

Haematology and serum biochemistry of rabbits fed acha (*Digitaria exilis*) offal meal-based diets supplemented with Maxigrains® enzyme



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Abstract

Food-feed competition between human and animals has necessitated farmers to turn to alternative feed resources such as Acha Offal. Forty eight rabbits of mixed breeds and similar live weight were utilized in an experiment to evaluate the effect of feeding acha offal meal-based diets supplemented with Maxigrain enzyme on their haematology and serum biochemistry. The experiment had two phases (weaner and grower) each lasting for 42 days. Six treatments diets namely T1, T2, T3, T4, T5 and T6 were compounded to be iso-caloric (2700kcal/kg) and iso-nitrogenous (18% crude protein) for the weaner phase while (15% crude protein) and isocaloric (2500kcal/kg) for the grower phase. The Acha Offal (AO) was included at 0, 15 and 30% while the enzyme was supplemented at 0 and 200ppm. The experiment was arranged in a 2x3 factorial fitted into a Completely Randomized Design. Each treatment was replicated 4 times having two rabbits per replicate. Feed and water were provided to the animals daily and all standard routine management practices were strictly observed throughout the experimental period. At the end of the feeding trial, blood samples were collected from each animal for blood analyses. The results show that there was no significant ($P>0.05$) variation on the haematological and biochemical parameters due to enzyme or AO effect. In the growing phase, main effect of AO was not significant ($P>0.05$) on the haematological parameters except on white blood cell (WBC) and mean cell haemoglobin concentration (MCHC). Effect of enzymes on growing rabbit was not significantly different ($P>0.05$) except on WBC at 0ppm ($5.75 \times 10^9/L$) and 200ppm ($6.60 \times 10^9/L$) and on MCHC at 0ppm ($33.27 \times 10^9/L$) and 200ppm ($33.20 \times 10^9/L$). The Interactive effect of AO and enzyme showed that T2 had the highest WBC ($8.80 \times 10^9/L$) while T4 had the lowest MCHC ($33.10 \times 10^9/L$). Serum biochemical parameters were not affected by Acha offal except phosphorus where there was a significant ($P<0.05$) reduction in 30% AO (1.35g/dL). Enzymes effect showed that animals on 0ppm had significantly ($P<0.05$) higher phosphorus (1.83g/dl) than 200ppm (1.38g/dL). Acha offal supplemented with Maxigrain enzyme can be included in the diets of grower rabbits without adverse effect on haematological and serum biochemical indices.

Keywords: Acha offal, serum biochemistry, enzyme, haematological parameters, rabbits

L'hématologie et la biochimie sérique des lapins nourris à base d'alimentation d'acha (*Digitaria exilis*) complétés par 'maxigrains® enzyme



Résumé

La concurrence entre les humains et les animaux en matière d'aliments pour animaux a obligé les agriculteurs à se tourner vers d'autres ressources alimentaires comme 'acha'. Quarante-huit lapins de races mixtes et de poids réel similaire ont été utilisés dans une expérience pour évaluer l'effet de l'alimentation d'acha complétés par l'enzyme 'Maxigrain' sur leur hématologie et biochimie sérique. L'expérience a eu deux phases (sevrage et

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producteur) chacune durant 42 jours. Six régimes de traitements, à savoir T1, T2, T3, T4, T5 et T6, ont été composés pour être iso-caloriques (2700kcal/kg) et iso-azotés (18% de protéines brutes) pour la phase de sevrage tandis que (15% de protéines brutes) et isocaloriques (2500 kcal/kg) pour la phase de croissance. L'alimentation d'acha (AO) a été inclus à 0, 15 et 30% tandis que l'enzyme a été complétée à 0 et 200ppm. L'expérience a été organisée dans un factorial 2x3 intégré dans une conception complètement randomisée. Chaque traitement a été reproduit 4 fois ayant deux lapins par réplique. Des aliments et de l'eau ont été fournis quotidiennement aux animaux et toutes les pratiques de gestion de routine standard ont été strictement observées tout au long de la période expérimentale. À la fin de l'essai d'alimentation, des échantillons de sang ont été prélevés sur chaque animal pour des analyses sanguines. Les résultats montrent qu'il n'y avait aucune variation significative ($P>0.05$) sur les paramètres hématologiques et biochimiques dus à l'effet d'enzyme ou d' 'AO'. Dans la phase de croissance, l'effet principal de l' 'AO' n'était pas significatif ($P>0,05$) sur les paramètres hématologiques, sauf sur les globules blancs (le 'WBC') et la concentration moyenne d'hémoglobine cellulaire (le 'MCHC'). L'effet des enzymes sur la croissance du lapin n'était pas significativement différent ($P>0,05$) excepté sur WBC à 0ppm ($5.75 \times 10^9/L$) et 200ppm ($6.0ppm \ 60 \times 10^9/L$) et sur le 'MCHC' à 0ppm ($33.27 \times 10^9/L$) et 200ppm ($33.20 \times 10^9/L$). L'effet interactif de l'AO et de l'enzyme a montré que T2 avait le 'WBC' le plus élevé ($8,80 \times 10^9/L$) tandis que T4 avait le 'MCHC' le plus bas ($33,10 \times 10^9/L$). Les paramètres biochimiques du sérum n'ont pas été affectés par le phosphore d'alimentation d'acha sauf où il y avait une réduction significative ($P<0.05$) de 30%AO (1.35g/dL). L'effet d'enzymes a prouvé que les animaux sur 0ppm ont eu sensiblement ($P<0.05$) le phosphore plus élevé (1.83g/dl) que 200ppm (1.38g/dL). L'alimentation d'Acha complété avec l'enzyme 'Maxigrain' peut être inclus dans les régimes des lapins 'grower' sans effet défavorable sur les indices biochimiques hématologiques et sériques.

Mots-clés : l'alimentation d'Acha', biochimie sérique, enzyme, paramètres hématologiques, lapins,

Introduction

A rabbit practices coprophagy and is classified as a monogastric herbivorous animal with the ability to convert high fibrous grasses and legumes of less importance to humans into meat. These animals are prolific and economical to produce when compared to other livestock species. Adequate nutrition in terms of providing the needed energy, protein and fibre requirements of these animals can results to efficient production (Adegbola *et al.*, 1985). According to Aduku and Olukosi (1990), for the desired optimum performance, a tropical rabbit requires 12-17% crude protein and 2390-2500 kcal/kg Metabolisable energy. The rapid growth of human population has brought the

competition between man and livestock for these cereal grains adding to high cost of feeds and consequently high prices of Animal products (meat and egg) resulting to very low levels of protein intake in most developing nations. Therefore, leading to the increased in cost of production, research attention is now geared towards unconventional cereal by-product that will not affect the overall feed quality. One of such cereal grain by-products that could provide energy and fibre is acha offal. Feeding cereal grains (e.g. maize bran and rice bran) as replacement for maize-based diets to rabbits have significantly reduced the cost of producing feed for livestock (Ukim *et al.*, 2012). Alu *et al.* (2012) reported that many of the cereals by-

product and grains contain some phytochemicals which can be reduced by enzymes supplementation. Wallis (1996) observed that feeding enzymes to rabbits is one of the major nutritional advances in the last fifty years. Rabbits naturally produce enzymes to aid the digestion of feed nutrients; however, they do not have enzymes to breakdown fiber completely and thus need exogenous enzymes in feed to aid digestion (Khattak *et al.*, 2006). According to Khattak *et al.* (2006), Enzymes helps in reducing viscosity of digesta, enhanced digestion and absorption of nutrients especially fat and protein. They are important in improving apparent metabolizable energy value of the diet in rabbit. They increased feed intake, weight gain, increased feed gain ratio, reduced beak impaction and vent plugging, decreased size of gastrointestinal tract, altered population of microorganism in gastrointestinal tract, reduced water intake, reduced water content of excreta, reduced production of ammonia from excreta, reduce output of excreta and also reduced nitrogen and phosphorus. Enzymes have been shown to improve performance and nutrient digestibility when added to diets such as barley (Hesselman *et al.*, 1982; Hesselman and Aman, 1986; Friesen *et al.*, 1992; and Marquardt *et al.*, 1994), maize (Salehet *et al.*, 2003), oats (Friesen *et al.*, 1992) for rabbits. Similarly, studies have reported increased feed breakdown especially of fibrous materials into easily digestible nutrients by exogenous enzyme supplementation in monogastric feeds (Ogbe *et al.*, 2013). Fonio is highly rich in amino acids and iron (De Lumen, 1991). It is also very nutritious for pregnant women and children. It is free of gluten and is a great alternative for gluten-intolerant people. The use of acha is mainly limited to traditional foods. These foods comprise thick and thin porridges, steam cooked products. According to Jideani (1990), acha

is one of the most nutritious and best-tasting of African cereals. In certain regions of Mali, Burkina Faso, Guinea and Nigeria, acha is consumed 2/3 times per day, being preferred to other cereals (Jideani, 1999). Acha remains vital to the food security of millions of African farmers who use it in several ways. It is mixed with other flours to make bread (Jideani, 1999). It can be cooked in various forms with fish, meat, legumes or constant vegetables. In the Hausa region of Nigeria and Benin, people prepare it as porridge, 'wusu-wusu'; it is also consumed whole as *tuo* (tuwo), gwete, achajollof, and kunuacha (Jideani, 1999; 2012). The importance of enzymes in improving digestibility as well as blood parameters in animals as necessitated a research with the objective of determining the haematological and biochemical indices of weaner and grower rabbits fed acha offal based diets supplemented with Maxigrain enzymes

Materials and methods

Experimental site

These experiments were conducted at the Teaching and Research Farm of Animal Science Department of the Faculty of Agriculture, Nasarawa State University Keffi, Shabu-Lafia Campus.

Feed ingredients, animals and experimental design

Acha offal (AO) was sourced from the local acha processors within Riyom Local Government Area of Plateau State and preserved under natural condition while other ingredients such as maize, maize bran, rice bran, groundnut cake, fish meal, bone meal lysine methionine were purchased from the suppliers in Lafia, Nasarawa State. Six experimental diets were formulated to be isonitrogenous (18% and 15% crude protein) and isocaloric (2800kcal/kg and 2700kcal/kg) for the weaner and grower phases respectively, with three levels inclusion of the acha offal (0, 15 and 30%)

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and two levels of enzyme were included in a 3X2 factorial arrangement. The treatments were; T1 = 0% AO with 0ppm enzymes serves as control, T2 = 0% AO with 200ppm enzymes, T3 = 15% AO with 0ppm enzymes, T4 = 15% AO with 200ppm enzymes, T5 = 30% AO with 0ppm enzymes and T6 = 30% AO with 200ppm enzymes. Forty-eight (48) rabbits of similar live weight (767-800g) were randomly assigned to the test diets. Each of the experimental treatment was replicated four times in each pen comprising of 2 rabbits each.

Haematological and serum biochemical indices analysis

At the end of the experiment, two set of container was used to collect blood samples. One set contains anticoagulant while the other was anticoagulant free. The blood samples collected into bottles containing anti- coagulant: Ethylene Diaminetetra-acetic Acid (EDTA) as reported by Jain (1987) was used for hematological indices {Packed Cell Volume (PCV), Hemoglobin Concentration (HB), mean cell haemoglobin concentration (MCHC), Red Blood Cell (RBC), White Blood Cell (WBC)}. Serum biochemical indices such as cholesterol, total protein, albumin and globulin

creatinine, Erythrocyte (calcium, magnesium and phosphorus) glycerinaldehydes were analyzed using SIGMA kits (Feteris, 1965).

Statistical analysis

Data collected were subjected to two-way analysis of variance (ANOVA) using SPSS (2007). Significantly different means were separated using Duncan's Multiple Range Test (Duncan, 1955). The following statistical model was used: $Y_{ijk} = U + A_i + B_j + (AB)_{k} + e_{ijk}$ where Y_{ijk} = individual observation, U = population mean, A_i = effect of factor A, B_j = effect of factor B, and AB_k = effect of interaction of factor A&B.

Results and discussion

Presented in Table 4 is the main and interactive effect of AO and enzymes on haematological parameters of weaner rabbits. There was no significant ($P > 0.05$) main effect of either AO or enzyme supplementation on all the parameters measured. Similarly, the interactive effects of acha offal and enzyme supplementation was not significant ($P > 0.05$). Haematological values obtained were similar to the normal range of values for rabbits reported by Burke (1994) and Kurtong *et al.* (2013).

Table 1: Proximate (%) and fiber fraction (%) composition of Acha offal

Parameters	Values
Dry matter (%)	90.45
Ash (%)	5.10
Crude protein (%)	13.93
Crude fibre (%)	11.75
Ether extract (%)	4.08
Nitrogen free extract (%)	55.95
Metabolizable energy (kcal/kg)	2819.74
Neutral detergent fibre (%)	37.87
Acid detergent fibre (%)	19.09
Acid detergent lignin (%)	5.67

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Table 2: Nutrients composition of the experimental diets for weaner rabbits

Ingredients (%)	% of maize replace by acha offal					
	(0%AO +0ppm)	(0%AO +200ppm)	(15%AO +0ppm)	(15%AO +200ppm)	(30%AO +0ppm)	(30%AO +200ppm)
Maize	44.00	44.00	37.40	37.40	30.00	30.00
AO*	0.00	0.00	6.60	6.60	13.20	13.20
Maize bran	11.75	11.75	11.75	11.75	11.75	11.75
GNC	10.00	10.00	10.00	10.00	10.00	10.00
Rice bran	14.00	14.00	14.00	14.00	14.00	14.00
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00
Fall fat soya	10.00	10.00	10.00	10.00	10.00	10.00
palm oil	2.00	2.00	2.00	2.00	2.00	2.00
Fish meal	5.00	5.00	5.00	5.00	5.00	5.00
Salt	0.25	0.25	0.25	0.25	0.20	0.20
Premix	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25
Toxic binder	0.25	0.25	0.25	0.25	0.25	0.25
Enzymes (PPM)	0.00	200.00	0.00	200.00	0.00	200.00
Total	100.00	100.00	100.00	100.00	100.00	100.00
Nutrient and energy composition						
ME (Kcal/Kg)	2894.45	2894.45	2860.12	2860.12	2825.78	2825.78
Crude protein (%)	18.24	18.24	18.58	18.58	18.93	18.93
Lysine (%)	1.32	1.32	1.30	1.30	1.29	1.29
Methionine (%)	0.53	0.53	0.51	0.51	0.50	0.50
Moisture (%)	0.72	0.72	1.04	1.04	1.35	1.35
Ether extract (%)	6.56	6.56	6.59	6.59	6.62	6.62
Crude fibre (%)	5.90	5.90	6.53	6.53	7.17	7.17
Calcium (%)	0.79	0.79	0.79	0.79	0.79	0.79
Phosphorus (%)	0.81	0.81	0.79	0.79	0.77	0.77

AO = acha offal, ME = metabolizable energy,

*A15,000 I.U, vitamin D3 300,000 I. U. vitamin E 3,000 I.U., vitamin K 2.50mg, vitamin B₁ (thiamin) 200mg, Riboflavin (B₂) 600mg, pyridoxine (B₆), Niacin 40.0mg, vitamin B₁₂ 2mg, Pantothenic acid 10.0mg, folic acid 100mg, Biotin 8mg, choline chloride 50mg, anti-oxidant 12.5mg, manganese 96mg, zinc 6mg, Iron 24mg, Copper 0.6mg, Iodine 0.14mg, Selenium 24mg, cobalt 214mg.

Table 3: Nutrients composition of the experimental diets for grower rabbits

Ingredients (%)	% of maize replace by acha offal					
	(0%AO +0ppm)	(0%AO +200ppm)	(15%AO 0ppm)	(15%AO +200ppm)	(30%AO +0ppm)	(30%AO +200ppm)
Maize	40.00	40.00	34.00	34.00	28.00	28.00
AO*	0.00	0.00	6.00	6.00	12.00	12.00
Maize bran	15.00	15.00	15.00	15.00	15.00	15.00
GNC	10.00	10.00	10.00	10.00	10.00	10.00
Rice bran	17.75	17.75	17.75	17.75	17.75	17.75
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00
Full fat soya	7.00	7.00	7.00	7.00	7.00	7.00
palm oil	2.00	2.00	2.00	2.00	2.00	2.00
Fish meal	5.00	5.00	5.00	5.00	5.00	5.00
Salt	0.25	0.25	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25
Toxic binder	0.25	0.25	0.25	0.25	0.25	0.25
Enzymes	00.00	200.00	0.00	200.00	0.00	200.00
Total	100.00	100.00	100.00	100.00	100.00	100.00
Nutrient and energy composition						
ME (Kcal/Kg)	2712.07	2712.07	2674.67	2674.67	2637.28	2637.28
Crude protein(%)	15.71	15.71	16.01	16.01	16.31	16.31
Lysine(%)	1.00	1.00	0.99	0.99	0.97	0.97
Methionine (%)	0.56	0.56	0.55	0.55	0.54	0.54
Ash (%)	4.45	4.45	4.37	4.37	4.30	4.30
Ether extract(%)	7.11	7.11	7.12	7.12	7.14	7.14
Crude fibre(%)	10.50	10.50	11.08	11.08	11.67	11.67
Calcium(%)	1.16	1.16	1.16	1.16	1.16	1.16
Phosphorus(%)	0.58	0.58	0.57	0.57	0.57	0.57

AO = acha offal, ME = metabolizable energy,

*A15,000 I.U, vitamin D3 300,000 I.U., vitamin E 3,000 I.U., vitamin K 2.50mg, vitamin B₁ (thiamin) 200mg, Riboflavin (B₂) 600mg, pyridoxine (B₆), Niacin 40.0mg, vitamin B₁₂ 2mg, Pantothenic acid 10.0mg, folic acid 100mg, Biotin 8mg, choline chloride 50mg, antioxidant 12.5mg, manganese 96mg, zinc 6mg, Iron 24mg, Copper 0.6mg, Iodine 0.14mg, Selenium 24mg, cobalt 214mg.

Table 4: Main and interactive effect of acha offal and enzyme(Maxigrain) on haematological parameters of weaner rabbits

Treatments	Parameters									
	PCV (%)	HB (g/dl)	RBC(x10 ⁹ /L)	WBC(x10 ⁹ /L)	LYMPHOCY TE (%)	NEUTROPHIL (%)	MCV(pg)	MCH	MCHC	
Acha offal(AO)										
0.00	34.00	11.30	3.42	5.13	58.50	38.75	94.60	33.08	33.20	
0.15	31.75	10.55	3.16	4.85	57.25	39.25	94.58	33.60	33.20	
0.30	34.50	11.45	3.43	4.30	51.50	47.00	100.60	33.38	33.20	
SEM	1.05	0.35	0.12	0.63	3.37	3.20	4.48	0.27	0.05	
LOS	ns	ns	Ns	ns	ns	Ns	ns	ns	ns	
Enzymes(E)										
Oppm	33.33	11.07	3.31	4.75	55.33	42.67	97.40	33.42	33.17	
200ppm	33.50	11.13	3.36	4.77	56.17	40.67	95.78	33.28	33.23	
SEM	0.86	0.29	0.10	0.52	2.75	2.61	3.66	0.22	0.04	
LOS	ns	ns	Ns	ns	ns	Ns	ns	ns	ns	
AO*E										
T ₁	33.00	10.95	3.25	4.60	56.00	42.50	91.55	33.65	33.15	
T ₂	35.00	11.65	3.59	5.65	61.00	35.00	97.65	32.50	33.25	
T ₃	33.00	10.95	3.29	5.35	60.00	36.50	100.25	33.25	33.15	
T ₄	30.50	10.15	3.03	4.35	54.50	42.00	88.90	33.95	33.25	
T ₅	34.00	11.30	3.39	4.30	50.00	49.00	100.40	33.35	33.20	
T ₆	35.00	11.60	3.47	4.30	53.00	45.00	100.80	33.40	33.20	
SEM	1.49	0.50	0.17	0.90	4.77	4.52	6.34	0.38	0.07	
LOS	ns	ns	Ns	ns	ns	Ns	ns	ns	ns	

ab means on the same column having different superscript differ significantly (p<0.05); ns = not significantly different (p>0.05); SEM = standard error of mean; LOS = level of significant; PCV = Packed cell volume; HBC = Haemoglobin count (g/dl); RBC = Red blood cell (×10⁹/L); WBC = White blood cell(×10⁹/L) ; MCV =mean cell volume(pg); MCH = Mean corpuscular haemoglobin (fl) = MCHC = Mean cell hemoglobin concentration(×10⁹/L)

Table 5: Main and interactive effect of acha offal and enzyme (Maxigrain) on haematological parameters of grower rabbits

Treatments	Parameters									
	PCV (%)	HBC (g/dl)	RBC ($\times 10^9/L$)	WBC ($\times 10^9/L$)	Neutrophil (%)	Lymphocyte (%)	MCV (pg)	MCH	MCHC	
Acha offal										
(AO)										
0%	40.00	13.30	3.98	7.35 ^a	56.75	43.00	99.98	32.65	33.28 ^a	
15%	36.50	12.13	3.6	5.25 ^b	60.25	37.75	101.43	33.73	33.18 ^b	
30%	35.75	11.90	3.52	5.93 ^b	55.25	44.25	101.70	33.83	33.25 ^a	
SEM	1.93	0.65	0.20	0.37	3.73	4.06	0.71	0.65	0.02	
LOS	ns	ns	Ns	*	ns	ns	ns	ns	*	
Enzyme (E)										
0ppm	36.33	12.08	3.59	5.75 ^b	56.50	42.67	100.87	33.17	33.27 ^a	
200ppm	38.50	12.80	3.81	6.60 ^a	58.33	40.67	101.20	33.63	33.20 ^b	
SEM	1.58	0.53	0.17	0.30	3.04	3.32	0.58	0.53	0.02	
LOS	ns	ns	Ns	*	ns	ns	ns	ns	*	
AO*E										
T1	38.50	12.80	3.84	5.90 ^b	57.50	42.50	99.15	31.80	33.25 ^a	
T2	41.50	13.80	4.12	8.80 ^a	56.00	43.50	100.80	33.50	33.30 ^a	
T3	36.00	11.95	3.56	5.70 ^b	60.50	37.00	101.30	33.70	33.25 ^a	
T4	37.00	12.30	3.65	4.80 ^b	60.00	38.50	101.55	33.75	33.10 ^b	
T5	34.50	11.50	3.38	5.65 ^b	51.50	48.50	102.15	34.00	33.30 ^a	
T6	37.00	12.30	3.66	6.20 ^b	59.00	40.00	101.25	33.65	33.20 ^a	
SEM	2.73	0.92	0.29	0.52	5.27	5.74	1.00	0.92	0.03	
LOS	ns	ns	Ns	*	ns	ns	ns	ns	*	

ab means on the same column having different superscript differ significantly ($p < 0.05$); ns = not significant; y different ($p > 0.05$); SEM = standard error of mean; LOS = level of significant; PCV = Packed cell volume; HBC = Haemoglobin count (g/dl); RBC = Red blood cell ($\times 10^9/L$); WBC = White blood cell ($\times 10^9/L$); MCV = mean cell volume (pg); MCH = Mean corpuscular haemoglobin (fl) = MCHC = Mean cell haemoglobin concentration ($\times 10^9/L$)

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The main and interactive effects of AO and enzymes on haematological parameters of grower rabbits are presented in Table 5. The main effect of AO was not significant ($P>0.05$) except on WBC and MCHC. The WBC value of control treatment was significantly higher than 15% and 30% AO included diets. The result of MCHC was significantly ($P<0.05$) higher in control and 30% AO than in 15% AO fed rabbits. The similarity between the control and other treatments for PCV indicates that the dietary treatments do not cause anaemic condition to the animals. This agreed with Ogunipe and Johnson (2012) who revealed that maize offal did not cause adverse effect on the haematological parameters of rabbits. Also, main effect of enzymes on haematological parameters of grower rabbits showed no significant ($P>0.05$) difference between the treatments (0ppm and 200ppm enzymes) except in WBC and MCHC where the highest WBC and MCHC was recorded from animals fed 200ppm and 0ppm enzymes included diets, respectively. The increased value of WBC due to inclusion of enzymes suggests an increased immunity in the animals. The treatment effect of AO and enzyme on haematological parameters of grower rabbit showed no significant ($P>0.05$) difference for all the parameters monitored except WBC and MCHC values. The significantly ($p<0.05$) highest value of WBC ($8.80\times 10^9/L$) was recorded in T₂. Meanwhile T₁, T₃, T₄, T₅ and T₆ were not significantly ($P>0.05$) different from each other. MCHC ($33.10\times 10^9/L$) was significantly ($P<0.05$) lower in T₄ than the rest of the treatments. The increased value of WBC due to inclusion of enzymes suggests an increased immunity in the animals.

Presented in Table 6 are the main and interactive effect of AO and enzymes on biochemical indices of weaner rabbits. The main effect of either AO or enzyme supplementation on all the parameters measured was not significant ($P>0.05$). Similarly, the interactive effects of AO and enzyme supplementation was not significant ($P>0.05$). This indicates that the supplementation when used singly or in combination had no effects that could result to either decrease or increase in the biochemical values of the animals.

The main and interactive effects of AO and enzyme on serum biochemical indices of grower rabbits are presented in Table 7. The main effect of AO did not affect the serum biochemical parameters significantly ($P>0.05$) though there was significant ($P<0.05$) reduction in serum phosphorus in rabbits fed 30% AO than those fed 0% and 15%. There was significant ($P<0.05$) effect of enzyme on phosphorus and calcium values. A significant ($P<0.05$) reduction in the value of phosphorus was recorded and an increased calcium level of the animals was recorded when 200ppm enzymes was included in the diets. The treatment showed no significant ($P>0.05$) difference between the treatments except on the values of phosphorus, globulin and calcium that were significant ($P<0.05$). Phosphorus was significantly ($P<0.05$) higher in T₁ than other treatments while globulin was significantly lower in animals fed T₆ diets although it was not different ($P>0.05$) from T₁ fed animals. This showed that the immunity of the animals was still maintained even when fed the diets. Rabbits fed T₁, T₂, T₃, T₄ and T₅ had no significant ($P>0.05$) calcium value. This showed that the needed calcium for bone formation in the animals was not affected by the dietary treatments.

Table 6: Main and interactive effect of acha offal and enzyme(maxigrain) on serum biochemical indices of weaner rabbits

Treatments	Parameters											
	UR	CR	T	ALBU MIN	GLOB	G	CHO	TR	HDL	Ca	Mg	P
(AO)												
0.00	3.38	90.00	61.50	39.25	23.50	6.30	4.48	1.33	0.93	2.10	1.30	2.18
0.15	3.48	80.25	69.75	42.00	30.00	5.35	4.38	1.30	1.08	2.18	1.18	1.73
0.30	2.90	97.50	64.50	39.50	24.75	6.08	4.93	1.65	1.18	2.05	1.43	1.60
SEM	0.38	11.38	2.67	1.25	1.88	0.67	0.33	0.24	0.08	0.21	0.12	0.22
LOS	ns	ns	ns	ns	ns	ns	Ns	ns	ns	ns	ns	ns
Enzyme												
0ppm	2.88	78.50	64.33	39.67	27.00	5.90	4.62	1.45	1.02	2.12	1.33	1.83
200ppm	3.62	100.00	66.17	40.83	25.17	5.92	4.57	1.40	1.10	2.10	1.27	1.83
SEM	0.31	9.30	2.18	1.02	1.53	0.55	0.27	0.20	0.06	0.17	0.10	0.18
LOS	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
AO*E												
T ₁	3.65	66.50	61.50	38.50	26.00	6.80	4.15	1.00	0.75	2.10	1.35	2.30
T ₂	3.10	113.50	61.50	40.00	21.00	5.80	4.80	1.65	1.10	2.10	1.25	2.05
T ₃	2.95	54.50	66.00	41.00	29.00	5.15	4.85	1.50	1.15	2.25	1.30	1.75
T ₄	4.00	106.00	73.50	43.00	31.00	5.55	3.90	1.10	1.00	2.10	1.05	1.70
T ₅	2.05	114.50	65.50	39.50	26.00	5.75	4.85	1.85	1.15	2.00	1.35	1.45
T ₆	3.75	80.50	63.50	39.50	23.50	6.40	5.00	1.45	1.20	2.10	1.50	1.75
SEM	0.54	16.10	3.77	1.77	2.65	0.95	0.46	0.34	0.11	0.30	0.17	0.31
LOS	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

NS = not significantly different (p>0.05); SEM = standard error of mean; LOS = level of significant; CR = creatinine (umol/L); T. protein = Total protein (g/dl); G = Glucose (mmol/L); CHO = Cholesterol (mmol/L); GLOB = Globulin (g/dl); HDL = high density lipoprotein(mg/dl); TR = Triglyceride (mg/dl); UR = UREA(umol/L); Mg =magnesium; Albumin (g/dl)

Table 7: Main and interactive effect of acha offal and enzyme(maxigrain) on serum biochemical indices of grower rabbits

Parameters Treatment	CR	UR	T.PROTEIN	Albumin(g/dl)	Glucose	CHO	GOT	P(g/dl)	GLOB	Mg	Calcium	HDL	TR
Acha offal													
0%	90.00	5.03	71.75	31.5	6.30	4.55	56.25	1.78 ^a	31.00	1.15	2.08	1.03	1.18
15%	103.5	5.10	71.50	33.5	6.20	4.45	69.5	1.70 ^a	33.50	1.18	2.60	0.93	1.10
30%	97.50	5.45	69.75	31.25	6.70	4.35	46	1.35 ^b	29.25	1.25	2.65	1.13	1.23
SEM	17.41	0.78	2.86	2.33	0.80	0.32	9.5	0.06	2.40	0.11	0.16	0.08	0.08
LOS	Ns	ns	ns	ns	ns	ns	ns	*	ns	ns	ns	ns	ns
Enzymes													
0ppm	89.50	5.05	70.00	31.00	6.60	4.50	56.50	1.83 ^a	33.00	1.12	2.20 ^b	1.07	1.17
200ppm	104.5	5.33	72.00	33.17	6.20	4.40	58.00	1.38 ^b	29.50	1.27	2.68 ^a	0.98	1.17
SEM	14.21	0.64	2.33	1.90	0.65	0.26	7.76	0.05	1.96	0.09	0.13	0.07	0.07
LOS	Ns	ns	ns	ns	ns	ns	ns	*	ns	ns	*	ns	ns
T1	99.50	5.35	69.00	26.50	6.60	4.60	51.00	2.40 ^a	27.00 ^{ab}	1.10	2.05 ^b	1.05	1.20
T2	80.50	4.70	74.50	36.50	6.00	4.50	61.50	1.15 ^c	35.00 ^a	1.20	2.10 ^b	1.00	1.15
T3	77.50	4.50	67.50	31.50	5.75	4.15	66.50	1.65 ^b	34.00 ^a	1.15	2.55 ^{ab}	0.95	1.10
T4	129.50	5.70	75.50	35.50	6.65	4.75	72.50	1.75 ^b	33.00 ^a	1.20	2.65 ^{ab}	0.90	1.10
T5	91.50	5.30	73.50	35.00	7.45	4.75	52.00	1.45 ^{bc}	38.00 ^a	1.10	2.00 ^b	1.20	1.20
T6	103.50	5.60	66.00	27.50	5.95	3.95	40.00	1.25 ^c	20.50 ^b	1.40	3.30 ^a	1.05	1.25
SEM	24.62	1.11	4.04	3.00	1.13	0.46	13.44	0.08	3.40	0.15	0.23	0.11	0.12
LOS	Ns	ns	ns	ns	ns	ns	ns	*	*	ns	*	ns	ns

Abc, means on the same column having different superscript differ significantly (p<0.05); NS = not significantly different (p>0.05); SEM = standard error of mean; LOS = level of significant; CR = creatinine (umol/L); T: protein = Total protein (g/dl); G = Glucose (mmol/L); CHO = Cholesterol (mmol/L); GLOB = Globulin (g/dl); HDL = high density lipoprotein(mg/dl); TR = Triglyceride (mg/dl); UR = UREA(umol/L); Mg =magnesium

Conclusion and recommendation

Acha offal based diets supplemented with maxi grain enzymes could be fed to rabbits without adverse effect on haematological and serum biochemical indices of the animals.

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