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THE REPLACEMENT OF FISH MEAL WITH MAGGOT MEAL ON THE PERFORMANCE, CARCASS CHARACTERISTIC, HAEMATOLOGICAL AND SERUM BIOCHEMICAL INDICES OF GROWING RABBITS

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ABSTRACT
An experiment was conducted to evaluate the influence of replacing fish meal with maggot meal on the performance, carcass characteristic, haematological and serum biochemical indices of growing rabbits. Sixty rabbits of mixed breed, aged 6 – 8 weeks were randomly taken for the dietary treatments in a completely randomized design with twelve rabbits per treatment were replicated three times with four rabbits per replicate. The rabbits were feed with diets containing 0, 1.25, 2.50, 3.75, and 5% maggot meal in diets as T_1 (control), T_2, T_3, T_4 and T_5 respectively. The experimental diets and clean drinking water were given *ad libitum* throughout the study period of nine weeks. The results indicated significant (P<0.05) difference in the dry matter intake of the animals. The intake increased with increasing levels of maggot meal across dietary treatments, with rabbits fed 3.75 and 5% maggot meal having the highest values and those on the control 0% and 1.20% the least significant (P<0.05) difference existed between treatments in average daily gain with diet 1 (control) and 5 recording the highest value and diet 4 the lowest. The range of feed efficiency values are significantly (P<0.05) different from each other and the values decreased with increasing levels of maggot meal across dietary treatments. The results of carcass characteristics indicated significant (P<0.05) difference among treatments for slaughter weight, carcass weight, dressing percentage, skin pelt, tail, feet and abdominal fat. The slaughter weight and carcass weight were better in groups receiving 2.50% maggot meal. The haematological showed significant (P<0.05) difference among the treatments in packed cell volume (PCV), red blood cell (RBC), white blood cell (WBC), mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH), but there was no significant (P>0.05) effect on haemoglobin and mean corpuscular haemoglobin concentration (MCHC). The result also revealed significant (P<0.05) difference in serum globulin, glucose, cholesterol, urea and creatinine, but there was no significant (P>0.05) effect on serum albumin and total protein. From the results, it can be concluded that inclusion of 5% maggot meal as replacement for fish (50% replacement) has no adverse effect on the performance, carcass characteristics, haematological and serum biochemical indices of growing rabbits.

KEY WORDS: Rabbits, Performance, Carcass characteristics, Blood component and Maggot meal.

INTRODUCTION

The rising prices of livestock feeds, especially in Nigeria and the scarcity of conventional proteins and energy concentrates for the formulation of feeds have forced animal scientist to search for attractive, cheaper, readily and locally available protein and energy sources. This underlines the need to examine other plants that can thrive for many years and can grow on degraded soil and require lower energy subsidies and still have the potentials of sustaining adequate nutrients.

For the expensive fish meal, maggots would seem to satisfy the criteria for alternative. Maggots, which are larvae from houseflies, grow easily on poultry droppings or any organic waste in a short period of 2 – 4 days. Teotia and Miller (1973) reported that housefly maggots and adults are sources of high quality protein. Maggots have an amino profile that is superior to that of groundnut cake (NRC, 1984). Atteh and Ologbenla (1993) observed that maggots could provide a partial replacement for fish meal in broiler diets. Earlier studies on blood constituents by Awoniyi and Aletor (1999) and Awoniyi *et al.* (2000) suggested that the maggot meal-based diet was not nutritionally inferior to fish meal. The availability of housefly maggots is indicative that it has the potential to replace some of the expensive protein supplements in livestock feeds if well harnessed. Bondari and Sheppard (1981) showed that 1 - 2 tonnes of maggots could be produced in a month in a 20,000 hen laying house. The use of maggots therefore could make compounded poultry feed a lot cheaper than when fish is used.The potentials of maggot meal as a protein source has however not been fully investigated in rabbit nutrition. The Maggot meal on dry matter basis contains 87.13% dry matter, 44.45% crude protein, 1.83% crude fibre, 9.76% ether extract, 14.29% total ash, 16.81% NFE, 0.03% calcium, 0.05% phosphorus and 2381.00 ME (Kcal/kg) (Morgan *et al.,* 1975).The ingestion of numerous dietary supplements has measurable effects on blood constituents (Animashahun *et al.,* 2006; Bhatti *et al.,* 2009). Although nutrient levels in the blood and body fluids may not be valid indicator of nutrient function at cellular level, they are considered to be proximate measures of long-term nutritional status (Animashahun *et al.,* 2006). According to Maxwell *et al.* (1990), blood parameters are important in assessing the quality and suitability of feed ingredient in farm animals. Animashahun *et al.* (2006) affirmed that the comparison of blood chemistry profile with nutrient intake might indicate the need for adjustment of certain nutrients upward or downwards for different population groups. The objective of this study was to assess the effects of maggot meal on the performance, carcass characteristics, haematological parameters and blood chemistry of growing rabbits.

MATERIALS & METHODS

Experimental Animals and Management

Sixty weaned rabbits (Dutch x New Zealand White), aged 6 to 8 weeks, were randomly assigned to five dietary treatments groups with twelve rabbits per treatment. Each rabbit was housed in cages measuring 45 x 30 x 42 cm. Five experimental diets designated as T_1, T_2, T_3, T_4 and T_5 containing 0 (control), 1.25, 2.50, 3.75 and 5% of maggot meal respectively were used for the study. These diets were analyzed for dry matter (DM), crude fibre (CF), ether extract (EE), ash, calcium and phosphorus according to AOAC (2002) method. The maggot meal replaced fish meal in the diets. The experimental diets and clean drinking water were provided to the rabbits *ad libitum* throughout the experimental period of nine weeks.

Maggot Production

Maggots were produced by culturing houseflies' larvae in poultry dropping. The larvae matured within 2 to 4 days and were harvested, sun dried and milled to form maggot meal.

Data Collection

The rabbits were fed in the morning (0700 – 0800 hrs) daily. The quantity of feed supplied to them was weighed every morning from which the left over was removed to determine daily feed intake. The rabbits were weighed at the beginning of the study and weekly thereafter. Fresh clean drinking water was provided *ad libitum* daily. At the end of the experiment, three rabbits per treatment were randomly selected, weighed, slaughtered and skinned. After evisceration, the gastrointestinal tracts (GIT) were removed and the empty carcass weight recorded. The carcass was cut into parts, head, tail, feet, shoulder, racks/ribs, loin and hind-legs. The organ weights which included liver, lungs, kidneys and fat were expressed as percentage of slaughter weight. Blood samples from each of the rabbit in the treatment groups were obtained using a 5 ml plastic syringe through the marginal ear vein into sample bottles that contained ethylene diamine tetra-acetic acid (EDTA) as anti-coagulant. The packed cell volume (PCV), red blood cell (RBC), white blood cell (WBC) and the haemoglobin (Hb) concentration were measured using method of Coles (1986), while mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentrate (MCHC) levels were calculated according to Bush (1991). Similarly, blood samples collected without anti-coagulant were used for the determination of serum biochemical constituents (total protein, albumin, globulin, glucose, cholesterol, blood urea and creatinine) using the methods outlined by WHO (1980).

Statistical Analysis

All data collected were subjected to analysis of variance (ANOVA), using randomized complete block design. Significant difference ($P<0.05$) among treatment means were determined by the least significant difference (LSD) as outlined by Steel and Torrie (1980).

RESULTS & DISCUSSION

Proximate Composition of Experimental Diet

The proximate compositions of the diets are presented in Table 2. The crude protein (CP) in the diets ranged between 24.03 and 24.25%, which is adequate; Omole (1977) recommended about 18% CP for growing rabbit. The crude fibre (CF) levels (10.44 to 16.87%) decreased with increase in the level of maggot meal in the diets. This may be due to the fact that maggot meal contains less crude fibre (Morgan *et al.,* 1975). The levels (10.44 to 16.87%) were adequate to meet the CF needs of rabbits, though levels above 17% were reported to depress weight gain (De-Blas *et al.,* 1986). The fat content ranged between 4.36 and 6.89% which compares favourably with the 2 – 5% fat levels recommended for young rabbits by Irlbeck (2001). The metabolizable energy (ME) was within the range of 2500 to 2800 Kcal/kg as recommended by Aduku and Olukosi (1990) for growing rabbits in tropical environments.

TABLE 1: Composition of experimental diets

Ingredients (%)	Treatments				
	(control)	12.5%	25%	37.5%	50%
White Maize	37.35	37.35	37.35	37.35	37.35
Groundnut cake	17.00	17.00	17.00	17.00	17.00
Groundnut Haulm	15.00	15.00	15.00	15.00	15.00
Maize bran	23.00	23.00	23.00	23.00	23.00
Fish meal	5.00	3.75	2.50	1.25	0.00
Maggot Meal	0.00	1.25	2.50	3.75	5.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	0.50	0.50	0.50	0.50	0.50
Premix	0.15	0.15	0.15	0.15	0.15

TABLE 2: Proximate composition of experimental diets and maggot meal (mm)

Nutrients (%)	Treatments					
	T_1	T_2	T_3	T_4	T_5	(MM)
Dry matter (DM)	97.53	97.28	97.03	96.78	96.53	84.13
Crude protein (CP)	24.03	24.11	24.18	24.25	24.03	42.67
Crude fibre (CF)	16.01	16.87	16.73	12.50	10.44	1.33
Ether extract (EE)	4.36	5.99	5.62	5.25	6.89	7.67
Calcium (Ca)	1.13	1.16	1.19	1.20	1.23	0.02
Phosphorus (P)	0.64	0.70	0.77	0.83	0.89	6.04
Ash	2.19	2.31	2.50	2.70	2.90	13.10
ME (Kcal/kg)*	2851.80	2851.87	2851.95	2851.10	2852.80	2281.00

*ME = Metabolizable energy

Productive Performance

Performances of rabbits fed the experimental diets are shown in Table 3. There was a significant (P<0.05) difference in the dry matter intake (DMI) of rabbits. The dry matter intake increased with increasing levels of maggot meal across dietary treatments, with rabbits fed 37.5% and 50% maggot meal having the highest values and those on the control, 12.5 and 25% maggot meal the least. This is similar to the finding of Abubakar *et al.* (2006) who reported a dry matter intake range of 60.95 to 70.22 g/day for weaner rabbits fed varying levels of plant protein sources in diets. All the animals gained weight, which indicated that the intake of energy and protein were well above maintenance requirements. However, significant (P<0.05) difference existed between treatments in average daily gain with diet 1 (control) and 5 recording the highest value and diet 4 the lowest. Fasanya and Ijaiya (2002) suggested that rabbits can perform better on weight gain basis when provided with diets containing at least 16% crude protein. The result of average daily gain in this study fall within the values of 6.12 – 12.12 g/day reported by Iyeghe-Erakpotobor (2006) for growing rabbits fed concentrate in different combinations. The range of feed conversion ratio of 5.22 to 7.15 which are significantly (P<0.05) different from each other are comparable to the previous values of 6.02 to 6.76 observed for weaner rabbits fed varying levels of spent sorghum residue (Abubakar *et al.*, 2006), but superior to the 11.20 to 12.50 reported by Taiwo *et al.* (2005) for weaned rabbits fed forages supplemented with concentrate. The amount of water intake was however not affected by dietary treatments.

TABLE 3: Replacement of maggot meal with fish meal on productive performance of weaned rabbits

Parameters	Treatments					
	(control)	12.5%	25%	37.5%	50%	SEM ±
Dry matter intake (g/bird)	58.69^b	59.49^b	62.65^b	67.85^a	68.27^a	4.86^*
Water intake (ml/day)	225.00	220.00	240.00	200.00	230.00	10.34
Average daily gain (g)	11.25^a	10.79^b	10.87^b	9.89^b	12.10^a	1.25^*
Feed conversion ratio (gfeed/g gain)	5.22^b	5.51^b	5.76^b	7.15^a	5.61^b	1.10^*

SEM = Standard error of mean, * Significant (P<0.05) difference.

TABLE 4: Replacement of maggot meal with fish meal on carcass characteristics of weaned rabbits

Parameters	Treatments					
	(control)	12.5%	25%	37.5%	50%	SEM ±
Slaughter weight (g)	1250.00^b	1166.00^b	1483.00^a	1450.00^a	1020.00^c	0.27^*
Carcass weight (g)	700.00^b	816.66^a	866.66^a	800.00^a	466.66^c	0.15^*
Percentage (%)	56.00^b	70.03^a	58.43^b	55.17^b	45.75^b	4.21^*
Body component expressed as percent slaughter weight						
Head	9.10	11.32	8.81	8.03	10.97	3.06
Skin pelt	10.12^a	12.29^a	6.59^c	7.02^c	8.31^b	2.28^*
Tail	0.61^a	0.76^a	0.25^b	0.27^b	0.22^b	0.08^*
Feet	0.72^b	2.68^a	2.28^a	2.08^a	0.89^b	0.28^*
Shoulder/forelegs	9.95	9.45	7.37	8.75	9.98	0.22
Backs/ribs	9.95	9.83	8.25	8.43	11.97	0.09
Loin	14.02	15.20	15.16	15.34	14.25	3.25
Hind legs	17.81	19.14	18.59	17.11	18.62	3.17

Mean within the same row with different superscripts significantly different (P<0.05); * = significant; SEM = Standard Error of Means

Carcass Characteristics

The results of the carcass characteristics are shown in Table 4. The slaughter weight and carcass weight were highest in rabbits fed diet 3 containing 2.5% maggot meal (50% fish meal replacement). There were significant differences (P<0.05) among treatments for skin pelt, tail and feet, with diet 2 having the highest value for skin pelt and tail. The dressing percentage ranged from 45.75 to 70.03% with the highest in diet 2 (70.03%) and lowest in diet 5 (45.75%). The higher dressing percentage may be related to the higher fat content recorded with the carcass. This is similar to the report of Fielding (1991), who opined that the dressing percentage of rabbits normally ranges from 50 to 56% and tends to be greater if the rabbits are fully grown and have some fat. This was also observed in the present study where diet 2 having the highest dressing percentage (70.03%) also had higher abdominal fat (60.77%), while diet 5 having the lowest (45.75%) dressing percentage also had lowest abdominal fat (0.32%). Fielding (1991) further stated that the dressing percentage would be 50% or less if the rabbit is young, thin and with a full digestive tract at killing. Uko *et al.* (2001) obtained dressing percentage ranging from 67.60 to 68.40% in rabbits in which the fur was removed by roasting and the head left intact. The study revealed that there was a relationship between dressing percentage and abdominal fat of carcass.Values obtained for heart, lungs, kidney and liver weights (Table 5) in this study showed non-significant difference (P>0.05) among treatment groups. It is a common practice in feeding trials to use weight of some internal organs like liver and kidneys as indicators of toxicity. Bone (1979) reported that if there is any toxic element in the feed, abnormalities in weights of liver and kidney would be observed. The abnormalities arise because of increased metabolic rate of the organ in attempt to reduce these toxic elements or anti-nutritional factors to non-toxic metabolites. Our observations regarding liver and kidney weight in rabbits of different treatment groups suggest that the test diets did not contain any appreciable toxin. Values obtained by Ekpo *et al.* (2009) did not show any significant difference (P>0.05) among treatments for heart, lungs, kidney and liver of rabbit fed cassava tuber meals.

TABLE 5: Replacement of maggot meal with fish meal on organ weight of weaned rabbits

Parameters	Treatments					
	(control)	12.5%	25%	37.5%	50%	SEM ±
Slaughter weight (g)	1250.00^{b}	1166.00^{b}	1483.00^{a}	1450.00^{a}	1020.00^{c}	0.27^{*}
Carcass weight (g)	700.00^{b}	816.66^{a}	866.66^{a}	800.00^{a}	466.66^{c}	0.15^{*}
Heart	0.35	0.38	0.22	0.28	0.27	2.00
Liver	3.11	3.61	3.01	3.27	3.52	1.37
Lungs	0.63	0.66	0.63	0.76	0.67	0.07
Kidney	0.86	0.85	0.76	0.57	0.67	0.14
Abdominal fat	0.52^{b}	0.77^{a}	0.38^{a}	0.39^{a}	0.34^{b}	0.19^{*}

Mean within the same row with different superscripts significantly different (P<0.05); * = significant; SEM = Standard Error of Means

Haematological Parameters

The results of the haematological indices are presented in Table 6. There were significant (P<0.05) difference among the group for all the haematological parameters, except for haemoglobin (Hb) and mean corpuscular haemoglobin concentration (MCHC). The packed cell volume (PCV) values 33.10 – 40.01% were within the range of 30 – 50% reported by Poole (1987) and 33 – 50% reported by Hillyer (1994) for growing rabbits. The values obtained for all the treatment groups indicated nutritional adequacy of all diets since values did not indicate under nutrition (Church *et al.,* 1984). The RBC showed significant (P<0.05) difference among the treatments. The values were within the range of 3.07 to 7.50 x 10^6 /mm^3 reported by Fudge (1999) but lower than 5 – 8 x 10^6 /mm^3 reported by Anon (1980). Hackbath *et al*. (1993) reported that increased RBC values were attributed to high quality dietary protein and with disease free animals. These observations were related to the composition of the diet (Table 1) and the health status of the rabbits since no rabbit died as a result of any disease. White blood cell (WBC) ranged from 5.30 to 9.10 x 10^3 /mm^3, the values were within the range of 5 to 13 x 10^3 /mm^3 reported by Hillyer (1994) for healthy young rabbits. These results indicate that the rabbits were healthy because decrease in number of WBC below the normal range is an indication of allergic condition, anaphylactic shock and certain parasitism, while elevated values (Leucocytosis) indicate the existence of a recent infection, usually with bacteria (Ahamefule *et al.,* 2008).

TABLE 6: Replacement of maggot meal with fish meal on haematological indices of weaned rabbits

Parameters	Treatments					
	(control)	12.5%	25%	37.5%	50%	SEM ±
Hb (g/dl)	9.70	13.70	9.70	11.70	11.70	2.36
PCV (%)	33.10^{b}	35.00^{b}	36.00^{b}	40.01^{a}	36.00^{b}	2.02^{*}
RBC ($x10^{6/}/mm^3$)	3.07^{b}	7.50^{a}	6.80^{a}	7.30^{a}	1.10^{a}	2.68^{*}
WBC ($x10^3/mm^3$)	9.10^{a}	5.30^{c}	5.40^{c}	6.90^{b}	7.50^{a}	1.39^{*}
MCV (fl)	110.74^{a}	56.69^{b}	51.47^{c}	56.16^{b}	50.70^{c}	0.32^{*}
MCH (Pg)	38.11^{a}	19.60^{b}	18.26^{b}	18.76^{b}	18.67^{b}	0.07^{*}
MCHC (%)	34.41	33.43	33.44	33.41	33.49	7.03

Mean within the same row with different superscripts significantly different (P<0.05); * = significant; SEM = Standard Error of Means

The haemoglobin (Hb) concentration compared favourably with the values of 9.4 – 17.4 reported by Fudge (1999). Animals given diet 4 had the highest Hb concentration, though it was within the normal range. Hackbath *et al*. (1993) recorded a strong influence of diet on haematological traits, PCV and Hb being strong indicators of nutritional status of animals. The MCH, MCV and MCHC values were within range of 50 to 75 mm^3, 18 to

24 Pg and 37 to 34% respectively, as reported by Burkey (1994), Fudge (1999) and Gillet (1996). Higher values of MCV (110.74 ft) and MCH (38.11 Pg) observed on diet 1 however, may not cause a serious problem since PCV, RBC, WBC, Hb and MCHC in all the treatments were within the normal ranges for healthy rabbits (Anon, 1980).

Blood Chemistry

The results of the blood chemistry are presented in Table 7. The albumin values showed no significant difference (P>0.05) among treatments and the values fell within the normal range of 2.5 to 4.0 g/dl reported by Anon (1980). The globulin values (1.02 to 2.02 g/dl) showed significant differences (P<0.05) among the treatments. The values for diet 1, 2, 3, 4 and 5 were lower than the values reported by Anon (1980) but similar to 1.94 – 2.26 g/dl obtained by Onifade and Tewe (1993) who fed various tropical energy feed resources to growing rabbits. The total protein values (4.41 to 5.51 g/dl) were within the range reported by Anon (1980) but lower than 5.81 – 6.75 g/dl reported by Onifade and Tewe (1993). Since total proteins, albumen and globulin are generally influenced by total protein intake (Birth and Schuldt, 1982; Onifade and Tewe, 1993), the values obtained in this study indicate nutritional adequacy of the dietary proteins. Abnormal serum albumin usually indicates an alteration of normal systemic protein utilization (Apata, 1990). Awosanya *et al*. (1999) demonstrated the dependence of blood protein on the quality and quantity of dietary protein. The values for blood glucose and cholesterol recorded in this study ranged from 4.80 to 7.6 mmol/l and 2.20 to 4.80 mmol/l respectively. Both glucose and cholesterol levels were significantly different (P<0.05) among treatments, the blood glucose was within the range 4.2 – 8.9 mmol/l reported by Fudge (1999). Since glucose and cholesterol levels were within the normal range, possibilities of anorexia, diabetes, liver dysfunction and mal-absorption of fat, which are symptoms of abnormal glucose and glucose levels in the blood (Bush, 1991) are ruled out. The blood urea values were within the range of 2.50 to 5.80 mmol/l reported by Abubakar *et al*. (2006) who fed *moringa oleifera* leaf meal to growing rabbits in tropical environment. Decreased blood urea may be associated with severe liver disease or protein malnutrition (Bush, 1991). There was no sign of ill-health observed in the rabbits and from the result of the feed analysis all the diets met the minimum levels required in the diets of growing rabbits. Serum creatinine levels were within normal range and did not differ (P>0.05) among treatment groups. The values obtained for animals on diets1, 2 and 3 were in consonance with the findings of Ahamefule *et al.* (2009), who fed cassava peels processed using different methods. The results also suggest that there was no wasting or catabolism of muscle tissues, and that animals were not surviving at the expense of body reserve. This was a good indication that dietary protein was well utilized by rabbits.

TABLE 7: Replacement of maggot meal with fish meal on serum of weaned rabbits

Parameters	Treatments					
	(control)	12.5%	25%	37.5%	50%	SEM ±
Total protein (g/dl)	4.51	4.41	5.51	5.01	4.91	1.19
Albumin (g/dl)	2.81	3.01	3.51	2.41	3.91	0.94
Globulin (g/dl)	1.71^a	1.41^b	2.02^a	1.62^a	1.02^c	0.02^*
Glucose (mmol/L)	6.50^a	4.80^b	6.40^a	7.60^a	6.10^a	1.32^*
Cholesterol (mmol/L)	2.80^c	4.00^a	2.20^c	3.50^b	4.80^a	0.22^*
Blood urea (mmol/L)	3.10^a	2.90^b	2.60^b	3.00^a	4.90^a	0.71^*
Creatinine (µmol/L)	63.10^a	67.11^a	54.11^b	52.10^b	66.10^a	4.65^*

Mean within the same row with different superscripts significantly different (P<0.05); * = significant; SEM = Standard Error of Means

CONCLUSION

From these result, it can be concluded that growing rabbits could tolerate up to 5% maggot meal (50% replacement of fish meal) in their diet without adverse effects on their performance, carcass characteristics and blood component.

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