The effects of instant noodles waste in diets for broiler chickens

Lala A.O., Oso, A. O., Fafiolu, A. O., Bamgbose, A. M., Eruvbetine, D. and Bemji, M.

¹Department of Animal Nutrition, University of Agriculture, P.M.B. 2240 Abeokuta, Nigeria.

²Department of Animal Breeding and Genetics, University of Agriculture, P.M.B. 2240 Abeokuta, Nigeria.

*Author for correspondence: e-mail: funmilala02@yahoo.com

Abstract

The effects of instant noodles waste (INW) as a replacement for maize was investigated using 144 day-old, unsexed broiler chicks of Anak strain which were randomly assigned into four dietary treatment groups of 36 birds each. Each dietary treatment group had 3 replicates of 12 broilers per replicate. These four different diets were fed, in which INW replaced maize at 0% (control), 10, 20 and 30% from day old to 8 weeks of age. The growth performance, nutrient digestibility, haematological parameters and carcass traits of the chickens were evaluated. Average final live weight ranged from 1559.44 g to 1730.91g with broilers fed control diet and 30% INW diet recording the highest and least values respectively among the treatments. Broilers fed the 30 % INW had lower ($P < 0.05$) live weight. Broilers fed INW based diets had higher blood profile comparable to the control. The results indicated that INW can replace up to 20% of broiler starter diet and 30% replacement of maize at the finisher phase without adverse effects on growth performance of the broilers.

Keywords: Instant noodles waste, diets, broilers chickens.

Introduction

The rapid population growth in Africa which was estimated to be 871 million people in 2004 (Gueye, 2007), This growth is characterized by increasing pressure on food resources most especially cereal grains. Maize is a major source of energy for poultry consisting of about 50-60% of the total diet (Cowieson, 2005). Maize is keenly competed for by man, industries and livestock resulting in an inadequate supply of maize for use in poultry diets. Poultry nutritionists have tried to harness industrial by products and wastes which are not directly utilized by man and less expensive for the feeding of livestock.

One of such wastes from food processing plant is the instant noodles waste. Instant noodles is fast becoming a staple meal in

Nigeria, according to WINA (2010), the national trend in instant noodles demand in Nigeria has increased from 1080 million tons in 2007 to 1600 million in 2009. As the production of instant noodles increased, higher quantity of waste is being generated in form of trimmings. The proximate composition of instant noodles showed it to contain 15.77MJ/kg metabolizable energy, 8.97% crude protein, 2.80% crude fibre, 17.14% ether extract and 0.9% ash. Instant noodles (produced from wheat) are suitable energy source because of its high energy and oil content. A strong negative correlation between the non starch polysaccharides in wheat, growth performance and nutrient digestibility of poultry has been reported in previous studies (Gracia *et al.*, 2003; Santos *et al.*,

2004). However, the processing methods employed in the production of instant noodles waste is expected to deal with the NSP effect and improved its utilization in poultry nutrition. The purpose of this study was to evaluate the effect of INW on the growth performance, nutrient digestibility and carcass traits in broilers.

Materials and Methods

Processing of instant noodles

Instant noodles are produced from wheat flour, alkaline ingredients and refined palm oil. The first stage in instant noodles production is the mixing of the wheat flour with alkaline ingredient (sodium carbonate, iron, folacin, riboflavin) to make a homogenous mixture. The mixture is passed through a presser to form noodles sheets, the instant noodles sheets are later sent to the slitter for slicing while the wet trimmings are discarded. The noodles were later passed to the steamer where they are pasteurized under temperature of about 900 970°C and sent into cutters where they are folded into desired shapes.

Experimental design

Four experimental diets were formulated with INW replacing maize at 0, 10, 20 and 30% of the diets respectively for the starter (0-4 weeks) and finisher (5-8 weeks) phases of the experiment. Experimental diets were formulated to meet the NRC requirements (NRC, 1994) for the starter and finisher phases of broiler. One hundred and forty four (144) unsexed, day old broilers of Anak strain were used for the experiment. Thirty six (36) birds were assigned to each dietary group replicated three times with of 12 birds per replicate. The experimental diets for the starting and finishing phases are shown in Table 2 and 3 respectively. Strict hygiene was maintained during the experimental period while scheduled vaccinations and necessary medications

were administered as at when due.

Data collection

Growth performance

At the end of each week, the birds were weighed and the feed consumption recorded for each replicate throughout the period of the experiment. The weight gained and feed conversion ratios were calculated from the data. Mortality were recorded as they occurred during the experiment.

Nutrient digestibility

Apparent digestibilities of dry matter, crude fibre, crude protein, ether extract, ash retention and gross energy of the diets were measured at the end of the starter, grower and finisher phases of the experiments by total collection method (Bourdillon *et al.*, 1990). One bird per replicate was randomly selected and housed in clean and disinfected individual cages for a 3-day adaptation period, one day fasting to empty their digestive tract and daily total excreta collection period for three consecutive days. During the adaptation period, feed and water were supplied *ad libitum*. At the termination of 24 hour starvation period, the birds were given known quantities of feed. Droppings were collected on 24 hour basis for three days, dried and samples were ground for subsequent analyses to determine the dry matter, crude fibre, crude protein, ether extract and ash digestibilities as described by AOAC (1995).

Haematological and serum parameters

At the end of each phase of the experiments, one bird per replicate was randomly selected for the collection of blood analysis. Blood was collected from the wing vein. A total of 5 ml blood samples was collected from each bird such that 2.5 ml was collected into bijour bottle treated with ethylene diamine tetra acetic acid (EDTA) for haematological assay, Packed Cell Volume (PCV), Haemoglobin (Hb), Red

Table 1. Composition of broiler diets

INGREDIENTS	Replacement levels of instant noodles waste (%)							
	Starter phase				Finisher phase			
	0	10	20	30	0	10	20	30
Maize	50.00	40.00	30.00	20.00	50.00	40.00	30.00	20.00
Noodles waste	0.00	10.00	20.00	30.00	0.00	10.00	20.00	30.00
Fish meal (72% CP)	3.50	3.50	3.50	3.50	2.50	2.50	2.50	2.50
Soybean meal	18.00	18.00	18.00	18.00	15.70	15.70	15.70	15.70
Groundnut cake	12.70	12.70	12.70	12.70	10.00	10.00	10.00	10.00
Wheat offal	11.00	11.00	11.00	11.00	17.00	17.00	17.00	17.00
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Oyster shell	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Lysine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Starter premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Determined analysis (%)								
Dry matter	85.50	84.50	82.50	82.50	93.00	92.50	91.00	90.50
Crude protein	22.64	22.30	22.29	21.70	20.59	20.41	20.23	20.05
Crude fibre	3.86	4.10	4.20	4.35	4.05	4.29	4.31	4.67
Ether extract	14.50	15.00	16.00	16.50	18.50	18.50	20.00	20.50
Ash	8.00	7.00	8.50	7.50	9.00	9.00	8.50	7.50
Calcium (%)	1.61	1.61	1.62	1.62	1.62	1.62	1.63	1.63
Phosphorus (%)	0.74	0.74	0.75	0.75	0.90	0.91	0.91	0.91
Gross Energy (MJ/kg)	16.40	16.78	17.07	17.53	16.57	16.78	17.21	17.82
*Metabolizable energy (MJ/kg)	11.78	11.79	11.79	11.80	11.99	12.00	12.01	12.02

*Calculated

Premix supplied per kg of feed: Vit. A 4,000,000iu, Vit. D₃ 1,200,000iu, Tocopherols 8000iu, Vit. K₁ 1000mg, Folic acid 400mg, Copper 2500mg, Iodine 400mg, Cobalt 80mg, Calcium Panthothenate 3500mg, Pyridoxine 1500mg, Cyanocobalamin 7.5mg, Biotin 3mg, Thiamine 900mg, Riboflavin 1800mg, Niacin 12,500mg, Manganese 40,000mg, Zinc 25,000mg, Iron 15,000mg, Choline chloride 200,000mg, Selenium 35mg, BHT 25,000mg, Anticaking agent 6000mg

blood cell (RBC) and White blood cell (WBC). The remaining half of the blood samples were collected in bottles without EDTA and allowed to coagulate to produce sera for blood chemistry measurements (Total Serum Protein (TSP), Uric acid, Creatinine, Albumin, Globulin, Cholesterol and Glucose).

The PCV was determined using Wintrobe's microhaematocrit, Hb concentration was measured by the cyanmethaemoglobin method, RBC and WBC were determined using an improved Neubauer haemocytometer as described by Baker and Silvertown (1985). Albumin was determined using the method of Grant *et al.* (1987), TSP was done using the Biuret method according to Weichselbaum (1952), Uric acid was determined using enzymatic colorimetric method by Fossati *et al.* (1980), Creatinine was determined by the Colorimetric method of Henry (1974), Glucose was determined according to the method of Barham and Trinder (1972) and

Cholesterol was measured using the method of Roeschlau *et al.* (1974).

3.6.4 Carcass characteristics

At the termination of the experiment, one bird per replicate whose weight is a true representation of mean body weight of birds in each pen was selected for carcass analysis. The birds were deprived of feed overnight before slaughter but had access to water. The carcasses were eviscerated and dissected according to the methods by Jones (1984). The weights of the cut-up parts (head, neck, thighs, drumsticks, breast, back, wings and shanks) and organs (liver, heart, lungs and kidney) were taken using a sensitive scale and expressed as percentage of live weights.

Statistical Analysis

Data obtained were subjected to Analysis of Variance (ANOVA) using the General Linear Model of SAS software (SAS, 1999). Treatment means were separated by Duncan Multiple Range Test (Duncan, 1955).

Table 2: Performance characteristics of broilers fed INW-based diet

Parameters	Instant noodles waste inclusion levels				
	0%	10%	20%	30%	SEM
Starter phase					
Average initial liveweight (g/bird)	38.75	39.31	38.33	37.78	0.26
Average final weight (g/bird)	634.85 ^a	641.67 ^a	628.80 ^a	580.56 ^b	8.99
Average body weight gain (g/bird)	596.10 ^a	602.36 ^a	590.45 ^a	542.78 ^b	8.95
Average total feed intake (g/bird)	1394.85 ^a	1333.35 ^b	1320.86 ^c	1299.61 ^c	11.70
Daily protein intake (g/bird)	11.22 ^a	10.64 ^b	10.32 ^c	10.21 ^c	0.12
Feed conversion ratio	2.34	2.22	2.20	2.40	0.03
Protein efficiency ratio	1.90	2.02	2.05	1.90	0.03
Finisher phase					
Average initial liveweight (g/bird)	634.85	641.67	628.79	580.56	8.94
Average final weight (g/bird)	1730.91 ^a	1613.89 ^a	1700.96 ^a	1569.44 ^b	31.30
Average body weight gain (g/bird)	1096.06 ^a	958.33 ^c	1094.39 ^a	988.89 ^b	27.30
Average total feed intake (g/bird)	3110.40 ^a	2831.11 ^c	2992.68 ^b	2836.40 ^c	39.90
Daily protein intake (g/bird)	23.60 ^a	20.64 ^c	21.62 ^b	20.31 ^c	0.42
Feed conversion ratio	2.84	2.91	2.82	2.88	0.05
Protein efficiency ratio	1.66	1.68	1.77	1.74	0.04

^{abc} Means on the same row having different superscript are significantly ($P < 0.05$) different

Results

The growth response of starting and finishing broilers fed instant noodles waste-based diets is shown in Table 2.

Average final live weight and average body weight gain were similar ($P > 0.05$) for birds fed the control diets, 10 and 20% INW based-diets while there was a reduction ($P < 0.05$) in these parameters for birds fed 30% INW based-diets. Feed intake of the starter broilers reduced ($P < 0.05$) significantly with increasing dietary inclusion of INW. Feed conversion ratio and protein efficiency ratio were not affected ($P > 0.05$) by dietary inclusion of INW in all phases of the study. At the finisher phase however, all the parameters measured with the exception of feed intake and protein intake were not affected ($P > 0.05$). Feed intake at the finishing phase was lower for broilers fed with INW based-diets than those fed with control diets. Protein intake at the finishing phase also followed similar trend with the

feed intake.

Table 3 revealed the nutrient digestibility of broilers fed INW based diet. Dry matter digestibility decreased with increase in dietary inclusion of INW at the starter phase. Broilers fed control diets recorded the highest ($P < 0.05$) value of 81.63% while birds fed 30 % INW diet recorded the least dry matter digestibility value of 75.91%. Dry matter digestibility however was not affected by dietary treatments at the finisher stage. Crude fibre digestibility decreased ($P < 0.05$) as INW inclusion in the diets increased.

The serum and haematological indices of broilers placed on INW based diet is shown in Table 4. At the starter phase, packed cell volume (PCV) increased ($P < 0.05$) as the level of INW inclusion in the diet increased. Red blood cell (RBC), white blood cell (WBC), haemoglobin (Hb), total serum protein (TSP), serum uric acid and serum creatinine were not significantly affected

Table 3: Nutrient digestibility of broilers fed instant noodles waste-based diets

Parameters (%)	Instant noodles waste inclusion levels				
	0%	10%	20%	30%	SEM
Starter phase					
Dry matter digestibility	81.63 ^a	80.07 ^b	78.22 ^c	75.91 ^c	0.77
Nitrogen retention	84.36	83.58	79.47	81.62	1.03
Crude fibre digestibility	67.87 ^a	65.30 ^a	67.24 ^a	59.35 ^b	1.62
Ash retention	83.89	82.52	79.78	77.77	1.82
Ether extract digestibility	91.03	90.39	91.99	92.33	0.40
Finisher phase					
Dry matter digestibility	84.38	83.18	83.26	83.15	0.78
Nitrogen retention	83.80	82.65	83.02	80.97	1.01
Crude fibre digestibility	71.93 ^a	66.33 ^b	62.68 ^c	60.30 ^c	1.58
Ash retention	76.87 ^b	80.30 ^a	73.15 ^c	74.62 ^c	0.99
Ether extract digestibility	71.91	71.80	75.70	72.13	1.43

^{abc} Means on the same row having different superscript are significantly ($P < 0.05$) different

Table 4: Serum and haematological parameters of broilers fed INW-based diets

Parameters	Instant noodles waste inclusion levels				SEM
	0%	10%	20%	30%	
Starter phase					
Packed cell volume (%)	27.67 ^c	29.67 ^b	29.00 ^b	32.00 ^a	0.53
Red blood cell (×10 ⁶ /mm ³)	3.53	3.40	3.27	3.87	0.09
White blood cell (×10 ⁹ /l)	5.87	6.00	5.96	6.20	0.05
Haemoglobin (g/dl)	11.13	10.10	10.00	10.97	0.24
Total serum protein (mg/dl)	40.00	40.33	39.67	38.67	0.31
Serum uric ac id (mg/dl)	1.37	1.37	1.36	1.36	0.01
Finisher phase					
Packed cell volume (%)	30.67 ^c	32.33 ^b	30.67 ^c	34.33 ^a	0.54
Red blood cell (×10 ⁶ /mm ³)	3.27 ^d	3.57 ^c	3.73 ^b	3.97 ^a	0.08
White blood cell (×10 ⁹ /l)	5.90	6.07	6.33	6.10	0.03
Haemoglobin (g/dl)	11.10 ^b	10.30 ^c	11.03 ^b	11.87 ^a	0.19
Total serum protein (mg/dl)	45.67 ^c	50.67 ^b	50.33 ^b	55.33 ^a	1.07
Serum uric ac id (mg/dl)	3.57 ^d	3.97 ^b	3.80 ^c	4.17 ^a	0.07

^{abc} Means on the same row having different superscript are significantly ($P < 0.05$) different

Table 5: Carcass yield of broilers fed instant noodles waste-based diets

Parameters	Instant noodles waste inclusion levels (%)				SEM
	0	10	20	30	
Live-weight (g)	1800.00	1833.33	1783.33	1733.33	38.1
Dressed weight (%)	1611.9 ^a	1645.96 ^a	1612.67 ^b	1562.60 ^b	30.16
Intestine (%)	8.53	8.35	9.19	9.49	0.40
Thighs (%)	11.14	10.44	10.85	11.04	0.32
Drumsticks (%)	8.96	9.56	9.75	8.87	0.35
Wings (%)	7.29	7.79	8.12	7.89	0.25
Breast (%)	15.87	18.78	16.17	16.93	0.80
Back (%)	12.08	11.87	13.00	13.72	0.47
Empty gizzard (%)	2.55	2.37	2.58	2.22	0.10
Liver (%)	2.09	2.03	1.93	2.00	0.03
Heart (%)	0.44	0.48	0.48	0.47	0.02
Abdominal fat (%)	0.43	0.49	0.48	0.50	0.02

^{abc} Means on the same row having different superscript are significantly ($P < 0.05$) different

($P > 0.05$) by the dietary treatment. However at the finishing phase, packed cell volume (PCV), RBC, Hb and TSP were significantly ($P < 0.05$) affected by the dietary treatment. Finishing broilers fed with 30% INW based-diets recorded the highest ($P < 0.05$) PCV, RBC, Hb and TSP

values.

Carcass yield as shown in Table 5 indicated no significant ($P > 0.05$) difference across the treatment levels for all the parameters measured with the exception of the dressed weight which was significantly ($P < 0.05$) higher in birds fed control and 10 % INW

diets than birds fed 20 and 30 % INW diets.

Discussion

The average final live weight and weight gained of the broilers were similar up to 20% level of inclusion of instant noodles waste at the starter phase, beyond which there was a decrease ($P < 0.05$) in these parameters. Similarity in the final live weight and weight gained of the broilers obtained could be as a result of the heat processing involved in the production of instant noodles. Heat processing (cooking and dry heating) had been reported to reduce the amylase inhibitors, haemagglutinin and phytic acid digestible nutrients available to non ruminant (Emiola and Ologhobo, 2006). Heat processing can also affect physical characteristics of NSP's (Cowieson, *et al.*, 2005; Gonzalez-Alvarado *et al.*, 2008). This result is contrary to several authors (Annison, 1990; Choct and Annison, 1992). Choct *et al.* (1992) reported that the use of wheat in poultry is limited because of deleterious effects of NSP.

The depression in final live weight at 30% inclusion level might be as a result of gut bulkiness due to increased quantity of INW in the diet. The mechanism of action may be related to the ability of insoluble fibre to hold water, thus influencing gut bulk (physical fill) and potentially motility (Aulrich and Flachowsky, 2001). In addition, the reduction in feed intake at this level could be a factor which is evidence in the gross energy of the diets. Feed intake decreased with increase in INW inclusion in the diets. This response agrees with the fact that under *ad libitum* feeding condition, birds consumed feed primary to satisfy their energy requirements first (Leeson *et al.*, 1996). This observation was in agreement with those of Rabie and Szilagyi (1998). The use of fat as a preservative in the

processing of instant noodles associated with higher energy level could also contribute to reduced feed intake of the broilers. Plavnik *et al.* (1997) reported that the supplemental fat had a marked effect on feed intake, such that feed consumption was ($P < 0.05$) reduced with increasing dietary energy density.

Dry matter digestibility decreased as INW inclusion in the diets increased at the starter phase while it shows no effect at the finisher stage. Digestibility values of nutrients were higher at the finisher phase than in the starter phase. The trend in age difference is consistent with the fact that the digestive systems of the broilers are not well developed at the starter phase compared with well developed digestive system at the finisher phase. Yasar and Forbes (2000) have reported reduction of intestinal digesta in chicks as early as between 2 and 3 weeks of age. Also the larger retention times in older birds due to the volume of the digestive tract improved digestibility (Palander *et al.*, 2005).

The increased in PCV values as the level of INW inclusion in the diets increased could be as a result of increased in the energy level of the broiler diets with increased inclusion of INW. Energy levels have been found to have a direct relationship with PCV of the blood (Jain, 1986). The similar ($P < 0.05$) haemoglobin values recorded from birds fed the control diet and INW based diets is an indication of good oxygen carrying capacity in which the birds are not bound to succumb to any form of respiratory disease. This argument is in line with the findings of Mmereole (1996). Ker *et al.* (1982) reported that low PCV and haemoglobin are due to iron deficiency. Higher values of haemoglobin and RBC observed for birds fed 30% INW diet may be as a result of increased quantity of INW in the diet which increased the concentration of the alkaline

ingredients in the diet. This subsequently increased the amount of folacin and iron in the diet. Folacin and iron had been observed to increase the number of RBC and blood concentration of haemoglobin (NRC, 1994). The total serum protein of the broilers fed INW based diets were similar to that of the control, which is an indication that INW is nutritionally similar to maize. Information regarding nutritional status and malnutrition is often obtained from the total protein (Allison, 1995).

The Uric acid and creatinine values increased as the level of INW inclusion in the diet increased. Eggum (1989) observed that there was a strong inverse relationship between efficiency of utilization of feed and blood uric acid. This was evident in the final live weight of the birds which ($P < 0.05$) decreased from birds fed the control diet (1730.91 g) to (1559.44 g) for birds fed 30% INW diet.

The dressed weight was directly proportional to the live-weight of the broilers. This corresponds with the findings of Yagoub and Salin (2008) who reported high positive correlation between live-weight and carcass weight. The similarity in the percentage weights of the cut parts and organs indicated a uniform growth pattern and muscle development in all birds across the treatments. The uniformity in growth rate and muscle development compared favourably with previous report on broiler growth pattern and muscle development (Roshitsko et al., 2004).

Instant noodles waste could be included in diets for starter broilers up to 20% and in finishing broilers up to 30% without adverse effect on performance.

References

A O A C, 1995. Association of Official Analytical Chemists, Official Method of Analysis, 16th Ed. Washington DC.

Allison, J. B. 1995. Biological Evaluation of proteins. *Physical Review* 35: 664-669.

Annisson, G. 1990. Polysaccharide composition of Australian wheats and the digestibility of their starches in broiler chicken diets. *Australian Journal of Experimental Agriculture* 30: 233-239.

Aulrich, K. and Flachowsky, G. 2001. Effects on nutrient release and hydration properties. *Archive of Animal Nutrition* 54: 19-32.

Baker, F. T. and Silvertown, R. E. 1985. Introduction to Medical laboratory technology, 6th edition Butterworth & Co publishing company, pp 523-531.

Barham, D and Trinder, P. 1972. Determination of Glucose. *Analyist* 97: 142.

Bourdillon, A., Carre, B., Conan, L., Duperray, J., Hayghabaert, G., Lectereq, B., Lessire, M., McNab, J. and Wiseman, J. 1990. European reference method for the in vivo determination of metabolizable energy with adult cockerels. Reproducibility effect of food intake and comparison with individual laboratory methods. *British Poultry Science* 31: 557-563.

Choet, M. and Annisson, G. 1992. The inhibition of nutrient digestion by wheat pentosans. *British Journal of Nutrition* 67: 123-132.

Cowleson, A. J., Hruby, M. and Fraurichou-Iakson, M. 2005. The effect of conditioning temperature and exogenous xylanase addition on the viscosity of wheat-based diets and the performance of broiler chickens. *British Poultry Science* 46: 717-724.

Eggum, B. O. 1989. Biochemical and methodology principles in protein metabolism in farm animals 1st Edition University Press, Berlin.

- Emiola, I. A. and Ologhobo, Z. A. D. 2006. Nutritional Assessment of raw and differently processed underutilized legume seed in broiler diet *Journal of Animal Veterinary Advance* 5(2): 96-101.
- Fossati, P., Prencipe, L. and Berti, G. 1980. Determination of uric acid using enzymatic colorimeter method *Clinical Chemistry* 26/2: 227-231.
- Gracia, M. L., Aranibar, M. J., Lazaro, P. M and Mateos, G. G. 2003. Alfa-amylase supplementation of broiler diets based on corn. *Poultry Science* 82: 432-442.
- Grant, G. H. 1987. *Amino Acids and Proteins: Fundamentals of Saunders Company Philadelphia, USA.* 328-329.
- Gueye, E. F. 2007. Evaluation of the impact of HPAI on family poultry production in Africa. *World Poultry Science Journal* 63: 391-400..
- Henry, R. J. 1974. Colorimetric method of determining Creatinine. *Clinical Chemistry., Principles and Tecnic*s, 2nd edn., Harper and Row, pp 525.
- Jain, N.C. 1986. Schalon's veterinary haematology 6th Edition Lea and Fabinger Philadelphia USA pp 178-207
- Jones, R., 1984. A standard method of dissection of poultry for carcass analysis. *West of Scotland Agricultural College, Technical Bulletin* No. 222
- Ker, G. R, Lae, E. S, Lan, E. K, Larmor, R. J, Randell E, Forthoter, R. N, Davis, M. A. 1982. Relationships between dietary and biochemical measures of nutritional status. *American Journal Clinical Nutrition* 35: 294-308.
- Leeson, S., Caston, L. and Yungblut, D. 1996. Adding Roxazyme to wheat diets of chicken and turkey broilers. *Journal of Applied Poultry Resources* 5:167-172.
- Mmereole, F. U. C. 1996. Study of Haematological Parameters in the Nigeria local chicken *Nigerian Journal of Animal Production* 23 (1): 94-97.
- NRC 1994. National Research Council. Nutrient requirements of poultry, 9th revised edition National Academy Press, Washington DC
- Palander, S., Nasi, M. and Jarvinen, S. 2005. Effect of age of growing turkeys on digesta viscosity and nutrient digestibility of maize, wheat, barley and oats fed as such or with enzyme supplementation. *Archive of Animal Nutrition*. 59: 191-203.
- Plavnik, I., Wax, E. Sklan, D. and Hurwitz, S. 1997. The response of broiler chickens and turkeys to steam-pelleted diets supplemented with fat or carbohydrates. *Poultry Science* 76:10061013.
- Rabie, M. H., and Szilagyi. M. 1998. Effects of L-carnitine supplementation of diets differing in energy levels on performance, abdominal fat content and yield and composition of edible meat of broilers. *British Journal of Nutrition* 80:391400.
- Reitman, S and Frankel, S., 1957. A Colorimetric Method for the determination of Serum GOT and GPT *American Journal of Clinical Pathology* 28: 56.
- Rodehutsord M, Kapcius M, Timmler R and Dieckmann A. 2004. Linear regression approach to amino acid digestibility in broiler chickens. *British Poultry Science*, 45: 85-92.
- Roeschlau, P., Bernt, E. and Gruber, J.W. 1974. Determination of cholesterol in serum. *Clinical Biochemistry* 12: 403.
- Santos, A. A. Jr, Ferket, P. R, Grimes J. L. and Edens F.W. 2004. Dietary supplementation of endoxylanases and phospholipase for turkeys fed wheat-

- Received: 29/03/2008
Accepted: 24/09/2011