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ORIGINAL RESEARCH ARTICLE

Growth, apparent nutrients digestibility, organ weights and blood profile of rabbits (*Oryctolagus cuniculus* Linn.) fed fungal treated maize husk based-diets

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ABSTRACT

Performance, organs weight, apparent nutrient digestibility and blood profile of growing rabbits fed graded dietary levels of fungal treated maize husk (FTMH) based diets were assessed in this study. In a completely randomised design, rabbits (n = 80) were assigned to five treatments each replicated four times with four rabbits per replicate. Wheat offal was replaced with FTMH at 0, 25, 50, 75 and 100% in rabbit diets and fed for 59 days. At day 56, blood (5 mL) was sampled for blood analyses. Five rabbits were selected and carefully dissected into prima cuts. organs, internal and external offals'. Data on performance indices, apparent nutrients digestibilities, proximate and crude fibre fractions of the diets were analysed. The FTMH based diets significantly improved (P<0.05) final weight and daily weight gain of rabbits. The FCR of rabbits (3.31, 3.27, 3.50, 3.15 and 3.90 for rabbits on T1, T2, T3, T4 and T5, respectively), differed significantly (P<0.05). Apparent digestibility of nutrients was significantly improved (P<0.05) by increased FTMH based diets. Serum protein, albumin and globulin were significantly (P<0.05) affected by dietary treatments with values ranging from 7.30 – 7.80 g/dL, 2.5 – 2.80 g/dL and 4.70 – 5.30 g/dL, respectively. Increased dietary FTMH reduced serum cholesterol significantly (P<0.05). Urea (mg/dL) ranged from 30 – 32 and creatinine (mg/dL) from 0.50 to 1.20. Observations from the present study suggests that FTMH could replace wheat offal at 25-75% without any deleterious effect on performance, apparent digestibility of nutrients and the blood profile.

Keywords: Rabbits feeding, Fungal treatment, Maize husk, Wheat offal

INTRODUCTION

Poor economic conditions in developing countries, especially in Nigeria and the attendant shortage of animal protein have given impetus to the production of rabbits. This is mainly because of its short gestation period, fast growth rate and low cost of production. Report (Nkwocha *et al.*, 2014) revealed that rabbits (*Oryctolagus cuniculus*) appear to be the most sustainable source of high quality animal protein for the expanding population of the developing countries like Nigeria.

The attributes of rabbits such as affordability or low management cost, small-bodies size, short generation interval, fecundity, rapid growth rate, genetic diversity, ability to utilise forage, adaptation over a wide range of ecological environment and most importantly, more effective utilisation of agricultural waste products when compared to other monogastrics species (Nkwocha *et al.*, 2014) were attractive. Nigeria is estimated to have up to 1.7 million rabbits (FAO, 1995).

Commercial rabbitry requires conventional cereal grains like corn for pellet production which are oftentimes expensive and/or unavailable. The high cost of feeding rabbit is a major challenge to producer and therefore the need for alternative feed resources that are cheaper and available. In Nigeria, large tonnage of maize husk is generated from maize production annually which are mostly burnt or left on the farm to rot. Burning with its attendant effect on the environment is scientifically not a sustainable option. However, the husk is a possible cheap feed resource that could be employed in the feeding of rabbits. Although, maize husk has low nutritional content, there are however, possible interventions such as fungal treatment which can assist in upgrading maize husk to value added herbivore feed.

The review of Mahesh and Mohinni (2013) was based on reports of fungal degradation techniques to enhance various agricultural crop residues for ruminants' feeding. In a more recent document, Shahzad *et al*. (2016) fed rations with a 33% replacement of wheat straw with fungal treated wheat straw in the total mixed rations and observed enhanced growth performance in Nili Ravi buffalo calves by improving feed intake and nutrient digestibility. Other reported attempts at enhancing the nutritive values of crop residues and by products using fungal biodegradation (Akinfemi *et al*., 2008 a, b; Belewu and Babalola, 2009; Akinfemi and Ogunwole, 2012; Akinfemi and Ogunwole, 2013) were focused on ruminants and rats (Belewu *et al*., 2004) without attempt at evaluating the effects such feeding resource could have on performance and implications on health of rabbits.

Therefore, this study was aimed at assessing the effect of replacing wheat offal with fungal treated maize husk in the diet of growing rabbits on performance, digestibility of nutrients, organ weights and blood profile.

MATERIALS AND METHODS

The experiment was carried out at the Rabbitry Unit of the Teaching and Research Farm, Yaba College of Technology, Epe Campus, Lagos State, Nigeria. The area is located in the rain forest zone of Nigeria.

Animal housing and their management

Eighty, 5-8 weeks old weaned rabbits of mixed breeds and sex with body weight ranging from 687-692g were randomly assigned to five dietary treatment groups of 16 rabbits per group in a completely randomised design. The rabbits were housed in all-wire metabolic cages with provision of feeding and drinking troughs. The rabbits were fed *ad-libitum* twice daily at 8.30 and 15.30 hours with adequate water provision. Feed intake and live weight were recorded daily and weekly, respectively throughout the experimental period which lasted 59 days. The rabbits were treated for ectoparasites and fed with the experimental diets before the commencement of the experiment.

Fungal treatments of maize husk in large scale (on-farm condition)

The experiment was carried out at the Small Ruminant Unit of Teaching and Research Farm, Yaba College of Technology, Epe Campus, Lagos State between the period of August and December. A heap of 100kg milled maize husk was moistened with water on a concrete floor, covered with cellophane sheet and allowed to ferment for two weeks. The fermenting heap of milled maize husk was turned every three hour intervals to allow even distribution of heat. After the completion of the composting process, the fermented substrate was then transferred to 2-tier inoculation trays (2ft x 6ft) and allowed to cool before inoculating with active fungal culture (spawn). The mixture of active fungal culture prepared in bags was used at 10% w/w, mixed well into the cool fermented maize stover and allowed to ferment for 21 days.

At the end of the fermentation period, the treated maize husk was sun dried until the substrate attained less than 10% moisture content. It was then bagged and stored until required for feeding trial with weaner rabbits.

Preparation of active fungal culture for on-farm inoculation of maize husk

The active fungal culture of *Pleurotus tuber-reguim* obtained from the culture bank of Department of Botany and Microbiology, University of Ibadan, Ibadan, Nigeria was reproduced in bags for on-farm inoculation. Each 5kg bag of sterilized Guinea corn grains was inoculated at 5% w/w, and immediately the bag was sealed and kept in a dark room for two weeks to allow total ramification of the Guinea corn grains by the active fungal culture. The treated substrates were subsequently used for inoculation on large scale.

Formulation and composition of the experimental diets

Five experimental diet supplements feed mixtures were formulated as follows:

T_1 =Feed mixture contained 0% fungal treated maize husk

T_2 = Feed mixture contained 10% fungal treated maize husk

T_3 = Feed mixture contained 20% fugal treated maize husk

T_4 = Feed mixture contained 30% fungal treated maize husk

T_5 = Feed mixture contained 40% treated maize husk

The dietary ingredients were mixed fortnightly and packed in sacks lined with polythene sheets to avoid rancidity and loss of palatability. The gross formulation of the fungal treated maize husk (FTMH) based experimental diets are presented in Table 1

Digestibility Study

Digestibility study was conducted using five rabbits per treatment (n=25) in the fourth and sixth weeks of the growth study and four days in each case. Faecal samples were collected daily and stored at -20 ^{0}C in a deep freezer immediately after collection. At the end of each collection period, the samples were bulked for each animal and the proximate composition of the feed samples as well as the faeces determined (AOAC, 1990).

Carcass Analysis

Five rabbits per treatment were selected for carcass analysis. The rabbits were fasted for 24 hours, stunned using electroshock method (Zotte, 2002) and bled by neck slit accomplished by the cutting of jugular artery using sharp knife. The rabbits were eviscerated and the internal organs (liver, pancreas, heart and kidneys) were carefully excised, clean of blood and weighed using electronic weighing scale. Weight of the skin and other organs were expressed as the percentage of the live weight of the animals. The carcasses were cut into primal cuts as described by Blasco and Ouhayoum (1993) weighed and expressed as the percentage of the live weight of the animal.

Chemical Analysis

The proximate composition and crude fibre fractions of the experimental diets were analyzed using standard methods (AOAC 1990).

Growth Study

The control and formulated diets containing varying levels of fungal treated maize husk were offered in separate earthen concrete feeders at 5% of body weight of the experimental rabbit. The rabbits were fed *ad libitum* twice daily at 8.30 and 15.30 hours with adequate water provision. Feed left over and/or wastage was weighed daily before feeding. Adequate water was provided throughout the experimental period. The rabbits were routinely treated against ecto – and endo parasite using 10 mg/mL ivomectin and coccidiostat. All rabbits were weighed at the start of the study prior to allotment to treatments and at weekly intervals during the growth study which lasted six weeks. Parameters determined were feed intake, weight gain and feed conversion ratio.

Blood Analyses

At week eight of the experiment, blood samples were collected from the marginal veins of the ears of six randomly selected rabbits per treatment. Blood samples (2 mLs) from each rabbit into a vacutainer bottle containing EDTA as anti-coagulant for haematological indices determination. Another set of blood were collected into bottles without anticoagulant and the serum harvested for serum biochemical indices analyses, Albumin and globulin were determined according to Doumas and Briggs (1972), cholesterol with the method of Roschlan *et al*. (1974).. Alanine amino transferase (ALT) and aspartate amino transferase (AST) were determined colorimetrically (Reitman and Frankel, 1957).

Statistical Analysis

Data were subjected to descriptive statistics and one way analysis of variance (SAS, 1998) and treatment means separated by Duncan multiple range option of the same software at $\alpha_{0.05}$

RESULTS

Chemical Composition of the Experimental Diets

The chemical composition of the experimental diets is shown in Table 1. The crude protein content of the diets was approximately 16%. The crude fibre ranged from 17.89 (T_2) to 22.14Unit (T_1) in the control. It decreased progressively from T_2 with increased replacement of wheat offal.

Performance of Rabbit

Performance of grower rabbit fed varying levels of fungal treated maize husk is shown in Table 2. There were significant differences (P<0.05) in the final weight gain, total weight gain, daily weight gain, daily feed intake and feed conversion ratio (FCR). Rabbits on T_3 recorded the highest final weight (1800g) with the least recorded in those on T_1 (1275g). Total weight gained (*g*) ranged from 550 (T_1) to 800 (T_3), daily weight gain (g) ranged from 9.82 (T_1) to 14.29 (T_3), while total feed intake (g) ranged from 1670 (T_1) to 2800 (T_3).

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Table 1: Gross composition of fungal treated maize husk based experimental diets fed to grower rabbit

Ingredients (g/100g DM)	T_1	T_2	T_3	T_4	T_5
Maize	30	30	30	30	30
Palm kernel cake	10	10	10	10	10
Groundnut cake	10	10	10	10	10
Wheat offal	40	30	20	10	_
Fungal treated maize husk	_	10	20	30	40
Common salt	1	1	1	1	1
Dicalcium phosphate	3.5	3.5	3.5	3.5	3.5
Soyabean meal	3.5	3.5	3.5	3.5	3.5
Vitamin premix	1.5	1.5	1.5	1.5	1.5
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Determined Nutrients					
Crude protein (%)	16.6	16.8	16.4	16	16.1
Crude fibre (%)	22.1	17.9	19.2	20.7	21.8

T1 = 0% Fungal treated maize husk-based diet, T2 = 10% fungal treated maize husk based diet, T3 = 20% fungal treated maize husk based diet, T4 = 30% fugal treated maize husk based diet, T5 = 40% fungal treated maize husk based diet

Table 2: Performance of growing rabbits fed fungal treated maize husk based diets

Treatment	T_1	T_2	T_3	T_4	T_5	SEM
Initial weight (g)	975	975	1000	975	1000	0
Final weight (g)	1275.0^e	1575.0^c	1800.0^a	1550.0^c	1525.0^d	19
Total weight gained (g)	550.0^d	600.0^b	800.0^a	575.0^c	525.0^e	20
Daily weight gain (g)	9.8^b	10.7^b	14.3^a	10.3^b	8.9^b	0.4
Total feed intake (g)	1670.0^b	1906.0^b	2800.0^a	1820.0^b	1960.0^b	76
Daily feed intake (g)	32.5^b	35.0^b	50.0^a	32.5^b	35.0^b	1.2
Feed conversion ratio (g)	3.3^c	3.3^c	3.5^b	3.2^d	3.9^a	0

$^{a, b, c}$ means along the same row with similar superscripts are not significantly different (P>0.05)
T1 = 0% Fungal treated maize husk based diet, T2 = 10% fungal treated maize husk based diet, T3 = 20% fungal treated maize husk based diet, T4 = 30% fugal treated maize husk based diet, T5 = 40% fungal treated maize husk based diet

Digestibility in Grower Rabbit

Apparent coefficient of digestibility in grower rabbit fed graded levels of fungal treated maize husk is presented in Table 3. Digestibility of ash, ether extract and crude protein differed significantly (P<0.05) with the highest values obtained in rabbits on T2 (63, 76 and 68, respectively), while least values were in those on control diet (52, 69 and 57, respectively). Digestibility of crude fibre was however, highest in rabbits on T5 (65%) and the least (47%) was obtained in T_1.

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Table 3: Apparent digestibility of nutrients in growing rabbits fed graded dietary levels of fungal treated maize husk

Nutrient (Unit)	T_1	T_2	T_3	T_4	T_5	SEM
Ash	52^d	63^a	62^b	61^c	0.61^c	0.06
Ether extract	69^d	76^a	76^a	75^b	72^c	0.04
Crude protein	57^d	68^a	64^b	61^c	61^c	0.03
Crude fibre	47^e	56^d	58^c	61^b	65^a	0.06

$^{a, b, c}$ means along the same row with similar superscripts are not significantly different (P>0.05)
T1 = 0% Fungal treated maize husk based diet, T2 = 10% fungal treated maize husk based diet, T3 = 20% fungal treated maize husk based diet, T4 = 30% fugal treated maize husk based diet, T5 = 40% fungal treated maize husk based diet

Carcass Characteristics, Organs Weight of Rabbits

Effects of feeding varying levels of fungal treated maize husk (FTMH) on carcass characteristics and rabbit organs weight are presented in Table 4. Live weight, hot carcass, head, troaters and other carcass parameters evaluated were significantly affected (P<0.05) by the treatments. The slaughter and hot carcass weights differed significantly (P<0.05) and varied from 825 to 1475g and 775 to 1350g in T5 and T3, respectively. Hot carcass weight (g) of rabbits on diets 1 and 2 (925.00) were similar (P>0.05) but higher (P < 0.05) than for rabbit in diet 5 (825).

Table 4: Carcass, offals and relative organs weight of growing rabbits fed graded dietary levels of fungal treated maize husk

Parameters	T_1	T_2	T_3	T_4	T_5	SEM
Live weight (g)	1275.00^c	1250.00^c	1800.00^a	1550.00^b	1000.00^d	18.63
Hot carcass weight (g)	925.00^c	925.00^c	1350.00^a	1200.00^b	775^d	20.75
Slaughter weight (g)	975.00^c	975.00^c	1475.00^a	1250.00^b	825.00^d	12.91
Empty carcass (%)	8.25^c	82500^c	1275.00^a	1150.00^b	725^d	14.91
Head (%)	12.27^b	14.26^c	9.7^{ac}	9.59^c	14.50^d	0.2
Troater (%)	7.91^b	8.80^a	6.26^d	7.12^c	8.63^{ab}	0.13
Hind limb (%)	24.76^a	24.46^a	20.29^b	20.97^b	24.68^a	0.53
Forelimb (%)	13.54^a	12.20^{ab}	8.88^c	11.20^b	14.44^a	0.41
Loin (%)	17.72^{ab}	18.43^{ab}	16.97^b	19.92^a	18.56^{ab}	0.45
Rack (%)	13.46^b	12.71^b	9.16^c	10.21^c	15.83^a	0.24
GIT (%)	11.40^b	12.14^{ab}	9.04^c	8.77^c	12.78^a	0.16
Kidney (%)	1.19^a	1.12^a	0.86^b	0.77^b	0.90^b	0.03
Liver (%)	4.27^a	4.51^a	3.36^b	4.08^a	4.37^a	0.09
Lungs (%)	0.84^{ab}	0.87^a	0.71^b	0.96^a	0.90^a	0.23
Heart (%)	0.47^a	0.47^a	0.27^b	0.34^b	0.43^a	0.02

$^{a, b, c, d}$ means along the same row with similar superscripts are not significantly different (P>0.05)
T_1 = 0% Fungal treated maize husk based diet; T_2 = 10% fungal treated maize husk based diet; T_3 = 20% fungal treated maize husk based diet; T4 = 30% fugal treated maize husk based diet; T_5 = 40% fungal treated maize husk based diet

Haematology of Rabbit

The haematology of growing rabbit fed varied levels of fungal treated maize husk (FTMH) is shown in Table 5 The PCV was significantly (P<0.05) affected by the treatment, while treatment had similar effect (P>0.05) on the haemoglobin (g/L). The MCV (%), MCHC (%) and MCH (%) differed significantly (P<0.05) among the treatments. White blood cell (WBC x 10^3/mm^3) ranged from 4.20 (T1) to 5.40 (T4). The value

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obtained in rabbits on T4 was higher than in other treatments, though not significantly different (P>0.05) from those recorded for rabbits on T3, T4 and T5. The red blood cell (x10^{12}/L) was significantly (P<0.05) higher for rabbits on control diets (T1) than those on other diets. Aside from monocytes (%) which had similar values (P>0.05), other indices of leukocyte differentials (neutrophils (%), lymphocytes (%) and eosinophils (%)) were significantly different (P<0.05) in no particular order.

Table 5: Haematological parameters of growing rabbit fed fungal treated maize husk (FTMH)

Parameters	T_1	T_2	T_3	T_4	T_5	SEM
Packed cell volume (%)	35.0^{c}	38.0^{a}	37.0^{ab}	36.00b^{c}	36.00b^{c}	0.33
Haemoglobin (g/L)	11.7	12.5	12.3	12	12.1	0.15
Red blood cell (x10^{12}/L)	11.96^{a}	5.40^{b}	5.24^{b}	5.12^{b}	4.10^{b}	0.25
Mean cell volume (Unit	60.42^{c}	60.37^{d}	60.61^{a}	60.31^{e}	60.59^{b}	0.003
Mean cell Haemoglobin (ug)	19.54^{b}	19.15^{d}	19.40^{c}	19.40^{c}	19.73^{a}	0.02
MCHC (%)	32.43^{b}	31.89^{e}	32.24^{d}	32.24^{d}	32.6	0.003
Neutrophils (%)	35.00^{c}	31.00^{d}	41.00^{a}	41.00^{a}	39.00^{b}	0.33
Lymphocytes (%)	61.00^{b}	65.00^{a}	57.00^{c}	57.00^{c}	59.00^{d}	0.33
Monocytes (%)	1.0	1.0	1.0	1.0	0.0	0.0
Eosinophils (%)	20.0^{ab}	3.00^{a}	1.00^{b}	1.00^{b}	2.00^{ab}	0.26
White blood cell x 10^3/mm^3	4.20^{b}	5.30^{a}	5.00^{ab}	5.40^{a}	4.47^{ab}	0.15

$^{a, b, c, d}$ means along the same row with similar superscripts are not significantly different (P>0.05); T_1 = 0% Fungal treated maize husk based diet; T_2 = 10% fungal treated maize husk based diet; T_3 = 20% fungal treated maize husk based diet; T4 = 30% fugal treated maize husk based diet; T_5 = 40% fungal treated maize husk based diet.

Serum Biochemical Profile of Rabbit

Table 6 shows the selected serum biochemical profile of growing rabbit fed varied FTMH. Rabbits on diet 2 had significantly higher (P<0.05) serum total protein, globulin, cholesterol HDL, triglyceride and glucose concentration than those on control, T3, and diets T4 and T5. The serum albumin concentration of the control diet was not significantly different from those on diets 2, 3, and 5. Rabbits on T3 recorded a significantly higher (P<0.05) concentration of HDL (55 mg/dL), urea (32 mg/dL) and uric acid (0.04 mg/dL).

Table 6: Selected serum biochemical profile of grower rabbit fed varying levels of fungal treated maize husk

Treatment	T_1	T_2	T_3	T_4	T_5	SEM
Total Protein (g/dl)	7.50^{b}	7.80^{a}	7.40^{c}	7.30^{c}	7.50^{b}	0.03
Albumin (g/dl)	2.60b^{c}	2.501^{cb}	2.80^{a}	2.80^{a}	2.70^{ab}	0.03
Globulin (g/dL)	4.90^{b}	5.30^{a}	4.70^{c}	4.70^{c}	4.80^{bc}	0.03
ALT (u/L)	50.00^{b}	42.00^{c}	51.00^{b}	53.00^{a}	30.00^{d}	0.33
AST (u/L)	53.00^{c}	47.00^{d}	55.00^{b}	60.00^{a}	37.00^{c}	0.33
Cholesterol (mg/dL)	74.00^{c}	80.00^{a}	76.00^{b}	73.00^{c}	61.00^{b}	0.33
HDL (mg/dL)	54.00^{a}	48.00^{a}	55.00^{a}	43.00^{c}	35.00^{d}	0.33
LDL (mg/dL)	32.00^{d}	40.00^{b}	42.00^{a}	37.00^{c}	20.00e	0.33
Triglycerides (mg/dL)	70.00^{b}	75.00^{a}	65.00c	70.00^{b}	50.00^{d}	0.33
Urea (mg/dL)	30.00^{b}	30.00^{b}	32.00^{a}	31.00^{ab}	30.00^{b}	0.33
Creatinine (mg/dL)	1.00^{b}	1.20^{a}	1.00^{b}	0.70^{c}	0.50^{d}	0.03
Glucose (g/dL)	76.00^{b}	79.00^{a}	75.00^{c}	80.00^{a}	77.00^{b}	0.3

$^{a, b, c, d}$ means along the same row with similar superscripts are not significantly different (P>0.05), AST=Aspartate aminotransferase; ALT=Alanine aminotransferase; HDL=High density lipoprotein; LDL=Low density lipoprotein; T_1 = 0% Fungal treated maize husk based diet; T_2 = 10% fungal treated maize husk based diet T_3 = 20% fungal treated maize husk based diet; T4 = 30% fugal treated maize husk based diet T_5 = 40% fungal treated maize husk based diet

DISCUSSION

The crude protein level of the formulated diets was below 18% recommended for growing rabbits in tropical environment (Omole, 1982) but higher (17.89 to 22.14) than 14% elsewhere (Ikurior and Akem, 1998). The gross energy of the formulated diets was within the reference range (2390–2500/kcal) for optimum growth and performance in rabbit (Aduku and Olukosi, 1990).

The improved total weight gain in rabbits on T_2 to T_5 compared with the control could be due to improved digestibility of the treated diets. This observation may be responsible for the relatively higher daily weight gain observed in rabbits on T_2 to T_4. The poor daily weight gain in rabbits on control diet (T_1) may be due to higher fibre content when compared with other diets. It was also observed that daily feed intake (g) was highest in rabbits on T_3 (50) followed by those on T2 (35) with a corresponding daily weight gain. This revealed the relatively higher effectiveness of growing rabbits on T2 and T3 in converting the feed consumed to flesh. This phenomenon involving favourable effect of fibre was earlier described as "ballast" effect (Collin *et al.,* 1976).

Observation in the present study conformed to those previously reported for growing rabbit (Onifade and Tewe, 1993; Agunbiade *et al*, 2002). The low daily feed intake (32.50 – 50.00 g/d) observed in rabbits on all treatments may be traced to variation in ambient temperature. Felding (1991) affirmed that high ambient temperature had adverse effect on rabbit feed intake.

Apparent coefficients of digestibility of ash, ether extract, crude protein, and crude fiber were consistently higher in rabbits on T_2–T_5 when compared with those on control. The inclusion of FTMH in the diet affected the digestibility of ash, ether extract, crude protein and crude fibre. Except for crude fibre, the digestibility decreased with the inclusion of FTMH, whereas, crude fibre digestibility improved with increased inclusion of FTMH. This suggests that replacement of wheat offal at 10% (T_2) and 20% (T_3) was favourable for the growing rabbit. This further reinforced the basis for the improved weight gain observed in rabbits on the same treatments. Digestibility in the present study was below those observed by other researchers (Amaefule *et al*., 2011) and comparable with those reported by Osakwe *et al*. (2008). Results in the present study may be the optimum range for efficient nutrient utilisation.

The hot carcass weight (HCW) was observed to be highest in rabbits fed T_3 and T_4 which could be attributed to diets quality. This observation is consistent with the reports of INRA (1989) and Lebas (1991) that variation in nutritional requirement of growing rabbit may modify the anatomical equilibrium of the carcass, tissues and the chemical components of the muscles. The total weight gain which is an indication of efficient utilisation of the feed consumption was best in rabbits fed T_2 to T_3. This may have also influenced HCW in rabbits fed T_3 and T_4. Meat and carcass characteristics depends on the age of the animal and its weight at a given age which determines how quickly they reach this weight (Quhayoun, 1998). The lowest value of HCW in rabbits fed control diet may be associated with the fibre content. The relatively higher fibre content of control diet compared with others was known to decrease growth rate and slaughter weight. The empty carcass, head, troater, loin and rack weights were higher in rabbits on T2, T3 and T4, a reflection of better efficiency in the utilization of feed and conversion to carcass. Diets T2, T3 and T4 which were 10, 20 and 30% replacement of wheat offal yielded better carcass results than control (T1) which also, was a reflection of HCW and slaughter weight.

The kidney, liver, lungs and hearts show remarkable differences in weight. As posited, Lebas and Leplace (1982) observed that differences in the weights of these organs among treatments could be associated with the roles played by the organs in growth anabolism and its proportion varies considerably in relation to rationing condition.

Haematology is a reflection of the dietary effects in animals in terms of the quality of the feed ingested and nutrients available to animals to meet its physiological requirements (Gbore and Akele, 2001). In the present study, the significantly reduced levels of red blood cell were inversely related to increased inclusion of FTMH, with the animals which consumed the diets containing higher dietary levels of FTMH recording lower red blood cells. The level of haemoglobin, an iron-

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containing conjugated protein which functions physiologically in the transport of oxygen and carbon dioxide *in-vivo* were similar in FTMH when compared with the control. This suggests that the animals in the treated diet did not experience any form of depressed respiratory capability. Additionally, the values obtained in the present study were within the documented reference range (Mitruka and Rawnsley, 1977; Annon, 1980 and Medirabbit, 2015). The PCV in this study was influenced by the inclusion of FTMH. The values were within the range of 30 to 50% reported by Annm (1980) and Prol (1987).
The WBC indices (MCH, MCV and MCHC) which reflect important morphological characteristics of anaemia, were within the normal reference range for healthy rabbit (Olabanji *et al*, 2007; and Togun *et al*, 2007). This is perhaps an indication that the rabbits were not anaemic. The WBC in this study were within the normal range of 5 x 10g/L to 13 x 10g/L reported (Medirabbit, 2015). The WBC differentials namely neutrophils, lymphoctyes, monocytes and eosinophils were significantly influenced by dietary inclusion of FTMH and were within the range recommended for rabbit (medirabbit, 2015). This suggests no hazard was associated with the diets.

The total protein and albumin recorded in this study were minimally affected by FTMH. This showed that the protein levels of the diets were enough to support normal protein reserves across the groups. The comparable albumin content could be attributed to the adequacy of protein intake across the groups (Olabanji *et al*., 2007). Report (Guache *et al*., 1991) showed that albumin content is specifically influenced by protein shortage. Other reports (Eggum, 1997) suggested that this implied a good quality of the test diet; the higher the value of serum total protein, the better the quality of the feedstuff.

As a measure of renal function status, serum uric acid, urea and creatinine are often regarded as reliable markers (Henry *et al*., 1982; Bonsnes and Taussky, 1982). Urea is the detoxification of the ammonia derived from deamination of amino acids, thus urea is considered to be the end product of protein catabolism (Sylvia and Mader, 1998). Creatinine is however, a catabolic end product, an anhydride of creatinine or phosphocreatinine product by loss of water (or phosphoric acid) from the molecule in an irreversible reaction (Mathew *et al,* 1997). In the present study, elevation of these markers was negligible therefore, renal injury was not suspected. The creatinine and uric acid observed in the present study were within the reference range (Medirabbit, 2007). However, the urea content was above the reference range (9.1 – 25.5 in mol/L) recommended (Medirabbit, 2007). Serum uric acid concentration did not follow any pattern. There were differences in the values obtained in all the treatments except in rabbits on treatment 2 (T_2) with reduced value. A decrease in serum uric acid could point to modification of purine catabolism (El Bagir *et al*., 2010).

Serum cholesterol was higher in control rabbits and those on T2 and decreased progressively. The increased serum cholesterol level was suggestive of increased lipid mobilization. The serum glucose was higher in the rabbits on treated diets except in those on T2. The increased serum glucose implies that the animals had no difficulty in meeting its energy requirement.
The decreased serum globulin concentration in rabbits fed T3 and T4 suggests a deficient protein synthesis in the rabbits compared with those on control, and diets 1 and 2. The values recorded in the present study were lower than those reported (Gbore *et al*., 2010) and documented reference range (Medirabbit, 2007). The AST and ALT did not follow any specific pattern, although there were significant differences among treatment. The AST and ALT are organ specific and are indication of the presence of toxic substances in the diet (Aletor, 1983; lyayi, 1994). The observed values in this study showed that the diets were tolerable by the rabbits on different treatments.

CONCLUSION

It is concluded from the present study that fungal treated maize husk could replace wheat offal in the diets of growing rabbits up to 50% without any deleterious effect on performance and health status of the treated rabbits

CONFLICT OF INTEREST

Authors hereby declared that no conflict of interest exists.

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