Pakistan Veterinary Journal

ISSN: 0253-8318 (PRINT), 2074-7764 (ONLINE)
Accessible at: www.pvj.com.pk

Haematology, Blood Chemistry and Carcass Characteristics of Growing Rabbits Fed Grasshopper Meal as a Substitute for Fish Meal

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ARTICLE HISTORY

Received: July 25, 2009
Revised: September 24, 2009
Accepted: October 05, 2009

Key words:
Blood components
Carcass characteristics
Rabbits
Grasshopper meal
Fish meal

ABSTRACT

An experiment was conducted to evaluate the effect of replacing fish meal with grasshopper meal on haematology, blood chemistry and carcass characteristics of growing rabbits. Forty rabbits of mixed breeds, aged 6-10 weeks, were randomly assigned to the dietary treatments in a complete randomized design with eight rabbits per treatment. The rabbits were fed with diets containing 0, 1.25, 2.50, 3.75 and 5% grasshopper meal in diets designated as T_1 (control), T_2, T_3, T_4 and T_5, respectively. The experimental diets and clean drinking water were supplied *ad libitum* throughout the experimental period of nine weeks. At the end of the feeding trial, three rabbits per treatment were slaughtered for carcass evaluation, while blood samples were collected for analysis. The result of the experiment showed significant differences ($P<0.05$) among the treatments for packed cell volume (PCV), red blood cell count (RBC), white blood cell count (WBC), mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) but there was no significant effect ($P>0.05$) on haemoglobin and mean corpuscular haemoglobin concentration (MCHC). The results also revealed significant differences ($P<0.05$) for serum globulin, glucose, cholesterol, urea and creatinine but there was no significant effect ($P>0.05$) on serum albumin and total protein. The results of carcass characteristics showed significant differences among treatments ($P<0.05$) 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 2.5% grass hopper meal (50% fish meal replacement). From the results, it can be concluded that inclusion of 2.50% grasshopper meal as a replacement for fish meal (50% replacement) has no adverse effects on the haematological parameters, serum biochemistry and carcass characteristics of rabbits.

To cite this article: Njidda AA and CE Isidahomen, 2010. Haematology, blood chemistry and carcass characteristics of growing rabbits fed grasshopper meal as a substitute for fish meal. Pakistan Vet. J., 30(1): 7-12.

INTRODUCTION

The use of non-conventional feeds is gaining ground in Nigeria and many other developing countries. Previously, livestock were fed on maize as main source of energy and soybean meal, groundnut cake and fishmeal as main protein sources. This practice has put the livestock industry into direct competition with man for these feed ingredients (Muriu *et al*., 2002). Consequently, the prices of the conventional feedstuff increased to a level that their inclusion at a required level completely eroded the expected profit of the farmers.

Rabbits can utilize low-grain and high roughage diets (McNitt *et al*., 1996). Moreover, they breed all year-round, and have a "quick" generation interval. Consequently, they are uniquely poised to provide animal protein for developing countries, where grains can only be justified for human use (Irlbeck, 2001).

Grasshoppers (*Zonocerus variegatus*) are known to be leaf eating insects and cause maximum destruction of leaves and soft tissues of plants. Grasshopper meal contains about 357.6g/kg DM of crude protein and ether extract of about 158.6g/kg DM (Ojewole *et al*., 2003). Moreover, it contains about 66.3g/100g dry weight of crude protein, 15.5g/100g dry weight for fat and 12.4g/100g dry weight of crude fibre. This can serve as a good source of protein to rabbits. The potential of

grasshopper meal as a protein source has, however, not been fully investigated in rabbit nutrition.

The ingestion of numerous dietary components 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 indication 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 ingredients 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 downward for different population groups. The objective of this study was to investigate the effects of grasshopper meal on haematological indices, blood chemistry and carcass characteristics of growing rabbits.

MATERIALS AND METHODS

Experimental animals

Forty weaned rabbits (Dutch x Zealand White), aged 6 to 10 weeks, were randomly assigned to five dietary treatment groups with eight rabbits per treatment. Each rabbit was housed in hutches measuring 45 x 30 x 42cm. Five experimental diets (Table 1) designed as T_1, T_2, T_3, T_4 and T_5 containing 0 (control), 1.25, 2.50, 3.75 and 5% of grasshopper meal (GHP), respectively were prepared. These diets were analyzed for dry matter (DM), crude fibre (CF), crude protein (CP), ether extract (EE), ash, calcium and phosphorus according to AOAC (2002) methods. The grasshopper meal replaced fishmeal in the diets. The experimental diets and clean drinking water were supplied to the rabbits *ad libitum* throughout the experimental period of nine weeks.

Post treatment monitoring

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 viz: head, tail feet, shoulder, rack/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 5ml plastic syringe through the marginal ear vein into well labeled sample bottles that contained ethylene diamine tetra-acetic acid (EDTA) as anticoagulant. The packed cell volume (PCV), red blood cell (RBC), white blood cell (WBC) and the haemoglobin (Hb) concentrations were measured using the Wintrobes Microhaematocrit, improved Neubauer haemocytometer and Cyanomethaemoglobin methods respectively (Coles, 1986), while mean corpuscular haemoglobin (MCH) levels were calculated according to Bush (1991). Similarly, blood samples collected without anti coagulant were used for the determination of serum biochemical constituents viz. albumin, globulin, total protein, glucose, cholesterol, blood urea and creatinine, using commercially available analytical kits.

Statistical analysis

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

RESULTS AND DISCUSSION

Proximate composition

The results of the chemical analysis of diets are shown in Table 2. The crude protein (CP) in experimental rations ranged between 24.03 and 24.25%, which is adequate for growing rabbits, as Omole (1977) recommended about 18% CP for growing rabbits. The crude fibre (CF) levels (10.44 to 16.87%) increased with increase in level of grasshopper meal in the diets. This may be due to the fact that grasshopper meal contains about 12.4% CF (Ladeji *et al.*, 2003). 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 in grasshopper meal 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). The results of the proximate analysis of the grasshopper meal showed that it contained 64.32% CP, 11.25% CF and 13.15% EE on the average.

Haematological parameters

The results of the haematological indices are presented in Table 3. There were significant differences ($P<0.05$) among groups for all the haematological parameters, except for haemoglobin (Hb) and mean corpuscular haemoglobin concentration (MCHC). The PCV values (34.00 to 41.00%) were within the range of 30–50% reported by Poole (1987) and 33 to 50% reported by Hillyer (1994) for growing rabbits. The values obtained for all the treatment groups indicate nutritional adequacy of all diets since values did not indicate mal-or-under nutrition (Church *et al*., 1984). The RBC count showed significant differences ($P<0.05$) among 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.* (1983) reported that increased RBC values were associated with 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. The white blood cell count (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 animals were healthy because decrease in number of WBC below the normal range is an indication of allergic conditions, anaphylactic shock and certain parasitism, while elevated values (leucocytosis) indicate the existence of a recent infection, usually with bacteria (Ahamefule *et al.*, 2008). The haemoglobin (Hb) concentration compared favourably with the values of 9.4–17.4 g/dl reported by

Fudge (1999) and Njidda *et al*. (2006). Animals given T_4 had the highest Hb concentration, though it was within the normal range. Hackbath *et al*. (1983) recorded a strong influence of diet on haematological traits, PCV and Hb being very strong indicators of nutritional status of animals. The MCH, MCV and MCHC values were within range of 50 to 75 um^3, 18 to 24 pg and 37 to 34% respectively, as reported by Burke (1994), Fudge (1999) and Gillet (1996). Higher values of MCV (110.74fl) and MCH (38.11pg) observed on T_1 however, may not pose a serious problem since PCV, RBC, WBC, Hb and MCHC in all the treatments were within the normal ranges for healthy rabbits (Anon, 1980). Njidda and Hambagda (2006) mentioned PCV, Hb and MCHC as the most dependable blood indices for assessing the health status of animals.

Blood chemistry

The results of the blood chemistry are presented in Table 4. 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 treatments. The values for T_1, T_2, T_3, T_4 and T_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, albumin 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 (Table 4) recorded in this study ranged from 4.80 to 7.6 mmol/1 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/1 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 the symptoms of abnormal glucose and cholesterol 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 Njidda and Hambagda (2006), who fed sesame seed 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 diets T_1, T_2 and T_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.

Carcass characteristics

The results of the carcass characteristics are shown in Table 5. The slaughter weight and carcass weight were highest in rabbits fed diet T_3 containing 2.5% grasshopper meal (50% fish meal replacement). There were significant differences (P<0.05) among treatments for skin pelt, tail and feet, with T_2 having the highest value for skin pelt and tail. The dressing percentage ranged from 45.75 to 70.03% with the highest in T_2 (70.03%) and lowest in T_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 T_2 having the highest dressing percentage (70.03%) also had higher abdominal fat (Table 6, 0.77%), while T_5 having the lowest (45.75%) dressing percentage also had the 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 kidneys and liver weights (Table 6) in this study showed non significant differences (P>0.05) among treatment groups. It is a common practice in feeding trials to use weights 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 weights 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 rabbits fed cassava tuber meals.

Conclusion

From these result, it can be concluded that growing rabbits could tolerate up to 2.5% grasshopper meal (50% replacement of fish meal) in their diets without adverse effects on their blood and carcass characteristics.

Table 1: Composition of experimental diets

Ingredients (%)	Treatments				
	T_1	T_2	T_3	T_4	T_5
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
Grasshopper 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 grasshopper meal (GHM)

Nutrients (%)	Treatments					
	T_1	T_2	T_3	T_4	T_5	GHM
Dry matter (DM)	97.53	97.28	97.03	96.78	96.53	94.45
Crude protein (CP)	24.03	24.11	24.18	24.25	24.03	64.32
Crude fibre (CF)	10.44	12.50	16.73	16.87	16.01	11.25
Ether extract (EE)	4.36	5.99	5.62	5.25	6.89	13.15
Calcium (Ca)	1.13	1.16	1.19	1.20	1.23	1.50
Phosphorus (P)	0.64	0.70	0.77	0.83	0.89	0.89
Ash	2.19	2.31	2.50	2.70	2.90	0.63
ME (Kcal/kg)*	2851.80	2851.87	2851.95	2851.10	2852.80	4.23

*ME = Metabolizable energy

Table 3: Effect of feeding grasshopper meal substituting fish meal on haematological indices of weaned rabbits

Parameters	Treatments					
	T_1	T_2	T_3	T_4	T_5	SEM
PCV (%)	34.00^b	35.00^b	36.00^b	41.00^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 ($x\ 10^3/mm^3$)	9.10^a	5.30^c	5.40^c	6.90^b	7.50^a	1.39*
Hb (g/dl)	11.70	11.70	9.70	13.70	9.70	2.36^{NS}
MCV (fl)	110.74^a	56.69^c	51.47^b	56.16^b	50.70^c	0.32*
MCH (Pg)	38.11^a	19.6^c	18.26^b	18.76^b	18.67^c	0.07*
MCHC (%)	34.41	33.43	33.44	33.41	33.49	7.03^{NS}

Means within the same row with different superscripts differ significant at ($P<0.05$); NS = Non significant ($P>0.05$); * = significant ($P<0.05$).

Table 4: Effect of feeding grasshopper meal substituting fish meal on serum metabolite of weaned rabbits

Parameters	Treatments					
	T_1	T_2	T_3	T_4	T_5	SEM
Albumin (g/dl)	2.81	3.01	3.51	2.41	3.91	0.94^{NS}
Globulin (g/dl)	1.71^a	1.41^b	2.02^a	1.62^a	1.02^c	0.02*
Total protein (g/dl)	4.51	4.41	5.51	5.01	4.91	1.19^{NS}
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^a	4.00^b	2.20^d	3.50^c	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 ($P<0.05$); NS = Non significant ($P>0.05$); * = significant ($P>0.05$); SEM = Standard Error of Means

Table 5: Effect of feeding grasshopper meal substituting fish meal on carcass characteristics of weaned rabbits

Parameters	Treatments					
	T_1	T_2	T_3	T_4	T_5	SEM
Numbers of Rabbits	3	3	3	3	3	-
Slaughter weight (g)	1250.00^{c}	1166.00^{d}	1483.00^{a}	1450.00^{b}	1020.00^{c}	0.27*
Carcass weight (g)	700.00^{c}	816.66^{d}	866.66^{a}	800.00^{b}	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^{NS}
Skin pelt	10.12^{a}	12.29^{a}	6.59^{b}	7.02^{b}	8.31^{a}	2.28*
Tail	0.61^{a}	0.76^{a}	0.25^{b}	0.27^{b}	0.22^{b}	0.08*
Feet	0.72^{a}	2.68^{b}	2.28^{b}	2.08^{b}	0.89^{c}	0.28*
Shoulder/forelegs	9.95	9.45	7.37	8.75	9.98	0.22^{NS}
Racks/ribs	9.95	9.83	8.25	8.43	11,97	0.09^{NS}
Loin	14.02	15.20	15.16	15.34	14.25	3.25^{NS}
Hind legs	17.81	19.14	18.59	17.11	18.62	3.17^{NS}

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

Table 6: Effect of feeding grasshopper meal substituting fish meal on organ weight of weaned rabbits

Parameters	Treatments					
	T_1	T_2	T_3	T_4	T_5	SEM
Number of rabbits	3	3	3	3	3	-
Slaughter weight (g)	1250.00^{a}	1166.00^{a}	1483.00^{a}	1450.00^{b}	1020.00^{c}	0.27*
Carcass weight (g)	700.00^{a}	816.66^{a}	866.66^{a}	800.00b	466.66^{c}	0.15*
Heart	0.35	0.38	0.22	0.28	0.27	2.00^{NS}
Liver	3.11	3.61	3.01	3.27	3.52	1.37^{NS}
Lungs	0.63	0.66	0.63	0.76	0.67	0.07^{NS}
Kidney	0.86	0.85	0.76	0.57	0.67	0.14^{NS}
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); NS = Non significant (P>0.05); *= significant; SEM = Standard Error of Means

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