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CARCASS QUALITY, HAEMATOLOGICAL AND BLOOD BIOCHEMICAL PROFILE OF BROILER CHICKENS FED DIETS CONTAINING GRADED LEVELS OF COMBINATIONS OF IRISH POTATO PEEL AND YAM PEEL MEALS (IPYPM) WITH ENZYME SUPPLEMENTATION

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ABSTRACT

In the search for alternative energy sources that can be substitute for maize in poultry feeds, a 9-week trial was conducted to ascertain the effect of diets containing varying levels of Irish potato and yam peel meals (IPYPM) with enzyme supplementation on carcass quality, haematological and blood biochemical profile of broiler chickens. Two hundred and forty (240) Anak-2000 broiler chicks aged 6 days were randomly assigned to 12 floor pens containing 20 birds each divided into four treatments with each treatment subdivided into three replicates. Four diets, based on 23 and 20% crude protein in the starter and finisher phases respectively, were formulated to contain 0, 10, 20 and 30% IPYPM replacement for maize grain. Maxigrain® enzyme was added according to manufacturer's specification. Each of the diets was fed to 3 pens of 20 birds in a completely randomized design. Data were collected on carcass quality, haematological and blood biochemical profile and were statistically analyzed using the general linear model procedure of statistical analysis (SAS, 2002). Significantly different means were compared using Dunnett' test (Dunnett, 1955). Differences between means were considered significant at $P<0.05$. There were no adverse effect of the test material on carcass quality, haematological and blood biochemical parameters as they all fell within normal range for broilers. It was concluded that IPYPM can replace maize up to 30% without adverse effect on carcass quality, haematological and biochemical profile of broiler chickens.

Key words: Blood, Enzyme, Haematology, Irish Potato, Peel Meal and Yam

INTRODUCTION

Poultry production has gained prominence mainly due to its short generation interval, the high quality protein from poultry products and relatively quick returns on its investment. Poultry production is generally accepted as the fastest way of increasing animal protein consumption in developing countries of the World due to its fast growth rate and quick returns on capital (Ogundipe, 1999). Broilers grow rapidly, hence the need to provide high quality diets to cater for their nutrient requirements. Birds normally eat to satisfy their energy requirement, hence the need for an adequate energy diet. (Kpanja, *et al*. 2020

In developing countries, Nigeria inclusive, there is inadequate supply of animal protein. An average Nigerian consumes about 8.6g of animal protein per day against the 54g recommended by (FAO, 1993, Ogundipe, 1996, Ojo, 2003 and Kpanja, *et al.* 2020). According to (Ogundipe and Sanni, 2003) and (FAO, 2006) reports, poultry production is considered to be a means of livelihood and a way of achieving certain level of economic independence in Nigeria. Sonaiya (1990) reported that 41.23% of animal protein yield per

annum in Nigeria is sourced from poultry meat and eggs, 9.77% from cattle and 12.43% from pigs. Nworgu *et al.* (1999) report states that the best logical solution to Nigeria's meat scarcity is to increase broiler chicken production.

Nutrition tackles the problems of supplying optimum nutrients required by animals at an economic level (Ogundipe, 1987). It is the most important consideration in livestock management. Inadequate feed supply, nutritionally unbalanced rations, adulterated ingredients or stale feeds are some factors responsible for low productivity of the livestock industry in the tropics (Igwebuike *et al.,* 2001). Apart from serving as food, poultry industry contributes significantly to family income. The major interest of the farmer is to reduce the feed cost, which accounts for 70-80% of the total cost of production (Nworgu *et al.,* 1999, Igwbuike *et al.,* 2001. and Ogundipe *et al*., 2003). Research efforts are geared towards evaluating alternative, non-conventional feed ingredients for poultry. Such alternatives should have comparative nutritive value but cheaper than the conventional protein and energy sources. They should also be available in large quantities (Aduku and Olukosi 1990; Alte and Ologbenla, 1993).

Maize has a lot of industrial and domestic uses, such as bio-fuel, brewing, starch industries and for human food etc. However, inadequate production of this grain and the intense competition for maize between man, industries and livestock has made poultry rations to be expensive. This situation has forced farmers and feed millers to think and search for non-conventional sources of feed ingredients which are available in large quantities and cheaper and can substitute for the scarce and expensive maize. Some of such are Irish potato (*Solanum tuberosum*) peels, which have great potentials as energy source in poultry nutrition and the pollution caused by the peels have even become an environmental concern as it is a waste product of some food industries. It poses a lot of disposal problem especially during the wet season as it decays easily and pollutes the environment. Yam peels are also abundant and are being wasted instead of being utilized in livestock nutrition.

Potato is processed into value added products by fast food industries. Potato is usually peeled during processing either by steam, lye or abrasive peeling depending on the type of products. As a consequence, large quantities of peels are generated which represent a severe disposal problem (Schieber *et al.*, 2009) with increasing awareness and aims of minimizing environmental impact and sustainability. Potato peels contain some nutritionally and pharmacologically interesting compounds such as polyphenols and glycoalkaloids which may serve as natural antioxidants and precursors for steroid hormones (Schieber *et al.*, 2009). Potatoes are good source of energy due to their carbohydrate level. They also contain some protein and are rich in organic micronutrients such as Vitamin C, some B vitamins and an appreciable level of minerals. (Charmney *et al.*,2006) estimated that 40-50% of potato production is unsuitable for human consumption, so the by-product can be divided into cull potatoes which are whole potatoes not suitable for human consumption, and potato processing waste, (the peels). The peels, which are the major portion of processing waste, represent a severe disposal problem to the industry since wet peels are prone to rapid microbial spoilage. Potato peels though a waste product of the food industry is a source of high value compounds (Schieber *et al.,* 2009).

Yam peel is a waste product obtained when yam is peeled for cooking and other purposes. Yam peels have relatively high amino acid content (Eka, 1986) and dietary fibre (Akinmutimi and Onen, 2008). Presently, yam peels do not form regular sources of food to man, as a result there may be considerable cost advantage in using it to replace a substantial amount of the maize component of poultry diet. Despite the enormous potentials of yam peels as an energy source in poultry nutrition, it has been relegated

to the background because of its relatively low metabolizable energy and dustiness.

MATERIALS AND METHODS

The study was carried out at the Teaching and Research Farm of the Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria, Nigeria. Zaria is located within the Northern Guinea Savanna Zone on latitude $11^0$9' 06" N and longitude $7^0$38'55' E, at an altitude of 706m above sea level. The maximum temperature varies from 26-32^{0}C depending on the season while the mean relative humidity during the dry and wet season are 21 and 72%, respectively, (MU, IAR, 2012).

Two hundred and forty 6-day-old (240) Anak 2000 broilers of mixed sexes with an average initial weight of 63.33g were used for the experiment. They were housed in a deep litter house. The birds were allocated into four dietary treatments in a complete randomized design. Each treatment had three replicates with sixty animals per treatment. Feed and water were provided *ad-libitum* throughout the 9 weeks' experimental period.

Irish potato peels were gathered from some households, restaurants and commercial fryers in Jos and Bukuru metropolis of Plateau State, and yam peels were sourced from households in Kuraga (Mbako) village of Wamba L.G.A. of Nasarawa State. The peels were sun-dried and milled before analysis and then incorporated into the diets. Four diets were formulated as shown on Table 1: T1 is devoid of the peels and served as control while T_2, T_3 and T_4 had equal combinations of Irish potato and yam peel meals replacing maize at 10, 20 and 30% levels, respectively and they were supplemented with maxigrain® enzyme at manufacturer's specification.

At the end of the feeding trial, six birds were selected from each treatment group according to average body weight. They were fasted overnight in order to empty the contents of the gastro-intestinal tract, they were slaughtered and blood samples were obtained. The blood samples were taken to the clinical pathology laboratory at the Faculty of Veterinary Medicine for haematological and blood biochemical analysis. The birds were then de-feathered and dressed before they were cut into prime cuts and expressed as percentage of dressed weight while organ weight were also taken and expressed as percentage of live-weight. The data collected was subjected to analysis of variance, significant differences among treatment means were separated using Dunnette (1955) in SAS, 2002.

Table 1: Composition of Broiler Starter Diets

	Composition			
Ingredients	**T1**	**T2**	**T3**	**T4**
Maize	53.50	48.50	43.50	38.50
SBM	38.00	38.00	38.00	38.00
Wheat-offal	5.00	5.00	5.00	5.00
IPPM	0.00	5.00	10.00	15.00
YPM	0.00	5.00	10.00	15.00
Bonemeal	2.50	2.50	2.50	2.50
Limestone	0.30	0.30	0.30	0.30
Salt	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00
Calc. analysis				
ME (Kcal/Kg)	2874.18	2855.12	2816.02	2785.35
CP (%)	23.00	23.00	23.00	23.00
CF (%)	4.33	2.68	4.09	4.36
Lipids (%)	2.99	3.74	3.91	4.41
Calcium	0.10	0.10	0.14	0.12
Available P	0.29	0.39	0.28	0.38
Lysine	0.10	1.24	1.31	1.22
Metionine	0.10	0.34	0.28	0.32

Vitamin-mineral premix provide per kg diet;Vit. A, 13340I.U; Vit D_3, 2680I.U; Vit E, 10 I.U.; Vit K, 2.68mg; Calcium pentothenate, 10.68; Vit. B_{12} 0.022mg; folic acid, 0.668mg, choline chloride,400mg; Chlorotetracycline, 26.68mg; Manganese, 13mg; Iron,66.68mg; Zinc,53.34mg; Copper,3.2mg; Iodine, 1.86mg; Cobalt,0.268mg; Selenium, 0.108mg.

IPPM = Irish Potato Peel Meal
YPM = Yam Peel Meal
SBM = Soyabean Meal
ME = Metabolisable Energy
CP = Crude Protein
CF = Crude Fibre

Table 2: Composition of Broiler Finisher Diets

	Composition			
Ingredients	**T1**	**T2**	**T3**	**T4**
Maize	61.35	56.35	51.35	46.35
SBM	30.00	30.00	30.00	30.00
Wheat-offal	5.00	5.00	5.00	5.00
IPPM	0.00	5.00	10.00	15.00
YPM	0.00	5.00	10.00	15.00
Bonemeal	2.50	2.50	2.50	2.50
Limestone	0.30	0.30	0.30	0.30
Salt	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00
Calc. analysis				
ME (Kcal/Kg)	3008	2998	2969	2929
CP (%)	20.00	20.00	20.00	20.00
CF (%)	4.03	4.16	4.42	4.71
Lipids (%)	3.68	3.77	3.86	3.95
Calcium	0.08	0.07	0.08	0.10
Available P	0.37	0.36	0.36	0.38
Lysine	1.44	1.03	1.02	1.01
Metionine	0.32	0.29	0.30	0.28
Cost/Kg (N)				

Vitamin-mineral premix provide per kg diet;Vit. A, 13340I.U; Vit D_3, 2680I.U; Vit E, 10 I.U.; Vit K, 2.68mg; Calcium pentothenate, 10.68; Vit**.** B_{12} 0.022mg; folic acid, 0.668mg, choline chloride,400mg; Chlorotetracycline, 26.68mg; Manganese, 13mg; Iron,66.68mg; Zinc,53.34mg; Copper,3.2mg; Iodine, 1.86mg; Cobalt,0.268mg; Selenium, 0.108mg.

IPPM = Irish Potato Peel Meal
YPM = Yam Peel Meal
SBM = Soyabean Meal
ME = Metabolisable Energy
CP = Crude Protein
CF = Crude Fibre

Table 3: Carcass Characteristics of Broiler Finisher Chickens fed Diets containing Varying Levels of Irish Potato Peel Meal

IPPM and combinations of IPPM/YPM inclusion levels (%)					
Parameters	T1	T2	T3	T4	SEM
Live- weight (kg)	1825.00	1700.00	1775.00	1650.00	42.08
Carcass weight (kg)	1400.00	1175.00	1200.00	1200.00	52.56
Dressing %	76.71	68.12	67.61	71.72	5.45
Prime cuts expressed as percentage of Carcass weight					
Breast	2.91	25.28	25.83	23.52	4.33
Thigh	14.74	15.74	17.50	17.07	4.33
Drumstick	13.33	14.07	15.56	12.70	0.99
Back	16.69	17.16	17.75	16.45	1.57
Wings	10.24	11.01	12.39	12.70	3.11
Organ Weight expressed as percentage of live weight					
Heart	0.32	0.71	0.45	0.42	0.24
Empty Gizzard	3.51	4.75	4.54	4.40	1.84
Full Gizzard	2.48	2.98	3.02	2.69	0.56
Liver	1.81	2.49	1.95	2.12	0.45
Lungs	0.60	0.80	0.58	0.69	0.29
kidneys	0.33	0.59	0.29	0.28	0.19
spleen	0.09	0.16	0.32	0.12	0.13
Abdominal Fat	1.04	1.10	1.24	1.35	0.30

[abc]= means on the same row with different superscript differs significantly among treatments, SEM= standard error of means LOS=level of significance, NS=not significant

Table 4: Effect of Diets Containing Graded Levels of Irish Potato Peel based Diets on Haematological Parameters of Broiler Chickens.

	IPPM inclusion levels (%)					
Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**	**Range**
PCV (%)	37.00	39.33	33.00	41.00	7.06	30 - 49
Hb(g/dl)	10.96	11.63	12.60	12.60	0.38	10.2 - 15.1
WBC($10^{10/L}$)	8.60	8.20	4.37	3.97	0.66	1.9 - 9.5
RBC($10^{12/L}$)	3.1	2.9	2.5	3.82	0.28	2.5 - 3.9
Total Protein(g/dl)	3.5	3.1	3.2	3.8	0.21	NA
Heterophils (%)	3.33	4.33	5.67	4.33	0.77	0.5 - 7.6
Lymphocytes (%)	0.96	0.91	0.90	0.92	0.04	0.0 – 1.00
Monocytes (%)	0.46	0.33	0.51	0.34	0.22	0.0 – 1.0
Eosinophils (%)	1.10	1.00	1.05	1.03	0.50	0.5 – 7.6
Basophils (%)	0.00	0.00	0.00	0.00	0.00	0.0 – 1.8
Band (%)	1.60	2.00	2.00	2.07	0.20	NA

abcd= means on the same row with different superscript differs significantly among treatments, PCV= Packed Cell Volume WBC=White Blood Cell RBC= Red Blood Cell SEM= Standard Error of Means Hb= Haemoglobin NA=not available Range Source = Clinical Avian Medicine Volume 11(608)

Table 5: Effect of Diets Containing Graded Levels of Irish Potato Peel Meal based Diets on Serum Biochemical Parameters of Broiler Chickens.

	IPPM inclusion levels (%)					
Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**	**Range**
T/ Protein(g/dl)	4.40^{b}	5.47^{a}	5.77^{a}	4.70^{b}	0.79	4.40^{b}
Cholesterol(mg/dl)	124.93^{a}	125.40^{a}	125.00^{a}	12.33^{b}	0.79	124.93^{a}
Triglyceride(g/dl)	1.60^{b}	4.87^{a}	2.00^{b}	1.27^{c}		1.60^{b}
AST (µ/l)	121.00^{b}	124.00^{a}	110.33^{c}	121.67^{b}		121.00^{b}
ALT (µ/l)	28.00	29.63	28.00	28.67		28.00
ALP (µ/l)	6.50^{c}	8.67^{a}	7.00^{b}	4.67^{d}		6.50^{c}
Urea (mg/dl)	3.00^{b}	4.33^{a}	4.00^{a}	2.77^{b}		3.00^{b}
Albumin(mg/dl)	29.00^{a}	35.33^{a}	28.33^{a}	24.67^{b}		29.00^{a}
Glucose(mg/dl)	211.27^{a}	210.77^{a}	229.77^{b}	210.47^{a}		211.27^{a}
Creatinine (mmol/l)	0.70^{c}	1.07^{a}	1.30^{a}	1.00^{b}		0.70^{c}
Globulin(g/dl)	3.30^{b}	3.70^{a}	4.00^{a}	3.17^{b}		3.30^{b}

RESULTS AND DISCUSSION

The effect of varying levels of IPYPM on carcass characteristics of broiler finisher chickens showed significant differences in all parameters except empty and full gizzard. This could probably be linked to the fibrous nature of the feed ingredients. Gizzard is known to be influenced by the degree of feed coarseness resulting from muscular activity of the gizzard during grinding (Fanimo, 1996). The superior dressing percentage in treatment 1 agreed with Kpanja *et al.* (2022) who observed the same trend when they fed IPYPM to broiler finishers. This could probably be due to increasing levels of IPYPM and their low metabolisable energy levels.

The higher values of liver, lungs, spleen and kidney in treatments may be due to the activities of these organs as they were known to play excretory roles removing toxic substances from the body. The result of these organs agreed with the works of Akinmutimi and Onen (2008) and Osei and Duodu (1988) when 15% sun-dried and fermented Cassava Peal Meal (CPM) were fed with fishmeal in place of ground-nut cake (GNC).

Results of prime cuts such as breast, thigh and drumstick showed that the test material did not have any negative effect on the performance of broiler chickens. This result agreed with the report of Akinmutimi and Onen (2008) and Osei and Duodu (1988) when 15% sun-dried and fermented CPM were fed with fishmeal in place of ground-nut cake (GNC), 15% was recommended and the level did not have any deleterious effect on the performance and carcass quality. In another study by Osei and Duodu (1988), they observed that the good performance may be as a result of feeding very high level of fishmeal rather than GNC used in the study. They also observed that at 15% CPM inclusion in broiler diet, there was no adverse effect on the carcass quality of the birds. Tewe (1986) replaced maize with CPM at 0, 10, 20 and 30%. They concluded that inclusion of cassava peels up to 20% in broiler diets promoted biological activity satisfactorily. Pido and Adeyanju (1978) replaced maize with combinations of yam and Irish potato peel meals to rabbits and reported that there was no adverse effect on carcass quality even at total replacement. This work concluded that up to 30% inclusion of IPYPM combinations in broiler diets had no adverse effect on their performance and carcass quality.

Haematological parameters showed that packed cell volume (PCV) and haemoglobin were significantly ($P<0.05$) higher in T3 while white blood cells (WBC) was significantly ($P<0.05$) higher in T1 which differed significantly ($P<0.05$) from T2 and T3 that were similar which also differed significantly ($P<0.05$) from T4. Red blood cells (RBC) showed that T1 and T3 were similar and differed significantly ($P<0.05$) from T2 and T4 that were similar. Blood haematological parameters serve as indicators of the physiological state of birds (Mohammed *et al.*, 2015). All the parameters measured were within the normal range for broilers. The haematological parameters showed that the haemoglobin was within the normal range of 10.2 to 15.1mg/dl and eosinophils was also within the normal range of 0.5-7.6x10^9/L as reported by (Chowdbury, 2005) and (Kpanja *et al.*, 2022). Total protein and white blood cells were within the normal range of 1.9-9.5x10^9/L as reported by Ruply (1997). Lymphocytes and heterophils make up the majority of white blood cells in birds (Nseabasi *et al*., 2013).

All the parameters measured were within the normal range reported by Mitruka and Rawnskey (1977) and Ruply (1997). PCV obtained were within normal range of 30 - 49, it is an index of toxicity, any reduction in its concentration in the blood usually suggest presence of toxic factors (haemagluttinins) which has adverse effect on blood formation (Swenson and Recce, 1993. It had been established that PCV, haemaglobin and total protein were strongly influenced by diet and were strong indicators of the nutritional status of animals (Ani and Adiegwu, 2005 and Oyawoye

and Ogukunle, 1998) and to assess the health of the animals.

Biochemical parameters as presented showed there were significant differences($P<0.05$) in all the parameters measured except ALT. The high cholesterol and albumin recorded in treatments 1, 2 and 3 agreed with the report of Hacbarth *et al.* (1983) who reported that differences in cholesterol, albumin and glucose by growing birds were basically due to differences in the fibre content of the diet. The cholesterol levels were within the range of 3.33 – 5.40g/d which agreed with the values reported by Nse-abasi *et al.* (2013) and Frank *et al*. (1983).

All values fell within the normal range as obtained from the Laboratory. They also agreed with the reports of Swenson and Recce (1993) and Akinola and Abiola (1999) who reported similar values on blood biochemical profile of broilers.

CONCLUSIONS AND RECOMMENDATIONS

From the trial and based on carcass quality, it was concluded that;

- Sun-dried Irish potato and yam peel meal with enzyme supplementation can replace maize up to 30% level in broiler chickens' diets without any adverse effect on carcass quality.
- Sun-dried Irish potato and yam peel meals with enzyme supplementation can replace maize up to 30% level in broiler chickens' diets without any adverse effect on haematological and blood biochemical parameters.
- It is recommended from the study that farmers and feed millers can use up to 30% Irish potato and yam peel meal with enzyme supplementation in broiler rations without any adverse effect on carcass quality, haematological and blood biochemical parameters.

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