing rabbits in the derived Savannah zone of Nigeria. Proc. 9th World Rabbit Congress, June 10-13 Verona Italy.
- Ojebiyi OO, Farinu GO, Babatunde GM, Morohunfolu OO (2006). Effect of varying levels of sun dried cassava peel-blood meal mixtures (3:2) on growth performance and organ characteristics of weaner rabbits. J. Ani. Vet. Adv. 5 (11): 886-890.
- Okeke EN, Usman JM, Osalusi CS, Akinola O, Abiola JK, Nwachi AC (2009). Performance characteristics and haematological profiles of adult rabbits fed Moringa oleifera leaf meal supplements. Proc. 14th Ann. Conf. Ani. Sci. Ass. Nig. (ASAN). September 14th -17th LAUTECH, Ogbomoso. Nig. 400-403.
- Omole TA, Sonaiya EB (1981). The effect of protein source and methionine supplementation of cassava peel meal utilization by growing rabbits. Nutr. Rep. Inter. 23 (4): 729-737.
- Opstevdt J (1998). Influence of drying and smoking on protein quality. In: Fish smoking and Drying. Burt, J.R. (ED.). Elsevier Applied Sci., Ltd. USA Pp. 23-36.

- Ranjhan SK (2001). *Animal Nutrition in the Tropics*. 5th edition. Vikas Publishing House PVT LTD, 576, Masjid Road Jangpura, New Delhi.
- SAS (2000). *Statistical Analysis for Science user's Guide*, SAS institute. Inc. Cary. No USA.
- Synder JW (1990). Mechanisms of toxic cell injury. *Clinical laboratory Medicine* 10: 311–318.
- Tewe OO (1991). Detoxification of cassava products and effects of residual toxins on consuming animals. In: proceedings of FAO expert consultation held in CIAT, Cali Columbia, D. Machin and S. Nyvold Eds. 21-25 January pp. 16.
- Wadha M, Bakshi MPS (2013). Utilization of fruit and vegetable wastes as livestock feed and as substrates for generation of other value-added products. APHCA/FAO Publication 2013/04, Rome, Italy.

PREVALENCE OF *Salmonella* SPECIES IN STRAY CATS IN MOSUL CITY, IRAQ

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ABSTRACT: Stray carnivores are often exposed to intestinal infection with *Salmonella* species and might remain carriers for long period, so they have great possibilities for shedding these organisms; particularly the stray cats in cities are more than others because of their size and habits; thus they might contribute actively in contamination of environment. The aim of this study was to detect *Salmonella* species in stray cats and to access their role in spreading of salmonella infection. Rectal swabs from 59 apparently healthy cats were cultured, tetrathionate broth and *Salmonella-Shigella* agar were used. Euthanization and post mortem examinations were done later. Bacterial isolation from internal organs was carried out also. Morphological properties and biochemical tests were dependent for detection of *Salmonella* organisms. They were serotyped in Central Health Laboratory in Baghdad. A high isolation rate of *Salmonellae* (10.16%) was recorded (by rectal swabs). Various *Salmonella* serovars were observed: *S. anatum* (3.38%), *S. montevideo* (3.38%), *S. typhimurim* (1.69%) and *S. brennderup* (1.69%). The isolation rate from internal organs was lower (0.67%) than that from rectum, *S. typhimurim* (1.69%) and *S. montevideo* (1.69%) were isolated from small intestine and mesenteric lymph nodes respectively. Stray cats have great chances to get intestinal infection in comparison with the house cats due to their living style. In conclusion asymptomatic (carriers) stray cats were considered a dangerous source of infection with *Salmonellae*, besides their significant role in contamination of environment; they will threat public and animal health particularly in cities.

Keywords: Salmonella, Cats, Enteric Infection in Mosul.

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INTRODUCTION

Salmonellosis is a world wide spread infection, it causes considerable economic losses and it is of public health significance (Hoelzer et al., 2011). *Salmonella* species mostly inhabits the intestinal tract of vertebrate and invertebrate, consequently they are excreted in feces and resulting in contamination of food, water and environment (Hale et al., 2012). Despite the disappearance of clinical signs the infected cats remain carriers for long period; particularly those recovered from acute infection continue to shed salmonellae in their feces for 12 week (Wall et al., 1995). Moreover excretion of the organisms may be increased with stress factors and prolong uses of antibiotics (Shane et al., 2003 and Mather et al., 2013). Cats can carry *Salmonella* organisms asymptotically and the clinical form is uncommon (Gallaway, 2008). Stray cats feed on diet of animal sources: rodents, wild birds, carcasses and west products of slaughters which will in turn increase the infection rate in cats and other species of animals. Salmonellosis had been extensively investigated in the different parts of the world: Infection rate of salmonellosis in apparently healthy cats (160) in Iran was 9.4% and in pet cats 18.4% (Shimi and Barin, 1977), in Sudan 10.5% (Khan, 1970), in the same instance very few studies on stray carnivores were performed in Iraq: high rate of *Salmonella* infection was reported in stray dogs in Mosul governorate- Iraq (Zenad and Ali, 2003), also it was reported a higher infection rate in diseased than healthy cats (Shimi and Barin, 1977). This was a preliminary study on cats in Mosul city. The aim of the present work is to find the prevalence of *Salmonella* species in stray cats and to access their role in spreading of disease in Mosul city.

MATERIAL AND METHODS

Fifty nine stray cats had been captured by using suitable cages, they were apparently healthy. Rectal swabs were taken for culturing, all these cats were humanly euthanized and post mortem examination was carried out.



Specimens (one gram) from internal organs: mesenteric lymph node, spleen, liver, brain and one milliliter of small intestinal content were collected; tissue organs were aseptically cut into small pieces. All tissue specimens and rectal swabs were inoculated into 10 ml buffer pepton water and incubated at 37 °c for 24 hours, one ml of the later transferred into 10 ml of enrichment tetrathionate broth and incubated at 42 °c for 48 hours, one loop full from the later broth was streaked on selective *Salmonella-Shigella* agar and incubated at 37 °c for 24 hours. The characteristic appearance of *Salmonella* colonies was dependent for identification and selection of them for further biochemical tests: triple sugar iron, Simmon's citrate and urea agar test. Accordingly those give positive reaction in triple sugar iron test and Simmon's citrate as well as negative reaction to urease, were selected for serotyping in Central Health Laboratory in Baghdad-Iraq (OIE, 2003). This work was done by approval of veterinary medicine college council and directorate of veterinary hospital in Mosul city.

RESULTS

Eight out of 59 apparently healthy cats were positive for *Salmonella* species isolation, the total isolation rate was 13.5% (Figure 1). Four different serovars (by rectal swabs) were isolated (10.16%) from six cats; they were: *Salmonella anatum* (3.38%), *Salmonella montevideo* (3.38%), *Salmonella typhimuruim* (1.69%) and *Salmonella brenderup* (1.69%; Table 1). Two other serotypes were isolated from internal organs of two cats (negative to rectal swab isolation): *Salmonella typhimuruim* (1.69%) from small intestinal content and *Salmonella montevideo* (1.69%) from mesenteric lymph nodes. The isolation rate from internal organs of necropsized cats was lesser than that from rectal swabs. The most frequent serotype was *Salmonella montevideo* (37.5%), *Salmonella anatum* and *Salmonella typhimuruim* (25% for each) and *Salmonella brenderup* (12.5%; Figure 1). Insignificant variation among both sexes was observed.

Table 1 - *Salmonella* serovars isolated from different samples.

Samples	No. of samples	No. of (+ve)*samples for <i>Salmonella</i> sp.	(%) of different salmonella serovars
Fecal swabs	59	2	<i>S. anatum</i> (3.38)
		2	<i>S. montevideo</i> (3.38)
		1	<i>S. typhimurium</i> (1.69)
		1	<i>Salmonella brenderup</i> (1.69)
Total	59	6	10.16
Internal organs			
Mesenteric L.N	59	1	<i>S. montevideo</i> (1.69)
Spleen	59	0	-
Liver	59	0	-
Brain	59	0	-
Small intestinal contents	59	1	<i>S. typhimurium</i> (1.69)
Total	295	2	0.67

(+ve)*= positive samples of feces and tissues of organs examined for salmonella species

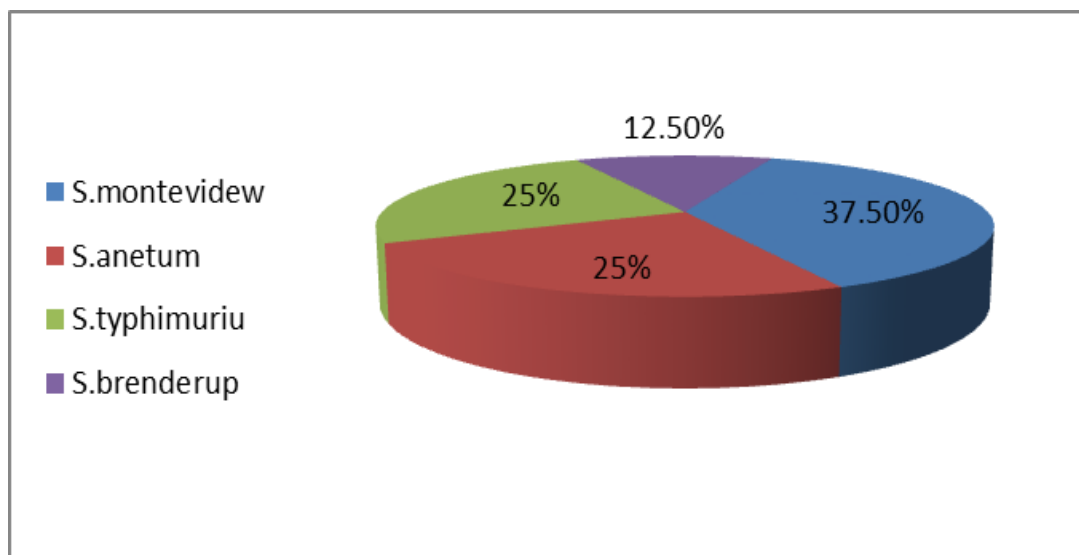


Figure 1 - Frequent rate of different salmonella serovars

DISCUSSION

Salmonellosis had been investigated in different animal species in Mosul city (Al-Nakshabandy and Zenad, 2004 and Saleem, 2003), as well as in human being (Al-Juboory et al., under publication). Seldom studies on stray carnivores had been done in Iraq. *Salmonella* infection rate was higher in stray dogs (15%) than other species (Zenad and Ali, 2003) in Mosul, in the same instance, low rate of *Salmonella* infection (4.6%) was recorded in housed dogs in Baghdad-capital city- of Iraq (Kallo and Hasso, 2001). The variations of *Salmonella* infection in dogs were recorded in many different countries (Nastasi et al., 1986; Kwaga et al., 1989 and Kozak et al., 2003). These variations could be attributed to differences in geography, time of studies, environments etc., and /or other factors (Ojo and Adetosoye, 2009). A total rate of *Salmonella* infection in stray cats was 13.5%, it was near to that value reported in stray dogs (15%) in Mosul (Zenad and Ali, 2003). Also it was similar to the prevalence of salmonellosis in cats in Iran (13.6%) reported by Shimi and Barin (1977). The isolation rate by rectal swabs (10.16%) was higher than that from internal organs (0.67%), this result increased the probability of shedding *Salmonellae* in feces of infected cats, furthermore the rate of *Salmonella* infection in apparently healthy pet cats was 12.8% in Iran (Shimi et al., 1977) also Fox and Beaucage (1979) reported an isolation rate 10.6% in cats from different sources. Moreover a surprising high rate of *Salmonella* infection (51.4%) in housed cats was reported (Immerseel et al., 2004). In contrary lower infection rate (1.92%) in healthy cats was reported in German (Weber et al., 1995). Similarly 1% of *Salmonella* infection rate was recorded in Colorado (Hill et al., 2000). Low rate of salmonella infection (0.36%, 0.8%) in healthy cats were also recorded in Belgium and New York (Immerseel et al., 2004 and Spain et al., 2001), however a wide range of isolation rate of salmonellae from clinically normal cats (0-14 %) was reported (Center et al., 1995). The variations of salmonella infection rates in cats in different localities are seemed to be resembled to those in dogs and might be due to the same factors. Despite asymptomatic infection of cats with *Salmonella* species they become carriers and can shed *Salmonella* organisms (Carter and Quinn, 2000) in their feces. Some researchers considered the apparently healthy cats have low risk on public health (Wilson, 2004). As the *Salmonella* organisms commonly inhabit the digestive tract and their associated lymph nodes of infected cats, they excrete *Salmonella* organisms intermittently in their feces (Gallaway et al., 2008 and Carter and Quinn, 2000). In spite of infected cats being asymptomatic they can perpetuate the *Salmonella* species in their bodies, besides an increase dissemination of *Salmonellae* occurs when they are exposed to stress factors or concurrent diseases (Bhaiyat et al., 2009) and prolong uses of antimicrobial drugs (Mather et al., 2013), therefore carriers will actively contribute to contamination of environment. Moreover stray cats scavenge or hunt: carcasses, west products of slaughter houses, rodents and wild birds, which in turn increase the rate of infection in such species. Also the uncontrolled wandering of stray cats helps in spreading of *Salmonellae* over a wide size area in cities. Moreover the small size and quite behavior of cats as compared to other carnivores; besides the merciful looking to them by people are greatly facilitated the spread of these organisms. This study revealed that *Salmonella montevideo* was the dominant serovar (37.5%) followed by *Salmonella anatum* and *Salmonella typhimurium* (25% for each Figure 1). In other studies the most frequent serovar was *Salmonella typhimurium* (Weber et al., 1995 and Philbey et al., 2008), this could be due to differences in geographical areas, time and species (Jay et al., 2003 and Tewari et al., 2012).

CONCLUSION

Asymptomatic (carriers) stray cats were considered a dangerous source of infection with *Salmonellae*, besides their significant role in contamination of environment; they will threat public and animal health particularly in cities. Conclusively the stray cats are potentially posing a significant threat to public health, therefore stray carnivores in large towns must be taken in consideration when prevention, control or irradiation programs of salmonellosis carried out. Condamnation of stray cats and dogs is ethically unaccepted now. The campaigns of hunting and surgical castration of males in veterinary hospitals are more humane procedures, beside education and awareness of people were necessary for cooperation.

RERERENCES

- Al-Juboory YH Zenad MM and Hassen RH (under publication). Prevalence of salmonella serotypes in diarrheic and non diarrheic patients in Mosul-Iraq.
- Al-Nakshabandy AA and Zenad MM (2004). Prevalence of salmonellosis in Buffaloes in Ninavha governorate with reference to pathological effect of isolated *Salmonella typhimurium* in rats. Iraqi J. Vet. Sci., 18: 165- 178.
- Bhaiyat MI Hariharan H Chikweto A Brathwaite-Sylvester E Burnett PJA Matthew V Oliveira S and Johnson C (2009). Concurrent lymphosarcoma and *Salmonella enteritidis* infection in a cat: a case report. Veterinarni Medicina, 9: 451- 454.
- Carter ME and Quinn PJ (2000). *Salmonella* in dogs and cats, In *Salmonella* in domestic animals. Wray C and Wray A Editors CAB, ISBN, International Publishing. 231- 244.
- Center SA Hornbuckle WE and Hoskin JD (1995) .In liver and pancreas in Veterinary Pediatrics edited by Hoskin JD.WB Saunders. Philadelphia. 212- 213.
- Fox JG and Beaucage CM (1979). The incidence of *Salmonella* from random- source cats purchased for use in research. J. Infect. Dis., 139: 362-365.



- Gallaway T Edrington T Anderson R Byd J and Nibest D (2008). Gastrointestinal microbial ecology and the safety of our food supply as related to *Salmonella*. *J. Anim. Sci.*, 86: E 163- E 172.
- Hale CR Scallan E Cronquist AB Dunn J Smith K Robinson T Lathrop SD Angelo MT and Clogher P (2012). Estimate of enteric illness attributable to contact with animals and their environments in United States. *Clin. Infect. Dis.*, 54: S 472-S 479.
- Hill SL Cheney JM Taton-Allen GF Reif JS Bruns C and Lappin MR(2000). Prevalence of enteric zoonotic organisms in cats. *J. Amer. Vet. Med. Asso.*, 216: 687- 692.
- Hoelzer K Switt AIM and Wiedmann MA (2011). Review: Animal contact as a source of human non-typhoidal salmonellosis. *J. Veterinary research*, 42:34
- Immerseel FV Pasmans F De Buck J Rychlik I Hradecka H Collard JM Wildemaauwe S Heyndrickx M Ducatelle R and Haesebrouck H (2004). Cats as a risk for transmission of antimicrobial drug resistant *Salmonella*. *Emerg. Infect. Dis.*, 10: 2169-2174.
- Jay LS Davos D Dundas M Frankish E and Light foot D (2003). *Salmonella*. Ch 8 in: Hocking AD (editor), *Foodborne microorganisms of public health significance* 6th edition. Australian Institute of Food Science and Tecnology (NSW Branch), Sydney. 207- 266.
- Kallo OJ and Hasso SA (2001). Prevalence of *Salmonellae* serotype in dogs and their sensitivity to antimicrobials. *Iraqi. J. Vet. Sci.*, 14: 67-71.
- Khan AQ (1970). *Salmonella* infection in dogs and cats in the Sudan. *Brit. Vet. J.*, 126: 607-612.
- Kozak M Horosova K Lasanda V Bilek J and Kyselova J (2003). Do Dogs and cats present a risk of transmission of Salmonellosis to humans? *Experimental study*. *Bratisl. Lek. Listy.*, 104: 323-328.
- Kwaga JKP Adesiyun AA Abdullahi SU and Bello CSS (1989). Prevalence of *Salmonellae*, *Shigellae* and *Plesiomonas shigelloides* in dogs in Zaria Nigeria. *Br. Vet. J.*, 145: 174-7.
- Mather AE Ried SWJ Maskell DJ Parkhill J Fookes MC Harris SR Brown DJ Coia JE Mulvey MR Gilmour MW Petrovaska L de Pinna E Kuroda M Akiba M Izumiya H Connor TR Suchard MA Lemey P Mellor DJ Hayon DT and Thomson NR (2013). Distinguishable epidemics of multidrug-resistant *Salmonella typhimurium* DT104 in different hosts. *J. Sci.*, 341:(6153) 1514-1517. 1.
- Nastasi A Massenti MF Scarlata G Mammina C Calco C and Villafrate MR (1986). *Salmonella* and *Yersinia enterocolitica* in soil and dog faeces. *Boll. Ist Sieroter Milan*, 65: 150- 152.
- Office International des Epizootics (OIE) (2003). *Manual of diagnostic tests and vaccines for terrestrial animals. A global salmonella surveillance and laboratory support project of the WHO. Laboratory protocols level-1, Training course. Isolation of salmonella* 4th ed. Edited by Renes, Hendriksen (DFVF).1-17.
- Ojo OE and Adetosoye AI (2009). *Salmonella typhimurium* infection in diarrheic and non-diarrheic dogs in Ibadan, Nigeria. *Veterinarski Arhiv.*, 79:371-377.
- Philbey AW Taylor DJ Mather HA and Coia JE (2008). *Salmonella typhimurium* in birds and cats and human. *Vet. Rec.*, 126: 120- 122.
- Saleem AN (2003). Isolation, Serotyping and Epidemiological aspect of Salmonellosis in lambs. *Iraqi J. Vet. Sci.*, 17: 143-150.
- Shane LS Kendall SF Michael JM and Eloise LS (2003). Septicemic *Salmonellosis* in two cats fed a raw-meat diet. *J. Amer. Anim. Hosp. Assoc.*, 39: 538 - 542.
- Shimi A and Barin A(1977). *Salmonella* in cats. *J. Comp. Path.*, 87: 315- 318.
- Spain CV Scarlett JM Wade SE and McDonough P (2001). Prevalence of enteric zoonotic pathogens in cats less than 1 year of age in Central New York State. *J. Vet. Intern. Med.*, 15: 33- 38.
- Tewari D Sandt CH Miller DM Jayarao BM and Mikanatha NM (2012). Prevalence of *Salmonella* cerro in laboratory-base submissions of cattle and comparison with human infections in Pennsylvania from 2005 to 2010. *Foodborne Path. Dis.*, 9: 928- 933.
- Wall PG Davis S Threlfall EJ WardLR and Ewbank AJ (1995). Chronic carriage of multidrug resistant *Salmonella typhimurium* in cats. *J. Small Animal Practice*, 36: 279-28.
- Weber A Wachowitz R Weigl U and Schafer-Schmidt R (1995). Occurrence of *Salmonella* in fecal samples of dogs and cats in Northern Bavaria from 1975 to 1994. *Berl Munch Tierarztl Wochenschr*, 108: 401-405.
- Wilson ME (2004). Summary and comment in January 2005: on Cats as a risk for transmission of antimicrobial drug-resistant salmonella an article published in *Emerg. Infect. Dis.*, 10:2169- 2174.
- Zenad MM and Ali HH (2003). Isolation and identification of salmonellosis in stray dogs in Mosul city. *Iraqi. J. Vet. Sci.*, 17: 173-179.



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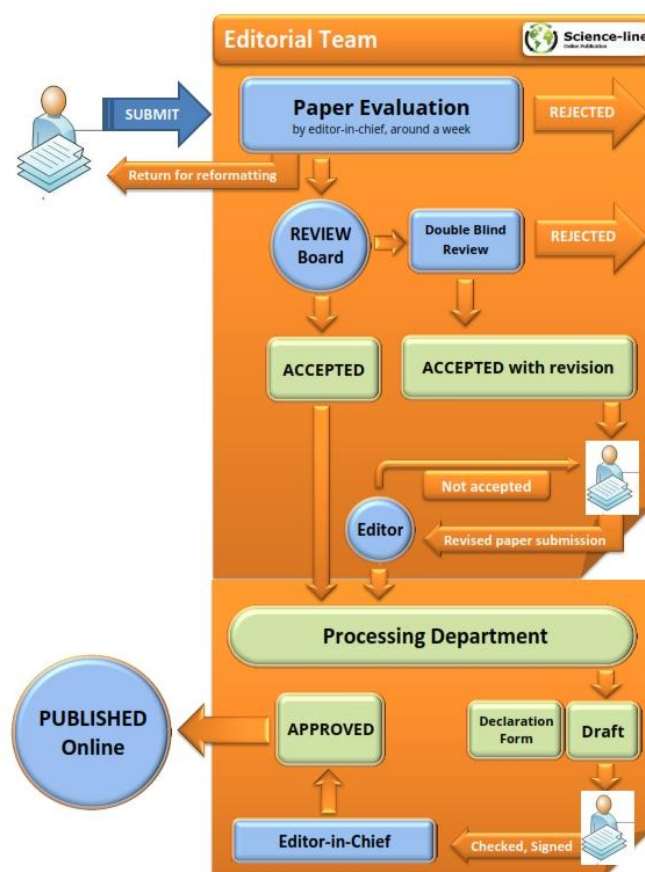
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