Growth Response, Hematological Indices, and Serum Lipid Profile of Growing Turkeys Fed Diets Supplemented with Niacin and Yeast.

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ABSTRACT

A total of 80 day old British United Turkeys were subjected to four dietary treatments at varying levels of niacin + yeast. Each treatment had 20 birds of 4 replicates with 5 birds in each replicate. Niacin + yeast (240 ppm niacin + 1.5g/kg yeast and 200 ppm niacin + 1.5 g/kg yeast, at the starter, grower, and finisher phase) showed significant effect on body weight gain, serum Low Density Lipoprotein (LDL), triglyceride, high density lipoprotein (HDL), cholesterol, Hemoglobin and red blood cells.

(Keywords: niacin, yeast, hemoglobin, PCV, white blood cells, HDL, LDL, cholesterol, British United Turkeys, poultry feed)

INTRODUCTION

Meat-type strains of poultry (like turkeys) are selected mainly for rapid weight gain, efficient feed conversion, and high yield of valuable carcass parts as demanded by processing industry and consumers and adaptability to conditions of the industry. Accumulation of fats in poultry cut parts and visceral organs represent a waste to consumers who are increasingly concerned about the nutritional and health benefit of their food (Oso *et al*., 2011). Reduction of fat in poultry birds has therefore become a main focus of nutritional research and it is essential not to compromise weight in this process.

Several dietary manipulations such as inclusion of feed additives and vitamin supplements have been used to reduce this accumulation of fat in poultry. Guyton (2012) reported that niacin acts on serum cholesterol level raising the so-called 'good cholesterol'- High Density Lipoprotein (HDL) and lowering the 'bad cholesterol' - Low Density Lipoprotein (LDL). Niacin has physiological critical roles in mitochondrial respiration and in the metabolism of carbohydrates, lipids and amino acids. Niacin and niacinamide function mainly as precursors of the co-enzymes NAD and NADP. They are mainly supplied from diets. Beneficial effects of dietary inclusion of niacin in animals have been reported. Increased levels of niacin in diets of layers reduced the liver fat content of laying hens (Hartfiel and Kirchner, 1973).

Waldroup *et al*.(1985) also reported that supplemental niacin improved weight gain and feed utilization. The use of niacin treatment for hypercholesterolemia was discovered and first reported by (Altschul *et al*., 1955; Altschul and Hoffer, 1958). These authors observed a significant decrease of serum cholesterol in man receiving niacin supplementation. Ashen and Blumentahl (2005) stated that niacin is the most effective substance, even better than statins, for both lowering LDL cholesterol, but importantly raising HDL. Niacin is essentially used in metabolism through co-enzyme formation NAD and NADP (Flachowsky, 1993). These co-enzymes are involved in transfers of hydrogen, which frequently occur in the synthesis and degradation of fatty acids, carbohydrates and amino acids.

The essential central metabolic role of niacin is as constituents of the pyridine nucleotides, nicotinamide adenine dinucleotide (NAD^+) and nicotinamide adenine dinucleotide phosphate ($NADP^+$). Niacin is important in energy production and storage and tissue growth (El-Husseiny *et al*., 2008). Adequate dietary niacin for birds have been reported to compensate for the problems faced in conventionally produced turkeys in terms of reduction of cholesterol level, deformed hock joints, shortened leg bones, high fat accumulation, bowed hock joint and stress (Jeremy *et al.*,1996).

Baker's yeast is a single-celled fungi produced from a group of fungi called *Saccharomyces cerevisiae*. It could be produced on farm, yeast by-products from breweries or distilleries, or commercial yeast products (Kemal *et al*., 2001; Saied *et al*., 2011). Commercial yeast products specifically for animal feeding are used worldwide in animal production particularly in ruminant diets. Beneficial effects of yeast products in ruminants are due to increased concentration of total and cellulolytic ruminal bacteria (Wallace, 1994).

Effects of yeast products on production and their mode of action in monogastrics have been reported in poultry (Zhang *et al.,* 2005). Yeast has been proven as a successful growth promoters in poultry industry (Savage and Zarrewska, 1996). This work therefore seeks to achieve the effect on niacin and yeast on growth performance and haematological indices of turkeys.

MATERIALS AND METHOD

Experimental Location

The study was carried out at the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, Nigeria. The area is located in the tropical rainforest vegetation zone with an average temperature of 34.7^0C. The vegetation in the university represents the interphase between the tropical rainforest and the derived savannah.

Test Ingredient

Feed grade niacin were procured from a commercial company in Lagos State, Nigeria and used for the study. Baker's yeast was purchased commercially from confectionery stores.

Experimental Diets

Four experimental diets were formulated for the pre-starter (0-4 weeks), starter (5-8 weeks), grower (9-12 weeks) and finisher (13-16 weeks) phases of the experiment, respectively. For each phase, a basal diet formulated to contain NRC (1994) vitamin requirement with no supplemental levels serve as control (Diet I). This implied that control diets for starter (5-8 weeks), grower (9-12) and finisher turkeys (13-16 weeks) contains 60, 50 and 50 mg/kg niacin, respectively which are normal NRC levels required. The three additional diets (Diet II, III and IV) for each phase was formulated using the respective control diets but supplemented with additional 100, 200 and 300% of NRC (1994) niacin requirements. Baker's yeast at 1.5 g/kg diet was included in all the diets except the control diets.

The supplemental level of niacin used in this study was based on the NRC (1994) minimum requirement for turkeys while the inclusion level of baker's yeast used was as recommended in previous literatures (Yalcin *et al.,* 1993 and Churchil *et al.,* 2000). The diets for each phase were formulated to meet the respective minimum requirement for other nutrients like carbohydrate, protein, fats, fiber, Ca, and P.

Experimental Birds and Management

A total of eighty (80), day old male British United Turkeys (BUT) were used for this experiment. Brooding of the poults was done for 28 days. Birds were maintained on a 24-hour constant light schedule during brooding, while brooding temperature and humidity was maintained close to their requirements.

The brooding units were previously washed and cleaned thoroughly with detergents and disinfectants solution four days prior to arrival of the birds. The brooding temperature was maintained close to their requirements. During brooding, temperature was maintained at 35.5^0C for the first 0 to 2 day and then gradually reduced by 1.5^0C per week to a final temperature of 29.5^0C at 28 days. Temperature was kept at ambient condition after brooding. Poults were fed for 28 days pre-experimental period with pre-starter turkey ration before the commencement of the feeding trial.

The birds were managed under a deep litter system of management with wood shavings used as beddings. At day 28, poults were allotted to dietary treatments on weight equalization basis. The experiment consisted of 4 treatments replicated four times with 5 poults per replicate. Birds contain in each treatment were fed respective diets. Feed and water were provided *ad libitum* while clean water was given on a daily basis. The experiment lasted for a total of 16 weeks.

Growth Performance

The live weight of the birds as well as their feed intake for each replicate was measured weekly. Feed to gain ratio for each replicate was determined by dividing the feed intake by the weight gain. Weight gain was calculated from the data obtained. Determination of feed intake was done by subtracting the left-over feed from the feed supplied to the birds.

COLLECTION OF BLOOD SAMPLES

Blood samples (about 2.5ml each) were collected from the wing vein of a turkey per replicate at the end of 8^{th}, 12^{th} and 16^{th} week of the study. A set was collected in EDTA bottles for the determination of haematological indices while another set was collected in plain tubes without EDTA. Plasma was harvested subsequently by centrifuging at 3000rpm for 15 minutes as described by Hayat *et al*. (1999).

Parameters Measured

Packed cell volume (PCV) was determined using the microhaematocrit reader (Baker and Silverton 1985).

Red blood cell and haemoglobin were estimated as described by Baker and Silverton (1985). White blood cell (WBC) count was determined by means of an automated hematology analyzer.
Serum lipid profile- The serum cholesterol, LDL, HDL was estimated using commercial diagnostic number 72201-04). kits (Qualigens India. Pvt. Ltd., Catalogue.

Statistical Analysis and Design

The data generated were arranged in a completely randomized design and subjected to one-way analysis of variance using the SAS package (SAS, 1999). Significant differences were considered at $P < 0.05$. The design of the experiment is as follows:

$$Y_{ij}=\mu+T_i+ \varepsilon_{ij}$$

Where,

Y_{ij}=Observed value of the dependent variable (turkey)

μ= Population mean.

T_i= Effect of treatment (niacin and yeast).

ε_{ij}=Experimental error

Table 1: Basal Diets Fed to the Turkeys.

Ingredient	Starter Phase	Grower Phase	Finisher phase
Maize	45.00	48.00	50.00
Soybean meal	40.00	37.00	24.10
Fishmeal	7.30	4.50	1.50
Wheat offal	0.00	4.00	17.55
Bone meal	4.50	2.85	3.22
Oyster shell	2.00	2.50	2.50
Vitamin Premix*	0.50	0.50	0.50
Salt	0.25	0.25	0.25
DL-methionine	0.30	0.20	0.10
Lysine	0.10	0.10	0.10
Determined Analysis			
ME (K cal/Kg)	2845.00	3100.00	3150.00
Crude protein (%)	26.00	22.40	19.50
Crude fibre (%)	3.90	4.26	4.65
Crude fat (%)	3.76	3.70	3.57
Calculated Analysis			
Basal Niacin (mg/kg)	60.00	50.00	50.00

*Each 1.25 kg of vitamin premix contains; 10,000,000 I.U Vitamin A, 2,200,000 I.U Vitamin D_3, 10,000 mg Vitamin E, 2000 mg Vitamin K_3, 1500 mg Vitamin B_1, 5000 mg Vitamin B_2, 1500 mg Vitamin B_6, 10 mg Vitamin B_{12}, 15,000 mg Niacin, 20 mg biotin, 125,000 mg Anti-Oxidant, 500 mg Folic acid, 5000 mg Calpan.

RESULTS AND DISCUSSION

Growth Performance

Table 2 shows that birds fed diet supplemented with 240 ppm niacin + 1.5 g/kg yeast recorded the least feed intake and the highest weight gain while control-fed birds had the highest feed intake and the least weight gain.

Table 3 showed similar result with the highest feed intake and least weight gain recorded in the control-fed groups while the niacin and yeast supplemented groups recorded higher weight gain and lower feed intake. Birds fed diet supplemented with 200 ppm niacin + 1.50 g/kg yeast showed the highest (P< 0.05) final live weight and weight gain. This result agreed with Celik *et al.* (2003) that dietary supplemental niacin + L-carnitine have positive effects on body weight gain and feed intake during the early growing stage of broilers. Improved weight gain and feed conversion was reported for broilers fed with supplemental brewer's yeast (Yalcin *et al.,*1993 and Churchil *et al.,* 2000).

At the finisher phase in Table 3, turkeys fed diet supplemented with 200 ppm niacin + 1.5 g/kg yeast had the highest final live weight (P< 0.05), feed intake and weight gain (P< 0.01). The final live weight and feed intake increased with increasing supplemental level of niacin. In all the three phases (starter, grower and finisher), weight gain of turkeys fed diets supplemented with 240 ppm niacin level + 1.5 g/kg yeast (starter phase), 200 ppm niacin level + 1.5 g/kg yeast in the grower phase and 200 ppm niacin level + 1.5 g/kg yeast (grower phase and finisher phase) were highest and consequently translated to the higher final body weight observed. The higher body weight gain observed in the supplemented groups can be attributed to the role of niacin in carbohydrate and protein metabolism. Also, yeast has been a proven growth promoter probiotics in the past. Onifade *et al.* (1999) reported that *saccharomyces cerevisiae* improved feed/gain ratio and body weight gain. The findings of this study is in agreement with the work of Waldroup *et al.* (1985) who reported that supplemental niacin improves body weight gain and utilization. Sentihilkumar *et al.* (1997) registered improvement in productive values when incorporating yeast in broiler diets.

Serum Lipid Profile

Table 4 shows the effect of level of niacin + yeast supplementation on serum lipid profile of 5-8 weeks turkeys. Least (P<0.05) serum cholesterol, triglyceride and Low Density Lipoprotein (LDL) values were obtained with poults fed with 240 ppm niacin + 1.5 g/kg yeast. The blood HDL was not significantly affected. This result agrees with the findings of Kamanna and Kashyap (2000) that the typical effects of niacin include decreases of LDL, cholesterol and Lipoprotein concentrations. Kwiterovich (2000) also affirms that niacin is best used to reduce serum Low Density Lipoprotein (LDL).

Table 2: Growth Performance of Starter Turkeys Fed Diet Supplemented with Niacin and Yeast (5-8 weeks).

Parameters	0 ppm	120 ppm Niacin + 1.5 g/kg Yeast	180 ppm Niacin + 1.5 g/kg Yeast	240 ppm Niacin + 1.5 g/kg Yeast	SEM	P value
Initial weight (g/bird)	940.30	920.10	950.10	940.30	4.50	0.110
Final weight (g/bird)	2280.20	2300.15	2400.20	2450.20	27.40	0.070
Feed intake (g/bird)	4960.20^a	4380.20^c	4480.15^b	4270.10^d	68.10	0.001
Weight gain (g/bird)	1339.90^d	1380.05^c	1450.10^b	1509.90^a	28.20	0.001
Feed/gain ratio	3.70^a	3.17^b	3.09^b	2.83^c	0.05	0.001
Mortality (%)	0.35	0.50	0.50	0.45	0.16	0.180
Total niacin intake(mg/bird	297.61^d	525.62^c	806.43^b	1024.82^a	0.02	0.030

[abc] Means on the same row having different superscripts are significantly different (P<0.05)

Table 3: Growth Performance of Turkeys Fed Diet Supplemented with Niacin and Yeast (9-12 weeks).

Parameter	0 ppm	100 ppm niacin + 1.5g/kg yeast	150 ppm niacin + 1.5g/kg yeast	200 ppm niacin + 1.5g/kg yeast	SEM	P<0.05
Grower Phase						
Initial weight (g/bird)	2280.20	2300.15	2400.20	2450.20	27.40	0.070
Final weight (g/bird)	5430.25[c]	5650.10[ab]	5530.25[b]	5750.15[a]	41.60	0.020
Feed intake (g/bird)	9620.15[a]	8850.00[c]	8840.10[c]	9050.00[b]	82.00	0.001
Weight gain (g/bird)	3150.05[d]	3350.00[b]	3130.05[c]	3299.95[a]	22.40	0.001
Feed/gain ratio	3.05	2.64	2.82	2.74	0.03	0.001
Mortality	0.0	0.0	0.0	0.0	0.00	0.000
Total niacin intake (mg/bird)	481.01[d]	885.00[c]	1326.02[b]	1810.00[a]	0.01	0.002
Finisher Phase						
Final weight (g/bird)	8350.25[c]	8150.25[d]	8480.15[b]	8740.25[a]	43.70	0.021
Feed intake (g/bird)	12451.15[b]	11090.35[c]	12520.25[b]	12710.40[a]	114.90	0.001
Weight gain (g/bird)	2920.00[b]	2500.15[c]	2949.90[a]	2990.10[a]	8.30	0.001
Feed/gain ratio	4.26[b]	4.43[a]	4.24[c]	4.25[bc]	0.14	0.001
Mortality	0.00	0.00	0.00	0.00	0.00	0.000
Total niacin intake (mg/bird)	622.56[d]	1109.04[c]	1878.04[b]	2542.08[a]	0.01	0.003

[abc] Means on the same row having different superscripts differ significantly (P<0.05)

Table 4: The Effect of Level of Niacin + Yeast Supplementation on Serum Lipid Profile of 4-8 Weeks Turkeys.

Parameters	0 ppm	120 ppm niacin+1.5g/kg	180 ppm niacin+1.5g/kg	240 ppm niacin+1.5g/kg	SEM	P-value
Cholesterol (mg/dl)	141.5[b]	142.00[b]	144.93[a]	130.40[c]	0.66	0.010
Triglyceride (mg/dl)	100.00[c]	121.00[a]	103.70[b]	94.30[d]	2.38	0.001
HDL (mg/dl)	39.30	39.40	40.60	39.70	0.19	0.050
LDL (mg/dl)	82.80[b]	78.55[d]	83.50[a]	79.70[c]	0.54	0.001

[abc] Means on the same row having different superscripts are significantly different (P<0.05)

The effect of varying levels of niacin and yeast on turkeys serum lipid profile at grower and finisher phase is shown on Table 5. Turkeys fed diets with varying levels of niacin and yeast showed marked difference in LDL, cholesterol and triglyceride serum contents with regard the control group. This is in agreement with the findings of Hu *et al*. (2012) who reported that niacin effectively reduces plasma triglyceride levels.

Turkeys fed diets containing 200 ppm niacin + 1.5 g/kg yeast had highest serum HDL, least (p<0.01) serum LDL, triglyceride and cholesterol at both the finisher and grower phase in Table 5. It has been stated that LDL lipoprotein is consistently reduced by the high level of HDL in the blood circulation. Niacin prevents athelosclerosis with the high level of HDL by extracting cholesterol from artery walls and disposing them through liver metabolism. Altschul and Hoffer (1958) observed a significant decrease of serum cholesterol in man receiving niacin supplementation. Human medical research confirmed that red yeast rice significantly reduces total cholesterol, LDL cholesterol, and total triacylglycerol concentrations (Heber *et al*., 1999).

Table 5: Effect of Niacin and Yeast Supplementation on Serum Lipid Profile of Turkeys.

Parameters	0 ppm	100 ppm niacin+1.5g/kg	150 ppm niacin+1.5g/kg	200 ppm niacin+1.5g/kg	SEM	P<0.05
Grower phase						
Cholesterol (mg/dl)	193.50[a]	159.35[b]	147.80[c]	126.50[d]	6.82	0.001
Triglyceride(mg/dl)	118.20[a]	115.40[b]	111.00[b]	109.75[c]	2.45	0.001
HDL (mg/dl)	42.65[b]	41.70[c]	41.40[c]	45.50[a]	1.35	0.001
LDL (mg/dl)	120.60[a]	115.50[b]	97.20[c]	67.40[d]	6.52	0.001
Finisher phase						
Cholesterol (mg/dl)	191.65[a]	157.88[b]	141.85[c]	114.40[d]	7.22	0.001
Triglyceride (mg/dl)	129.20[a]	110.40[b]	109.03[b]	100.40[c]	2.74	0.001
HDL (mg/dl)	35.70[b]	30.30[c]	32.30[c]	41.30[a]	1.10	0.001
LDL (mg/dl)	125.20[a]	105.50[b]	87.50[c]	58.60[d]	6.33	0.001

[abc] Means on the same row having different superscripts are significantly different (P<0.05)

Table 6: Effect of Niacin and Yeast Supplementation on Blood Hematology of 4-8 Weeks Turkeys

Parameter	0 ppm	120 ppm niacin + 1.5g/kg yeast	180 ppm niacin + 1.5g/kg yeast	240 ppm niacin + 1.5g/kg yeast	SEM	P<0.05
Packed Cell Volume (%)	34.00	36.00	39.00	38.00	0.59	0.002
Hemoglobin (g/dl)	10.70[c]	11.70[b]	13.30[a]	11.50[b]	0.25	0.001
Red Blood Cell ($X10^{12}$/L)	2.90[c]	3.13[b]	3.21[a]	2.74[b]	0.05	0.001
White Blood Cell (Cumm^3)	31010.00[a]	28125.00[b]	27690.00[c]	15560.00[d]	1531.96	0.001

[abc] Means on the same row having different superscripts are significantly different (P<0.05)

Hematology Indices

Table 6 shows that turkey groups fed diets with varying levels of niacin + yeast had higher (P<0.01) red blood cells (RBC) and hemoglobin (Hb) values.

The white blood cells were least (P<0.01) in turkeys fed diets containing 240 ppm niacin + 1.5 g/kg yeast. Table 7 showed similar results of grower and finisher phase RBC and hemoglobin parameters. RBC and Hb values were highest (P<0.01) in birds fed diets supplemented with 200 ppm niacin + 1.5 g/kg yeast. In all the phases of the experiment, packed cell volume (P>0.05) was insignificant.

The reduced value of WBC in the supplemented groups is an indication that the birds were not under disease threat. Close (1998) reported that niacin plays a vital role in synthesis of hemoglobin. Thus, this work also proves supportive of the role niacin plays in hemoglobin synthesis and its positive relation with other hematological indices. This agreed with Gheisari and Kholeghipour (2006) who reported RBC and Hb were high in chickens fed diet containing 0.2% *Saccharomyces cerevisiae* (granular). Onifade *et al.* (1999) also reported a positive correlation between dietary levels of *saccharomyces cerevisiae* and hematological indices of poultry birds.

CONCLUSION

From the result of this study, it can be concluded that turkeys fed diets supplemented with 240 ppm niacin + 1.5 g/kg yeast at the highest starter phase and 200 ppm niacin + 1.5 g/kg yeast at the grower phase and finisher phase had body weight gain and better live weight at the end of the experiment.

This study showed improved hematological indices and reduced serum lipids profile from the supplementation of varying levels niacin and yeast. 200 ppm niacin + 1.5 g/kg yeast level proves the best among other levels used in this experiment for growth, serum and hematological parameters.

Table 7: Effect of Niacin + Yeast Supplementation on Haematological Indices of Turkeys.

Parameters	0 ppm	100 ppm niacin + 1.5g/kg	150 ppm niacin + 1.5g/kg	200 ppm niacin + 1.5g/kg	SEM	P<0.05
Grower Phase						
Packed Cell Volume (%)	32.00	34.00	35.00	37.00	1.86	0.15
Hemoglobin (g/dl)	13.00[a]	10.40[b]	10.20[b]	9.86 [b]	0.42	0.001
Red Blood Cell ($X10^{12}$/L)	2.47[c]	2.57[b]	2.49[c]	3.28[a]	0.11	0.001
White Blood Cell ($Cumm^3$)	26330.0 [a]	24850.00 [b]	21190.0[c]	19600.00[c]	705.30	0.001
Finisher phase						
Packed Cell Volume (%)	29.00	32.00	30.00	40.00	1.50	0.16
Hemoglobin (g/dl)	9.68 [b]	10.40[b]	10.20[b]	13.50[a]	0.31	0.001
Red Blood Cell ($X10^{12}$/L)	2.47[b]	2.58[b]	2.47[b]	3.46[a]	0.11	0.001
White Blood Cell ($Cumm^3$)	26450.00	25000.00	24300.00	25650.00	715.80	0.001

[abc] Means on the same row having different superscripts are significantly different (P<0.05)

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