RESPONSE OF STARTING TURKEYS FED MALTED SORGHUM SPROUT-BASED DIETS SUPPLEMENTED WITH HIGHER LEVELS OF ROXAZYME G® AND YEAST (*SACCHARROMYCES CEREVISIAE)*

Obadire[1], F.O., Obadire[2], S.O., Ige[3], I.P., Osofowora[4], A.O., Oke[5], C.O., Oso[4], A.O. and Jegede[4], V.A.

[1]Department of Animal Science, Federal University Dutse, Jigawa State, Nigeria.
[2]Medical Laboratory Department, Federal Medical Centre Birnin Kudu, Jigawa State, Nigeria
[3]Medical Laboratory Department, Achievers University, Owo, Ondo State, Nigeria
[4]College of Animal Science and Livestock Management, Federal University of Agriculture, Abeokuta Ogun State.
[5]Ladoke Atintola University, Oyo State, Nigeria
**Corresponding author: florenceobadire@gmail.com*

ABSTRACT

A study was conducted to determine the performance characteristics, nutrient digestibility and some blood indices of starting turkeys fed diets containing 100 g/kg Malted Sorghum sprout (MSP) supplemented with varying combinations of enzyme and yeast. A total of 100-day-old, British United Turkeys (BUT) were reared for 28 days' pre-experimental period. At 28d, birds were assigned to 5 dietary treatments. Experimental diets were formulated such that (Diet 1-without MSP, Roxazyme G /enzyme or yeast) and 4 MSP diets were made of a basal diet containing 100 g/kg MSP supplemented with 200 mg/kg Enzyme + 200 mg/kg Yeast (Diet 2), 250 mg/kg Enzyme + 250 mg/kg Yeast (Diet 3), 300 mg/kg Enzyme + 300 mg/kg Yeast (Diet 4), and 350 mg/kg Enzyme + 350 mg/kg Yeast (Diet 5) in (ratio 1:1) respectively. Starter turkeys fed on mixed additives regardless of the inclusion level had highest growth parameters. Turkeys fed the diet supplemented with 200 mg/kg E+200 mg/kg Y had the best (p<0.05) feed conversion ratio. All apparent nutrient digestibility parameters measured were significantly (p<0.05) affected except for crude protein, ether extract and acid detergent lignin (ADL). Turkeys fed diets supplemented with 200 mg/kgE+200 mg/kg Y and 350mg/kgE+350 mg/kg Y recorded increased values of the nutrient digestibility. All blood parameters measured were significantly (p<0.05) influenced except ALT. Values of PCV Hb, RBC, Glucose, TP, Albumin and Globulins reduced linearly with increasing dosage of enzyme + yeast in the diets. Turkeys fed diet containing a combination of 200 ppm enzyme + yeast obtained higher (p<0.05) values of all the parameters. The AST, Creatinine and uric acid of turkeys fed 350 mg/kg E+350 mg/kg Y was highest for all the parameters. It was concluded that supplementation with equal yeast + enzyme in starter turkey diets containing 100 g/kg regardless of the inclusion level showed improved growth performance, and nutrient utilization and posed no threat to the blood indices. Meanwhile, 200 mg/kg yeast + enzyme in diets containing 100 g/kg was economical in terms of feed cost per kilogram weight.

Keywords: *Blood indices, Enzyme, Malted Sorghum Sprout, Nutrient Utilization, Turkey poults, Yeast*

INTRODUCTION

In Nigeria, feeding constitutes the highest variable cost in poultry production, accounting for at least 60% of such costs, especially in an intensive rearing system (Ahiwe *et al.,* 2018). Mengesha (2011) reported that inadequate animal protein intake is one of the problems of a balanced diet in Nigeria. The poultry industry is one of the fastest means of bridging the protein deficiency gap prevailing in developing countries. Turkey, one of the biggest species of poultry is now widely consumed as it played an important role within the poultry market (Aumueller, 2008). Turkey production is becoming more popular in Nigeria due to the recent embargo on importation of poultry products into the country. Unlike broiler, which matures at 8 weeks with average weight of 2.2 kg, turkey could attain 20 kg weight at 20-24 weeks of age. The advantage of turkey is in its efficient turnover rate and maturity within a short period. Turkey is said to be one of the most nutritional sources of meat protein commercially available and it is low in fat (10%) when compared with beef (24%) and pork (23%) (Pattison, 1992). Smith (1990) reported that turkey contained a higher percentage of protein 28.55% than chicken 27.30%.

Feed manufacturers play a major role in the formulation and preparation of balanced feed by selecting ingredients based on their nutritional properties, availability, and cost, in order to meet the nutrient requirements of the various categories of animals. Meanwhile, the cost of the ingredients required to formulate diets for poultry has risen greatly due to competition between humans, livestock and production industries (Emenalon, 2004). Maize, as example, is used in breweries and bakeries and is the main source of energy which accounts for about 50-60% of a typical monogastric animal diet (Cowieson, 2005). The rising cost of feeding farm animals has compelled nutritionists to search for alternative feedstuff sources which could be produced cheaply and readily available for most parts of the year. Also, capable of being processed and stored without loss in quality or feeding value, fairly high in nutrients and not harmful to the animal. This therefore, necessitates the utilization of alternative feed ingredients. (Mariscal-Landı´n e*t al.,* 2004; Mukhtar, 2007). Sorghum sprout is an example of an agro-industrial by-product which could be used as an alternative feed ingredient. *Sorghum spp.* (Guinea corn) had replaced barley as a raw material in the confectionery and brewing industry in many tropical countries (Evera *et al*., 2019). Malt is extracted from germinated sorghum seeds and the residue consists of sorghum shoots and roots. These residues are collectively referred to as malted sorghum sprouts (MSP). Malting essentially involves soaking of cereal grain (sorghum) for 24-48 hours under controlled condition of moisture, aeration and temperature.

Malted sorghum sprout has a lot of prospects as a livestock feed but its usefulness is limited by its tannin content and non-starch polysaccharides (Elkin *et al.,* 1995). Malted sorghum sprout is reported to contain about 845, 226, 224, 33, 16 and 522 g/kg of dry matter, crude protein, neutral detergent fire, ether extract and nitrogen-free extract in that order (Aning *et al.,* 1998*;* Oduguwa *et al.,* 2001; Oduguwa *et al.,* 2007; Oke *et al.,* 2016b). The low nutritive value for monogastric animals suggested that it cannot be used as a main protein source (Oduguwa *et al.,* (2001) due to its tannin content and non-starch polysaccharides (Elkin *et al.,* 1995). Various methods have been explored in a way to reduce the anti-nutritional factors in MSP although with little success. Hence, there is a need for protein supplements such as yeast and the use of exogenous enzymes is considered appropriate. The use of enzymes as feed additives in livestock feed has shown a lot of prospects as a way of improving weight gain, dry matter digestibility and nutrient digestibility of high-fibre feedstuff by monogastric animals (Sundu *et al.,* 2006). Application of enzymes had been reported to improve fibre digestion and reduce viscosity of digesta (Atteh, 2001; Oke *et al.,* 2010). Oke *et al.* (2010) showed that dietary inclusion of MSP supplemented with single additives at 15% for broilers showed a slight improved growth response. In addition, Oke *et al.* (2016b) reported an improved performance following supplementation of commercial enzymes and yeast in a finisher turkey's diet. Previously, Oke *et al.* (2016a) reported better growth response at a 5% inclusion level and a poorer growth performance at 10% inclusion in Turkey's diet regardless of the inclusion level of the additives. Furthermore, yeast has been reported to improve body weight gain, feed intake and feed conversion ratio. This attribute of yeast could be traced to its content of beta-glucans which has growth-promoting and immune- enhancing effects (Park *et al.,* 2001; Paryad and Mahmoudi, 2008).

Blood according Adeyemi *et al.* (2000) is a means of assessing the clinical and nutritional health status of animals exposed to feeding trials. Biochemical and haematological components of blood are sensitive to elements of toxicity in feed, especially with feed constituents that affect the formation of blood (Oyawoye and Ogunkunle, 2014).

Changes in the constituent compounds of blood when compared to normal values could serve as a health predicator of an animal as well as quality of feed (Wheater *et al.,* 2017). This prompted the conduct of the experiment to determine the effect of combining increased dosage of the solely additives used on higher levels of 10% MSP where poor performance was noticed. Therefore, a study was carried out to determine the performance characteristics, nutrient digestibility and some blood indices of starting turkeys fed diets containing 100 g/kg Malted Sorghum sprout (MSP) supplemented with varying levels of higher combinations of enzyme and yeast.

MATERIALS AND METHODS

Experimental site

The research work was carried out at the Turkey Unit of the Teaching and Research Farms, Federal University of Agriculture, Abeokuta, Nigeria. The study area lies in Latitude 7^0 13' 49.46''N and Longitude $3^0$26'11.98''E.

Test ingredients

Malted Sorghum Sprout and feed additives

The dried MSP used in this study was obtained from a commercial brewery located in Sango-Ota, Ogun State, Nigeria.

The commercial enzyme used in this study is ROXAZYME G® a blend of multi-enzyme blend consisting of endo – 1, 4 – β – xylanase [EC 3.2.1.8], endo – 1, 3 (4) – β – glucanase [EC 3.2.1.6] and endo – 1, 4 – β – glucanase [EC 3.2.1.4] produced by *Trichoderma reesei.* The yeast used was purchased commercially.

Experimental birds and Management

A total of 100 day-olds male British United Turkeys (BUT) was obtained from a commercial hatchery at Ibadan, Oyo State of Nigeria. The poults were brooded for 28 days, vaccinated against diseases scheduled for turkey production and given appropriate prophylactic medications against coccidiosis and stress. A pre-starter diet was formulated to be 28.19% CP and 11.93MJ/kg ME and the diet and water were given *ad libitum* on deep litter housing system for 28 days.

Experimental design and diets

At 28 days, the birds were assigned to 5 dietary treatments with 20 turkeys per treatment based on weight. Each treatment was replicated 4 times with 5 birds per replicate. The 5 treatments consisted of a control diet (Diet 1-without MSP, Roxazyme G /enzyme or yeast) and 4 MSP diets (Table 1). The MSP diets were made of a basal diet containing 100 g/kg MSP supplemented with 200 mg/kg Enzyme + 200 mg/kg Yeast (Diet 2), 250 mg/kg Enzyme + 250 mg/kg Yeast (Diet 3), 300 mg/kg Enzyme + 300 mg/kg Yeast (Diet 4), and 350 mg/kg Enzyme + 350 mg/kg Yeast (Diet 5). The design of the study was a completely randomized design. The feeding trial lasted for 28 days.

Parameters measured

The turkeys were weighed weekly to determine the changes in body weight. Feed intake was determined daily by measuring the feed leftovers; body weight gain and feed conversion ratio were also computed between 28-56 days of the study. A record of mortality was kept as it occurred.

Table 1: Gross composition (g/kg) of the experimental diets (5-8weeks)

Ingredients	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Maize	425	425	425	425	425
Soybean meal	240	240	240	240	240
Full fat soya bean	100	100	100	100	100
Fish Meal	80	80	80	80	80
Wheat offal	100	-	-	-	-
Malted sorghum sprout	-	100	100	100	100
Bone meal	30	30	30	30	30
Oyster shell	14	14	14	14	14
Lysine	1.5	1.5	1.5	1.5	1.5
Methionine	2.0	2.0	2.0	2.0	2.0
Vitamins / Minerals Premix	5.0	5.0	5.0	5.0	5.0
Common salt	2.5	2.5	2.5	2.5	2.5
Enzyme + Yeast	-	+	+	+	+
Total	**1000**	**1000**	**1000**	**1000**	**1000**

Vitamin/Minerals premix supplied per kg diet; vita, 8,000iu; vit D3,1440iu; VitE,21.6mg; VitK3,2.7mgVitB1,1.8mg; VitB2,3.6mg: VitB6,2.7mg; Niacin,21.6mg; VitB12,0.018mg; FolicAcid,0.54mg; Pantothenic acid,9.0mg; Biotin,0.036mg; Choline chloride,270mg; Zinc,27mg; Mn,108mg; Fe,18mg; I2,0.72mg; Se,0.072mg; Cu,1.44mg; Co,0.14

Digestibility study

Metabolic trial was conducted when the birds were 56 days to determine the apparent nutrient digestibility of the diets. Two turkeys per replicate to make a total of 8 turkeys per treatment were randomly selected and housed separately in metabolic cage. The birds were acclimatized for 2 days prior to the commencement of 3-day metabolic trial. A known weight of feed was fed to the birds. Excreta collected per bird per day for 3 days were oven dried (60^0 C). Feed and dried faecal samples were pooled together for proximate analysis according to procedures of official Methods of Association of Analytical chemist (AOAC, 2012), fibre fraction (Van Soest *et al.,* 1991). The ash was treated with HNO3 under mild heat and digested. Analysis was done using the Atomic Absorption Spectrophotometer (Perkin Elmer Optimal 4300DV ICP Spectrophotometer, Beaconsfield, UK). Values obtained were then used to calculate the apparent nutrient digestibility.

Blood parameter

At 56 days of the study, blood samples were collected from 8 randomly selected turkeys per treatment (2 per replicate) to determine the blood profile of the birds. Blood collection was done through brachial vein puncture using needles and syringes (Frandson, 1986). Each blood sample was emptied into 2 sets of well-labeled sample bottles; the sample containing Ethylene diamine tetra acetic acid (EDTA) an anti-coagulant was used for the analysis of hematological traits while the plane bottle without anti-coagulant was used to analyze the serum biochemical traits of the birds. The hematological traits analyzed were: packed cell volume (PCV), haemoglobin (Hb), red blood cell (RBC) and white blood cell (WBC) and biochemical traits: the total serum protein, albumin and globulin using bromocresol green method by Varley *et al.* (1980), Serum creatinine (Bunsnes *et al.*,1945) and serum uric acid concentration (Wootton, 1964) was determined according to standard procedures. Serum enzymes: alanine transaminase (ALT) and aspartate serum transaminase (AST) were analyzed using the commercial kits (Qualigens India. Pvt. Ltd., Catalogue number 72201-04).

Statistical analysis

Data generated were subjected to ANOVA in a Completely Randomized Design (CRD) using SAS (2009) statistical package. Significant means were separated using Duncan's Multiple Range Test. The Polynomial contrast (Linear and quadratic) was applied to determine the effect of inclusion levels of varying mixtures of enzymes and yeast in the diet.

RESULTS AND DISCUSSION

The chemical composition of MSP supplemented with varying higher inclusions levels of additive is presented in Table 2. The study showed crude protein content to have increased with increasing inclusion levels of mixed additives. The dry matter was similar across the dietary treatments regardless of additives inclusion levels. Diet supplemented with 300 ppm mixed additives recorded numerically high dry matter compared to other treatment groups. The crude fibre ranged from 4.44% to 4.28 % for diets supplemented with 350 ppm and 200 ppm mixed additives. The Ash and ether extract were within the same range of 5.68% (Diet 3) to 5.79% (Diet 2) and 3.93% (Diet 5) to 3.74% (Diet 2). The NFE values ranged from 44.67% (Diet 5) to 47.58% (Diet 2). The values of ADF and ADL were similar across the treatments. Although, ADF value decreases with increasing additives inclusion levels and the ADL values reduced across the treatments.

The increase noticed in crude protein following the increased inclusion of mixed additives shows that the additives probably the enzyme acted as catalyst to break the non-starch polysaccharide limiting the utilisation of MSP to release more crude protein in the feed. Enzymes are protein catalyst present mostly in living cells which are constantly and rapidly degraded although, renewed by new synthesis (Cole, 1986). The crude protein content was adequate for starting turkey according to NRC standards. The crude fibre (4.44 %) observed was at variance with the findings of Oduguwa *et al.* (2001) and Obadire *et al.* (2018) who reported 3.69% in MSP diet. The crude fibre (4.44%) reported here was slightly higher compared with 3.69% by Obadire *et al.* (2018). Meanwhile, at highest level compared with 10.75% reported by Oduguwa *et al.* (2001). The low crude fibre might be attributed to the higher combinations of additives which exert great force to break through the NSP in malted sorghum sprout for more solubility. The NFE value of 47.58 % did not agree with findings of Obadire *et al.* (2018) who reported 55.79% in broiler diets supplemented with solely additives. The ash content and ether extract were consonant with the findings of Oduguwa *et al.* (2007) and Obadire *et al.* (2018). Furthermore, ether extract (3.93%) was slightly higher than the values 3.8% and 3.76% reported by Oduguwa *et al.* (2001) and Akinola (2002) respectively. The reduced values of ADF and ADL recorded across the treatments subject to increasing additives inclusion levels could be attributed to the activeness of either or both additives used which militate against the tannin and NSP in MSP thereby enhancing fibre digestion in the feedstuff. Individual works on enzyme and yeast have shown improved fibre digestion and reduce viscosity of digesta (Atteh, 2001; Oke *et al.,* 2010).

The effect of supplementation of varying higher inclusions levels of additives (enzyme + yeast) on the performance of starter turkeys fed basal diets containing 100 g/kg MSP (5-8weeks) is presented in Table 3. Final live weight, weight gain, feed intake, feed conversion ratio, cost of feed per kg diet and cost of feed per kg weight gain were significantly (*p<0.05*) affected by dietary treatment. Starting turkeys fed the diet containing combinations of 200 ppm and 350 ppm enzyme + yeast had the highest (*p<0.05*) final live weight than their counterparts fed control diets, 250 ppm and 300 ppm. Turkeys fed the diet containing combinations of 200, 300 and 350 ppm `enzyme + yeast recorded the highest (*p<0.05*) weight gain and feed intake. Similar report was obtained by Oke *et al.* (2016b) who recorded a significant increase in final live weight, total feed intake and weight gain following dietary supplementation of additives in finisher turkeys fed MSP diets. The increased final live weight observed in 200 ppm and 350 ppm suggested that the crude protein in the diets was properly utilized regardless the inclusion level of the mixed additives either at lower or higher dosages. In addition, the mixed additives might have neutralized the effect of non-starchy polysaccharides in MSP for proper digestion of the nutrients which translated to the better performance recorded. The increased performance of turkeys fed the diets containing combinations of 200, 300 and 350 ppm enzyme + yeast noted in terms of weight gain and feed intake could be attributed to effect of oligosaccharides in yeast and the constituent blend of the multi enzyme used which possibly resulted to formation of more stable intestinal flora and improve feed conversion efficiency as a result of adequate digestion which translated to appreciable performance (Paryad and Mahmoudi, 2008). Previous studies attested to improved performance of poultry following enzyme supplementation (Café *et al.,* 2002; Santos *et al.,* 2004). Also, yeast has been reported to improve growth performance of turkeys (Soil De LosSantos *et al.,* 2007; Huff *et al.,* 2010). The least (*p<0.05*) weight gain, feed intake and the poorest feed conversion ratio was obtained with starter turkey fed combinations of 250 ppm and control diet. Meanwhile, the best feed conversion ratio was obtained with turkeys fed diet containing a combination of 200 ppm enzyme + yeast. This was similar to values obtained for turkeys on the diet 300 and 350 ppm enzyme + yeast. The improved feed conversion ratio observed across the dietary treatments following the supplementation of the mixed additives regardless of the inclusion level could be attributed to combined effect of the two additives which created a great synergy to have broken the bond of non-starchy polysaccharide (NSP) in MSP that resulted to proper digestion of nutrients for better feed efficiency. The result agreed with Ghasemi *et al.* (2006) and Park *et al.* (2001) who reported better improvement in

Table 2: Chemical Composition of the Experimental Diets

Determined analyses (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Dry matter	91.06	90.86	90.77	90.92	90.89
Crude protein	28.65	29.47	31.24	31.75	32.13
Ether extract	4.05	3.74	3.89	3.78	3.93
Ash	5.57	5.79	5.68	5.85	5.72
Crude fibre	3.64	4.28	3.89	4.33	4.44
NDF	35.82	36.12	36.06	35.83	35.54
ADF	19.66	18.87	18.63	18.54	18.29
ADL	2.97	2.73	2.52	2.36	2.31
NFE	49.15	47.58	45.59	45.21	44.67

NDF=Neutral digestible fibre; ADF=Acid detergent fibre; ADL=Acid detergent lignin; NFE=Nitrogen free extract weight gain and feed conversion ratio of chicks fed a diet supplemented with yeast (*Saccharomyces cerevisiae*). In addition, Paryad and Mahmoudi (2008) observed improved weight gain, feed intake and feed conversion ratio in broiler chickens a fed diet supplemented with 1.5% *Saccharomyces cerevisiae*. Similarly, Rajmane *et al.* (1995), Atteh (2000) and Langhout and Schutte (2001), reported improved growth performance in poultry birds following dietary supplementation of enzymes. The study aligned with the theory that combinations of two or more additives resulted in a greater positive effect on poultry production (Oke *et al.,* 2012). Furthermore, cost of feed per kg diet significantly ($p<0.05$) increased with increasing mixed additives inclusion level used. The cost of feed per unit weight gain was cheapest ($p<0.05$) for turkeys fed the diet containing combination of 200 ppm enzyme + yeast. Birds fed the diets containing combination of 250, 300 and 350 ppm enzyme + yeast showed similar feed cost per kg weight gain and were more expensive compared to turkeys fed the 200 ppm combination of additives. The cost of feed per unit weight gain was cheapest for turkeys fed diet containing a combination of 200 ppm enzyme + yeast. It implied that it's more economical to produce starter turkey on 100 kg/g MSP with combination of 200 ppm enzyme + yeast than at higher inclusion levels since similar results were obtained with other treatments. Survivability was not ($p>0.05$) affected across the treatments. Although, turkeys on control diet survivability was numerically lower compared to others. It's worth noting the fact that survivability was not affected across the treatment means the combined additive regardless of the inclusion levels did not pose any toxic or deleterious effect which led to high survival with the 100 kg/g MSP diet.

The effect of supplementation of varying higher inclusions levels of additives (enzyme + yeast) on apparent nutrient utilization of starter turkey fed MSP-based diet is shown in Table 4. The result revealed that the percentage dry matter, ash, crude fibre, NDF, ADF and NFE digestibility were significantly ($p<0.05$) influenced by the treatments imposed. Meanwhile, the protein retention, fat and ADL digestibility were not significantly ($p>0.05$) different across the treatments. It suggested availability of more nutrients for effective utilization which corroborated the improved growth performance observed in the turkeys. Birds fed diet containing 250 and 300 ppm of mixtures of enzyme + yeast recorded significantly ($p<0.01$) higher dry matter digestibility which was similar with birds fed 350 ppm. The least dry matter digestibility value ($p<0.05$) was recorded for birds on 200 ppm mixtures of enzyme + yeast diet. Birds fed the diet containing 300 ppm mixtures of enzyme + yeast had increased ($p<0.05$) NDF digestibility. However, birds on 200, 250 and 300 ppm mixtures of enzyme + yeast had the lowest ($p<0.05$) NDF digestibility. The non-significance observed in the protein retention and ADL digestibility with reduced NDF digestibility of turkeys are indications that higher dosage of mixed additives was able to ameliorate the effect of tannin and anti-nutritional factors present in MSP for proper feed digestion which increased the efficiency of nutrient utilization. Furthermore, the use of enzyme as feed additives in livestock feed has been reported to show positive effects on weight again, dry matter digestibility and nutrient digestibility of high fibre feedstuff (Sundu *et al.,* 2006). Also, Ravindran *et al.* (1999) also affirmed that enzyme supplementation significantly improved body weight, feed consumption, dietary energy and protein utilization. Consequently, findings of this study corroborate the observation of Annison and Choct (1993) and Oke *et al.* (2012), who reported improved protein digestibility, dry matter digestibility, crude fibre digestibility and fat digestibility in poultry following supplementation of additives.

The effect of higher combinations of enzyme and yeast supplementation levels on blood parameters of the turkeys is presented in Table 5. The results revealed a significant ($p<0.05$) effect on all parameters measured except ALT values. Turkeys fed diet containing combination of 200 ppm enzyme + yeast recorded higher numerical value while the least similar values were recorded for other treatment groups. Values of PCV Hb, RBC, Glucose, TP, Albumin and Globulins reduced linearly (*p<0.05*) with increasing dosage of mixed additives of enzyme + yeast increased in the turkey's diet although values were within the normal range for healthy birds. Turkeys fed diet containing combination of 200 ppm enzyme + yeast recorded the highest (P<0.05) of all the parameters measured above in table 5. Above 200ppm combination of enzyme + yeast recorded lower values for all the parameters measured with birds on control diet. The aspartate aminotransferase (AST) values were highest for turkeys fed the diet containing combination of 350 ppm enzyme + yeast. Similar but lower values were obtained for birds on

Table 3: Effect of supplementation with varying higher inclusions levels of additives (enzyme + yeast) on performance of turkey poults fed basal diets containing 100g/kg MSP (5-8 weeks)

Parameters	Enzyme and Yeast Levels (mg/kg)						*p value*	
	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SEM	L	Q
Initial weight (g/bird)	1500.00	1510.00	1540.00	1500.00	1570.00	7.07	0	0
Final live weight (g/bird)	3566.30^{c}	3957.50^{a}	3622.50^{b}	3692.50^{b}	3895.00^{ab}	55.32	0.822	0.037
Total Feed intake (g/bird)	5035.00^{c}	5232.50^{ab}	5072.50^{b}	5137.5^{ab}	5340.0^{a}	37.32	0.259	0.014
Total Weight gain (g/bird)	2066.30^{ab}	2447.50^{a}	2082.5^{b}	2192.5^{ab}	2325.0^{ab}	54.48	0.553	0.038
Feed Conversion Ratio	2.44^{a}	2.13^{b}	2.44^{a}	2.34^{ab}	2.30^{ab}	0.04	0.290	0.036
Survivability (%)	97.00	100.00	100.00	100.00	100.00	0.00	1.01	1.22
Cost of feed/kg diet (₦/kg)	137.40^{e}	146.2^{c}	148.9^{c}	151.7^{b}	154.4^{a}	0.79	0.610	0.042
Cost of feed/kg wt gain (₦/kg)	303.12^{c}	312.03^{b}	362.57^{a}	356.0^{a}	354.35^{a}	6.69	0.049	0.021

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

Table 4: Effect of supplementation with varying higher inclusions levels of additives (enzyme + yeast) on apparent nutrient digestibility of turkeys fed basal diets containing 100g/kg MSP based diet (5-8 weeks) fed MSP based diet

Parameter Diet 1	Enzyme and Yeast Levels (mg/kg)					*p value*	
	Diet 2	Diet 3	Diet 4	Diet 5	SEM	L	Q
DMD 68.79^{ab}	66.49^{b}	71.03^{a}	71.41^{a}	69.50^{ab}	0.69	0.132	0.009
Protein 72.89	75.42	73.45	72.99	73.15	0.56	0.155	0.237
Fat 75. 40	76.70	76.65	76.75	77.07	0.48	0.789	0.951
Ash 82.57^{ab}	83.02^{b}	84.26^{ab}	86.85^{a}	85.32^{ab}	0.57	0.042	0.079
Crude 72.34^{b}	73.72^{b}	72.79^{b}	74.37^{b}	76.70^{a}	0.48	0.008	0.003
ADF 53.13^{c}	56.07^{a}	53.24^{ab}	51.68^{b}	55.48^{ab}	0.73	0.624	0.043
ADL 44.65	46.37	47.47	48.97	45.93	0.53	0.969	0.143
NFE 62.23^{c}	67.66^{a}	63.21^{b}	64.53^{ab}	64.68^{ab}	0.66	0.210	0.009

[abc] *Means on the same row having different superscripts are significantly different (P<0.05), DMD-Dry matter digestibility, NDF-Neutral detergent fiber, ADF-Acid detergent fiber, ADL-Acid detergent lignin, NFE-Nitrogen free extract*

control diet and turkeys fed diets containing combination of 200, 250 and 300 ppm enzyme + yeast. The serum uric acid showed a significant increase (*p<0.05*) for birds fed diet containing combination of 350 ppm enzyme + yeast while a statistically reduced value was recorded for turkeys on 200, 250 and 300 ppm enzyme + yeast. Creatinine values increased significantly (*p<0.05*) with increased additive inclusion. Birds fed diet containing combination of 200 ppm enzyme + yeast had the least (*p<0.05*) value for creatinine while other counter parts recoded higher similar values.

The improved values of PCV Hb, RBC, Glucose, TP, Albumin and Globulins obtained with increasing dosage of mixed additives (enzyme + yeast) in the turkey's diet support the work of Isaac *et al.* (2013) which states that animal with good blood composition will likely portray good performance which is attributed to high protein efficiency ratios and better feed conversion recorded in all treatments supplemented with mixed additives that proofs the efficacy of additives to be able to ameliorate the effect of tannin without any negative effect on the turkeys.

The increased PCV, Hb and TP of birds on mixtures of enzyme + yeast especially 200 ppm as compared to their counterparts on the control diet implied that starter turkeys had higher blood plasma and haemoglobin levels which are positively correlated with protein quality and levels in the diets. It is an indication that the nutritional profile of the diet was more enriched when supplemented with combined additives than solely enzyme or yeast. Nutrition was reported to influence the haemoglobin level of the blood (Adamu *et al.*, 2006). The PCV is a function of the cellular component of the blood and varies with the amount of blood plasma (Jain, 1986). The haematological parameters especially PCV and Hb were positively correlated with the nutritional status of the animal as opined by (Adejumo, 2004). Also, the increased RBC, and HB of starter turkeys fed 200 ppm enzyme + yeast supplementation suggested that the turkeys had high oxygen-carrying capacity (Chineke *et al.,* 2006). Consequently, the increased WBC values for turkeys above 200 ppm dietary supplementation of enzyme + yeast suggested that a combination of two or more additives triggers the production of leucocytes. White blood cells played prominent roles in disease resistance especially concerning the generation of antibodies and the process of phagocytosis (Soetan *et al*., 2013). The reduced value of WBC obtained for turkeys fed diet containing 200 ppm additives portrays the absence of foreign bodies which could trigger or raise the leucocyte count. The reduction in serum urea concentrations noticed in birds fed 200 ppm additive as compared to increased serum uric acid in birds on control diet add credence to the fact that additives were able to ameliorate the tannin and NSP present in MSP which resulted to efficient protein utilization. The reduction in serum urea concentrations could be attributed to nutritionally balance protein-based diets. Esonu *et al.,* (2001) opined that serum urea and TP content depends on both the quantity and quality of the protein supplied in the diet. Oduguwa and Ogunmodede (1995) reported high serum uric acid concentration due to inefficient protein utilization. The non–significance observed in ALT and the reduction in AST of turkeys fed mixed additives indicates improved liver function. Oloruntola *et al.,* (2018) postulated that abnormal rising of AST concentration indicates liver and biliary system disease, skeletal muscle disease, myocardial injury, haemolytic disorder and haemolysis.

CONCLUSION

In conclusion, starter turkey diet containing 100 g/kg MSP could be supplemented with varying combined additives regardless of inclusion level for improved growth performance, nutrient digestibility and without any negative influence on blood indices. Meanwhile, supplementation with equal mixtures of 200 mg/kg yeast + enzyme fed in diets containing 100 g/kg gave a better cost-benefit in terms of feed cost per kilogram weight for starter turkeys. Further research should be carried out by subjecting a higher quantity of malted sorghum sprout (MSP) to different pro-

Table 5: Effect of supplementation with varying higher inclusions levels of additives (enzyme + yeast) on hematological measurements of turkey poults fed basal diets containing 100g/kg MSP based diets (5 - 8 weeks)

Parameter	Enzyme and Yeast Levels (mg/kg)					*p value*		
	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SEM	L	Q
Packed cell volume (%)	30.12^{d}	40.25^{a}	37.25^{b}	32.25^{bc}	35.75^{c}	0.47	0.000	0.000
Haemoglobin (g/l)	10.01^{d}	13.43^{a}	12.40^{b}	12.08^{bc}	11.93^{c}	0.16	0.000	0.000
White blood cell (x10^{9}/L)	189.75 ^{a}	159.25^{b}	159.50^{b}	160.75^{c}	180.00^{a}	3.30	0.387	0.000
Red blood cell (x10^{12}/L)	157.62^{b}	204.75^{a}	143.75^{b}	133.25^{b}	141.50^{b}	7.59	0.001	0.000
Glucose (mg/dl)	175.50^{b}	183.75^{a}	164.20^{c}	172.30^{b}	159.53^{d}	2.42	0.000	0.002
Total protein (g/dl)	41.05^{ab}	43.13^{a}	40.35^{ab}	39.15^{b}	39.23^{b}	0.51	0.001	0.001
Albumin (g/l)	17. 04 ^{ab}	17.83^{a}	16.80^{b}	17.33^{ab}	17.10^{ab}	0.14	0.207	0.165
Globulin (g/L)	24.01^{ab}	25.30^{a}	23.53^{ab}	21.83^{b}	22.13^{b}	0.48	0.004	0.006
AST (iu/L)	57.15^{b}	57.25^{b}	59.00^{b}	67.00^{b}	79.25^{a}	2.15	0.016	0.000
ALT (iu/L)	6.15	6.25	5.50	5.50	10.50	1.00	0.162	0.127
Uric acid (mg/dl)	2.36 ^{a}	1.87^{b}	1.85^{b}	1.87^{b}	2.03^{a}	0.07	0.269	0.000
Creatinine (mg/dl)	1.60^{b}	1.05^{c}	1.43^{b}	1.58^{b}	1.70^{a}	0.13	0.356	0.018

^{abc}Means on the same row having different superscripts are significantly different ($P<0.05$);
ALT=Alanine aminotransferase AST-=Aspartate aminotransferase

cessing methods with supplementation of equal mixtures of 200 mg/kg yeast + enzyme in turkeys' diet to ascertain level of MSP tolerance in turkey.

REFERENCES

Ahiwe E.U., Apeh, A.O., Medani, B.A. and Paul, A.I. (2018). Managing dietary energy intake by broiler chickens to reduce production costs and improve product quality. Animal husbandry and nutrition. http://dx.doi.org/10.5772/Intech open 76972.

A.O.A.C. (2012). Official methods of analysis (19th Ed.). Association of Official Analytical Chemist, Washington D.C. USA.

Adamu, S., Thomas A., Iseh, N.M., Fathum, M.Y. and Esiene, K.A.N. (2006). Normal values of haematology of Nigeria adopted abino rats (*Rattus norvegicus)* in Zaria. *Proceedings of the 31st Annual Conference of Nigerian Society for Animal Production.* Pp. 217-219.

Adejumo, D.O. (2004). Haematology, growth and performance of broiler finisher fed ration supplemented with Indian almold (*Terminalia catappa*) husk and kernel meal. *Ibadian Journal of Agricultral Research,* 1 (1):1-6.

Adeyemi, O.A., Fasina, O.E. and Balogun, M.O. (2000). Utilization of full fat Jatropha seeds in broiler diet: Effect on haematological parameters and blood chemistry, *Proceedings of the 25th Conference of Nigerian Society for Animal Production held at Michael Okpara University of Agriculture, Umudike*, pp. 108-109.

Akinola, O.A. (2002). Effect of alkaline treated MSP and untreated MSP on broilers. A Master of Agric. Dissertation submitted to Animal Nutrition Department. University of Agriculture Abeokuta, pp. 27-34.

Aning, K.G., Onifade, A.G., Awkan, J.A. Adekola, A.L. and Letor, V.A. (1998). Effect of replacing dried brewers dried grain with sorghum rootlets on growing nutrient utilization and some blood constituent in rats. *Animal Feed Science Technology,* 71: 185-190.

Annison, G. and Choct, M. (1993). The inhibition of nutrient digestion by wheat pentosans. *British Journal of Nutrition*, 67: 123-132.

Atteh, J.O. (2000). The use of enzyme to improve the nutrients value of wheat milling by-product (wheat bran) in poultry feeds. Seminar on starting the New Millennium with an array of tailor made biotechnical improved for flour milling and baking industry, Lagos, Nigeria.

Atteh, J.O. (2001). Versatility of nutrase xyla as a feed additive for monogastric animals. A paper presented at a two-day seminar on starting the millennium with an array of tailor-made biotechnology improvement of flour milling and baking industry at Sheraton hotel, Lagos, May 2-3, 2001.

Aumueller, R. (2008). Certified production of commercial turkeys. Production Proc. Special Turkey. *World's Poultry Magazine* 10 pp. 18.

Bunsnes, R.W. and Taussky, A.A. (1945). The calorimetric determination of creatinine by the Jaffe reaction. *Journal of Biology and Chemistry,* 158: 581-591.

Cafe, M.B., Borges, C.A., Fritis, C.A. and Waldroup, P.W. (2002). Avizyme improves performance of broilers fed corn-soybean meal-based diets. *Journal of Applied Poultry Resource*, 11: 20-33.

Chineke, C.A., Ologun, A.G. and Ikeobi, C.O.N. (2006). Haematological parameters in rabbit breeds and crosses in humid tropics. *Pakistan Journal of Biological Sciences,* 9(11): 2102-2106.

Coles, E.H. (1986). Veterinary Clinical Pathology of Domestic Animals. 2nd edition, Academic Press, New York, USA.

Cowieson, A.J. (2005). Factors that affect the nutritional value of maize for broilers. *Animal Feed Science Technology,* 119: 2293-305.

Elkin, R.G., Rogler, J.C. and Sulliven, T.W. (1995). Differential response of ducks and chicks to dietary Sorghum tannins. *Journal of the Science of Food and Agriculture,* 57: 542-553.

Emenalon, O. D. (2004). Comparative performance of broiler chicks fed diets containing differently processed *Mucuna pruriens* seed meals. *Nigerian Journal of Animal Prod*uction, 3(1): 13-16.

Esonu, B.O., Emenalom, O.O., Udedibie, A.B.I., Herbert, U., Ekpor, C. F., Okoli, I.C. and Ihukwumere, F.C. 2001. Performance and blood chemistry of weaner pigs fed raw mucuna beans (velvet bean) meal. *Tropical Animal Production Investiment,* 4: 49-54.

Evera, E, Abedin Abdallah, S.H., Shuang, Z., Sainan, W. and Yu, H. (2019). Shelf life and nutritional quality of sorghum beer: Potentials of phytogenic- based extracts. *Journal of Agricultural food and Technology,* 9: 1-14

Frandson, R.D. (1986). Anatomy and Pysiology of farm Animals, 4th Edition. Lea and Febilger. Pennsylvania, USA. Pp. 240-242.

Ghasemi, H.A., Tahmasbi, A.M., Moghaddam, G.H., Mehri, M., Alijani, S., Kashefi, E. and Fasihi, A. (2006). The effect of phytase and *Sacharomyces cerevisiae* (Sc47) supplementation on performance, Serum parameters, phosphorous and calcium retention of broiler chickens. *International Journal of Poultry Science,* 5(2): 162-168.

Huff, G.R., Huff, W.E., Farnell, M.B., Rath N.C., Soli de Los Santos, F. and Donoghue, (2010). Bacterial clearance, heterophil function and hematological parameters of transport- stressed turkey poults supplemented with dietary yeast extract. *Poultry Science*, 89: 447-456.

Isaac, L.J., Abah, G., Akpan, B. and Ekaette, I.U. (2013). Haematological properties of different breeds and sexes of rabbits. *Proceedings of the 18th Annual conference of Animal Science Association of Nigeria*: Pp. 24-27.

Jain, M.C. (1986). *Schalon's Veterinary haematology*. 6thedition. Lea and Fabinger, Philadelphia. U.S.A. pp. 178-207.

Langhout, D.J., Schutte, J.B., Geerse, C., Kies, A.K. and Dejong, J. (2001). Effect of chick performance and nutrient digestibility of an endogenous enzyme added to wheat and rye -based diet in relation to fat source. *British Poultry Science,* 40(5): 557-563.

Mariscal-Landı´n, G., Avellaneda, J.H., Reis de Souza, T.C., Aguilera, A., Borbolla, G.A. and Mar, B. (2004). Effect of tannins in sorghum on amino acid ileal digestibility and on trypsin and chymotrypsin activity of growing pigs. *Animal Feed Science Technology,* 117: 245-264.

Mengesha, M., Tamir, B. and Dessie, T. (2011). Village Chicken constraints and traditional management practices in Jamma District, South Wollo, and Ethiopia. *Livestock Research for Rural Development*, 23: 37. Retrieved http// www.Irrd.org./ Irrd23/ 2/meng23037.htm.

Mukhtar, A.M. (2007). The effect of feeding Rosella (*Hibiscus sabdariffa*) seed on broiler chick performance. *Research Journal of Animal and veterinary Science*, 2: 21-23.

Obadire, F.O., Olorunisola, R.A., Obadire, S.O., Oluwatosin, O.O., Muhammad, A.I., Tijjani, A. and Amin, A. B. (2018). Blood chemistry and carcass characteristics of starter broilers fed containing malted sorghum sprouts or wheat offal based diets supplemented with yeast culture and enzyme. *Bulletin of Animal Health and Production in Africa*, 66 (1): 35-44.

Oduguwa, O.O., Fafiolu, A.O. Jegede, A.V. and Akinwale, P.B. (2007). The effect of diets containing malted sorghum sprout supplemented with yeast and amyloglucosidase enzyme on blood composition of broiler chickens. *Proceedings of the spring meeting of the World's Poultry Science Association, UK Branch held at Southport U.K 3rd -4th April, 2007, 40-41.*

Oduguwa, O.O., Fanimo, A.O., Oduguwa, B.O. Iyayi, E.A. and Opadotun, A.I. (2001). Effects of enzyme supplementation on the nutritive value of MSP in the rat. *Tropical Journal of Animal Science,* 4(1): 189-195.

Oduguwa, O.O. and Ogunmodede, B.K. (1995). Comparative growth response of three commercial vitamins and trace minerals premixes for rearing broiler chicks at the starter and finisher phases. *Pertanika Journal of Tropical Agriculture,* 19: 81-87.

Oke, F.O., Oduguwa, O.O., Fafiolu, A.O, Jegede, A.V., Idowu, O.M.O. and Südekum, K.H. (2010). Effect of yeast and enzyme supplementation on energy metabolisability by broiler chickens fed diets containing malted sorghum sprouts and wheat bran. *Proceedings of the Spring meeting of the World's Poultry Science Association, UK Branch held at Queens University, Belfast, UK. 13/14 April, 2010.* Pp. 40.

Oke, F.O., Oduguwa, O.O., Fafiolu, A.O, Jegede, A.V., Idowu, O.M.O. and Südekum, K.H. (2012). Response of turkeys to diets containing malted sorghum sprouts enzyme or yeast. *Proceedings of the Annual Spring meeting of the World's Poultry Science Association, UK Branch held at Queens University, Belfast, UK. 13/14 April,* pg 35.

Oke, F.O., Oduguwa, O.O., Fafiolu, A.O, Jegede, A.V., Idowu, O.M.O. and Südekum, K.H. (2016a). Effect of yeast and enzyme supplementation on energy metabolisability by broiler chickens fed diets containing malted sorghum sprouts and wheat bran. *Proceedings of the Spring meeting of the World's Poultry Science Association, UK Branch held at Queens University, Belfast, UK. 13/14 April, 2010.* Pp 40.

Oke, F.O., Oso, A.O., Oduguwa, O.O., Adeyemi, O.A, Oso, A.O, Jegede, A.V., Osofoora A.O, Olorunisola R.A. and Adeoye, A.A. (2016b). Performance Characteristics and nutrient digestibility of Finisher Turkeys fed diets containing malted sorghum sprout with varying combinations of additives. *Nigerian Journal of Animal Production,* 43(1): 77-85.

Oloruntola, O.D., Ayodele, S.O., Adeyeye, S.A. and Agbede, J.O. (2018). Performance, haemato-biochemical indices and antioxidant status of growing rabbits fed on diets supplemented with mucunapruriens leaf meal. *World Rabbit Science,* 26: 277-285.

Oyawoye, and Ogunkunle, (2014). Effects of feeding tannin containing forage in varying proportion with concentrate on the voluntary intake, haematological and biological indices of goats. *Trakia Journal of Science*, 1: 73-83.

Parks, C.W., Grimes, J.L., Ferket, P.R. and Fairchild, A.S. (2001). The effect of mannan oligosaccharides, bambermycins, and virginiamycin on performance of large white male market turkeys. *Poultry Science*, 80: 718-723.

Paryad, A. and Mahmoudi, M. (2008). Effect of different levels of supplemental yeast *Ssaccharomyces cerevisiae*) on performance, blood constituents and carcass characteristics of broiler chicks. *African Journal of Agricultural Research*, 12: 835-842.

Pattison, M. (1992). *The health of poultry*. Longman Scientific and Technical, Longman group U.K. Ltd. 2nd ed. Pp. 123-128.

Rajmane, B.V., Patil, B.M. and Ranade, S.A. (1995). Peformance of broilers on unconventional feeds supplemented with Roxazyme G. *Biotechnologija SU. Stocarstvu*. 11 (3-6): 153-163.

Ravindran, V., Cabahug, S., Ravindran, G. and Bryden, W.L. (1999). Effect of phytase supplementation individually and in combination with glycanase on the nutritive value of wheat and barley. *Poultry Science,* 78: 1588 -1595.

Santos, A. A., Fecket, P. R., Grimes, J. L. and Edens, F. W. (2004). Dietary supplementation of endoxylanases and phospholipase for turkeys fed wheat based ration. *International Journal of Poultry Science,* 3(1): 20-32, 2004.

SAS (2009). Statistical Analysis Systems. User's Guide, Version 9.0 for windows, SAS Institute, Inc. Cary.

Soetan, K.O., Akinrinde, A.S. and Ajibade, T.O. (2013). Preliminary studies on the haematological parameters of cockerels fed raw and processed guinea corn (Sorghum bicolor). Pp: 49-52. *Proceedings of 38th Annual Conference of Nigerian Society for Animal Production.* Vol. 2(1): 2014.

Smith, A. J. (1990). *The Tropical Agriculturalist Poultry* London, CTA Macmillan. Pp. 108.

Solis De Los Santos, F., Donoghue, A. M., Farnell, M.B., Huff, G. R., Huff, W.E. and Donoghue, D.J. (2007). Gastrointestinal maturation is accelerated in turkey poults supplemented with a mannan oligosaccharide yeast extract (Alphamune). *Poultry Science Journal*, 86: 921-930.

Sundu, B., Kumar, A. and Dingle, J. (2006). Response of broiler chicks fed increasing levels of Copra meal and enzymes. *International Journal of Poultry Science,* 5(1): 13-18.

Van Soest, P.J., Robertson, J.B. and Lewis, B.A. (1991). Methods for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science,* 74: 3588-3597.

Varley, H.A., Gowshock, H. and Bell, M. (1980). Determination of serum urea using the diacetyl monoxide method. Practical Clinical Biochemistry 5th Edition. William Heinemann Medical Books Ltd London.

Wheater, G., Elshahaly, M., Naraghi, K., Tuck, S.P., Datta, H.K. and van Laar, J.M. (2017). On behalf of the Hours trial investigator group. Changes in bone density and bone turnover in patients with rheumatoid arthritis treated with rituximab, results from an open- label, single treatment arm, and prospective clinical trial. PLOS One Aug 6: 13 (8): eo201527. Doi: 10.1371/journal.pone.0201527. PMID: 30080871; PMCID: PMC6078302.

Wootton, I.D.P. (1964). Microanalysis in Medical Biochemistry. 4th Edition, Churchill, London, pp 1159.