Nig. J. Anim. Prod. 2020, 47(6): 54 - 64
Nigerian Journal of Animal Production

Effect of Ronoxyme hiphos® supplementation on nutrient digestibility and blood parameters of grower rabbits fed sunflower seed meal-based diets

[1]Onazi, B. O., [2]Alu, S. E., [2]Ogah, D. M., [2]Adua, M. M. and [2]Baba, M. K.

[1]*Dept. of Agricultural Education, School of Vocational Education, Federal College of Education (Tech), Gusau, Zamfara State, Nigeria.*

[2]*Dept. of Animal Science, Faculty of Agriculture, Nasarawa State University, Keffi, P.M.B.135, Shabu-Lafia campus, Nasarawa State, Nigeria.*

Corresponding author: onazit2000@gmail.com; Tel +2348060905028

Abstract

A 42- day experiment was conducted to evaluate the response of grower rabbits fed cooked sunflower seed meal (SFSM) supplemented with enzyme on nutrient digestibility and blood parameters using 72 growing rabbits. Nine diets namely T1 to T9 were compounded to be isocaloric (2500 kcal/kg, ME) and isonitrogenous (15%) with treatments T1, T2 and T3 having 0% inclusion rate of SFS meal and 0PPM, 150PPM and 250PPM of the enzyme supplementation. Treatments T4 to T6 and T7 to T9 had 10 and 20% levels of SFS meal inclusion rate respectively but maintaining same levels of enzyme supplementation as in T1 to T3. This arrangement translated to T1, T4 and T7 serving as the control diets for T2 and T3, T5 and T6 and T8 to T9, respectively. The rabbits were allotted to the three levels of SFS meal (0,10 and 20%) and three levels of enzyme supplementation (0,150, and 250PPM) in a 3x3 factorial arrangement of a completely randomized design (CRD) to produce nine treatment diets. The treatments were replicated four times. Crude fibre, neutral detergent fibre, acid detergent fibre and cellulose were significantly (P<0.05) higher in rabbit fed 20% (84.58%, 72.24%, 67.16% and 64.27%) SFS diet than 0% (64.20%, 66.68%, 59.40% and 57.81%) and 10% (76.88%, 70.63%, 64.04% and 61.90%) respectively. Enzyme supplementation significantly (P<0.05) improved RBC, the values increased from 5.23 $x10^{12}$/l for non-enzyme supplementation to 5.38 -5.73 $x10^{12}$/l. Red blood cell and was significantly (P<0.05) lower in rabbits fed T4 diet than the other groups. Similarly, haemoglobin (11.42 vs. 11.37 and 12.01 g/dl), cholesterol (3.83 vs. 4.33 and 4.31mmol/l) and triglyceride (0.95 vs. 1.16 and 1.03mmol/l) were improved (P<0.05) as the level of enzyme supplementation increased in the diets. In view of the significant improvement in nutrient digestibility and some of the blood parameters recorded, rabbit farmers can use the 150 PPM of the enzyme in SFS meal based diets without affecting the nutrient digestibility and health of the rabbits.

Keywords: Ronoxyme HiPhos®, Supplementation, Nutrient Digestibility, Grower Rabbits, Sunflower Seed Meal.

L'Effet de la supplémentation en Ronoxymehiphos® sur la digestibilité des nutriments et les paramètres hématologiques des lapins en croissance nourris avec des repas à base de graines de 'sunflower'

Résumé

Une expérience de 42 jours a été menée pour évaluer la réponse de lapins en croissance nourris avec de la farine de graines de 'sunflower' cuite (le 'SFSM') supplémentée en enzyme sur la digestibilité des nutriments et les paramètres sanguins en utilisant 72 lapins en croissance. Neuf régimes à savoir T1 à T9 ont été composés pour être iso caloriques (2500 *kcal / kg, ME) et iso nitrogènes (15%) avec les traitements T1, T2 et T3 ayant un taux d'inclusion de 0% de repas 'SFS' et '0PPM', 150PPM et 250PPM de la supplémentation enzymatique. Les traitements T4 à T6 et T7 à T9 avaient respectivement 10 et 20% de taux d'inclusion de repas SFS, mais conservaient les mêmes niveaux de supplémentation enzymatique que dans T1 à T3. Cet arrangement traduit en T1, T4 et T7 servant de régimes de contrôle pour T2 et T3, T5 et T6 et T8 à T9, respectivement. Les lapins ont été attribués aux trois niveaux de repas SFS (0,10 et 20%) et à trois niveaux de supplémentation enzymatique (0,150 et 250 PPM) dans un arrangement factoriel 3x3 d'une conception complètement randomisée (CRD) pour produire neuf régimes de traitement. Les traitements ont été répétés quatre fois : les fibres brutes, les fibres détergentes neutres, les fibres détergentes acides et la cellulose étaient significativement plus élevées (P <0,05) chez le lapin nourri à 20% (84,58%, 72,24%, 67,16% et 64,27%) régime 'SFS' que 0% (64,20%, 66,68%, 59,40% et 57,81%) et 10% (76,88%, 70,63%, 64,04% et 61,90%) respectivement. La supplémentation enzymatique a considérablement amélioré (P <0,05) les globules rouges, les valeurs ont augmenté de 5,23 x 1012 / l pour la supplémentation non enzymatique à 5,38 -5,73 x 1012 / l Les globules rouges étaient significativement (P <0,05) plus bas chez les lapins nourris au régime T4 que les autres groupes. De même, l'hémoglobine (11,42 vs 11,37 et 12,01 g / dl), le cholestérol (3,83 vs 4,33 et 4,31 mmol / l) et les triglycérides (0,95 vs 1,16 et 1,03 mmol / l) ont été améliorés (P <0,05) à mesure que le niveau de supplémentation enzymatique augmentait dans les régimes. A cause de l'amélioration significative de la digestibilité des nutriments et de certains des paramètres hématologiques enregistrés, les éleveurs de lapins peuvent utiliser les 150 PPM de l'enzyme dans les régimes à base de repas 'SFS' sans poser aucun problème à la digestibilité des nutriments et la santé des lapins.*

Mots clés: RonoxymeHiPhos®, supplémentation, digestibilité des nutriments, lapins de croissance, farine de 'sunflower'.

Introduction

Conventional feed stuffs are very expensive and scarce. This high cost and scarcity according to Esonu *et al.* (2004) are derived from crippling realities which are characteristics of the economics of developing countries. Conventional feed ingredients are expensive since they suffer stiff competition with channels in the food chain which command higher priority and can pay higher prices than the compound feed industry (Esonu *et al.,* 2004). Therefore, the use of cereal based feeds in livestock nutrition may not be sustainable especially in developing countries where cereal grains form a major staple in human diets. Again, the challenge of anti-nutritional factors and anti-nutrients in most non-conventional feedstuffs has remained a major hindrance to their use. Exogenous enzyme supplementation has been advocated (Alu *et al.,* 2012) as one of the ways or methods of alleviating the problems of anti-nutritional factors in feeds. One of such non-conventional protein sources is the sunflower seed, (*Helianthus annuus* L.) which is one of the few crop species that originated in North America. Sunflower was probably first introduced to Europe through Spain, and spread as a curiosity until it reached Russia where it was readily adapted. Commercially available sunflower varieties contain from 39 to 49% oil in the seed. Any attempt towards improvement of growth performance in rabbits should be complimented with consideration on the nutrient digestibility, haematology as well as serum biochemistry of the animals. Haematological parameters are good indicators of the physiological status of animals (Adenkola and Durotoye, 2004; Khan and Zafar, 2005). Changes in haematological parameters are of value in assessing the responses of animals to various physiological and disease condition (Khan and Zafar, 2005). This study was designed to evaluate the effect of enzyme supplementation on the nutrient digestibility and blood parameters in grower rabbits fed SFS meal-based diets.

Materials and methods

Study area

The study was carried out at the research and teaching farm of Faculty of Agriculture Nasarawa State University Keffi, Shabu-Lafia Campus. It is located in the Guinea Savanna Zone of North Central. It is found in latitude 08 35N and longitude 08 33E. The mean monthly maximum and minimum temperatures were 35.06˚C and 20.16˚C respectively at the time of the experiment while the mean monthly relative humidity and rainfall were 74.67% and 168-190mm, respectively (NIMET, 2017).

Source of test ingredient

Sunflower seed (SFS) which is the test ingredient was purchased at Gambali Unique Gardens Jos, Plateau State, cooked, sun-dried, crushed and mixed with other feed ingredients to compound the experimental diets.

Chemical analysis

Proximate analysis of SFS was done at Animal Science Laboratory of Faculty of Agriculture, Nasarawa State University, Keffi, Shabu-Lafia Campus, using the standard procedure of AOAC (2002). Nitrogen Free Extract (NFE) was calculated using the formula: NFE (%) = 100 – CP + CF + EE + Moisture + Ash.

Experimental diets and design

Nine experimental diets namely T1, T2, T3, T4, T5, T6, T7, T8 and T9 were compounded to be isocaloric (2500 kcal/kg, ME) and isonitrogenous (15% CP) having treatments T1, T2 and T3with 0% inclusion rate of SFS meal and 0, 150 and 250PPM of the enzyme supplementation. Treatments T4 to T6 and T7 to T9 had 10 and 20% levels of SFS meal inclusion rate, respectively but maintaining same levels of enzyme supplementation as in T1 to T3. This arrangement means that T1, T4 and T7 serve as the control diets for T2 and T3, T5 and T6 and T8 to T9, respectively. Other ingredients were added to meet the nutrient requirements of grower rabbits as described by Olomu *et al.* (2019). The gross composition of the experimental diets is presented in Table 1.

Management of rabbits and experimental design

Seventy-two cross-bred growing rabbits of about 6-7 weeks old with a mean weight of 567g were obtained from Dagwam Farms, National Veterinary Research Institute (NVRI) Vom, Jos, Plateau State. The rabbits were fed *ad-libitum* and had access to drinking water at all times and were administered anti-stress vitamin/mineral premix orally at the recommended dosage after randomization before the commencement of the experiment. Other management practices were adopted as described by Aduku (2004). The rabbits were paired and allotted to the 9 treatments and each treatment was replicated 4 times giving rise to a 3x3 factorial arrangement fitted into a Completely Randomized Design.

Apparent nutrient digestibility determination

A nutrient digestibility trial was carried out seven days (11^{th} week) before the expiration of the feeding trial using two rabbits per replicate which were kept in metabolism cages. Known quantities of feed was given to the rabbits in each replicate in the morning and left over collected the following day in the morning for seven

Table 1: Percentage chemical and energy composition of experimental diets for grower rabbits

	DIETS								
Feedstuff	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**
Groundnut shell	10.00	10.00	10.00	13.00	13.00	13.00	21.00	21.00	21.00
Salt (NaCl)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Maize Bran	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Groundnuts Cake	8.00	8.00	8.00	4.00	4.00	4.00	4.00	4.00	4.00
SFS (Cooked 3h)	0.00	0.00	0.00	10.00	10.00	10.00	20.00	20.00	20.00
*Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Maize	30.00	30.00	30.00	21.00	21.00	21.00	11.00	11.00	11.00
Rice Offal	25.00	25.00	25.00	25.00	25.00	25.00	20.00	20.00	20.00
Soybean (full fat)	17.00	17.00	17.00	17.00	17.00	17.00	14.00	14.00	14.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Lysine	0.25	0.25	0.25	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	0.25	0.25	0.25
Enzymes(ppm)	0.00	150.00	250.00	0.00	150.00	250.00	0.00	150.00	250.00
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated chemical and energy composition									
**Energy (kcal/kg, ME)	2515.83	2515.83	2515.83	2532.51	2532.51	2532.51	2579.36	2579.36	2579.36
Crude protein (%)	15.31	15.31	15.31	15.04	15.04	15.04	15.26	15.26	15.26
Crude fibre (%)	8.32	8.32	8.32	11.03	11.03	11.03	15.77	15.77	15.77
Ether Extract (%)	8.52	8.52	8.52	7.56	7.56	7.56	7.13	7.13	7.13
Ash (%)	6.72	6.72	6.72	7.00	7.00	7.00	6.52	6.52	6.52
Calcium (%)	1.32	1.32	1.32	1.28	1.28	1.28	1.30	1.30	1.30
Phosphorus (%)	0.88	0.88	0.88	0.88	0.88	0.88	0.87	0.87	0.87
Lysine (%)	0.92	0.92	0.92	0.98	0.98	0.98	1.03	1.03	1.03
Methionine (%)	0.46	0.46	0.46	0.49	0.49	0.49	0.51	0.51	0.51

*The vitamin – mineral premix supplied the following per 100kg of diet: Vitamin A, 15,000 I.U; Vitamin D_3, 300,000 I.U; Vitamin E 3,000 I.U; Vitamin K, 2.50mg; Thiamin (B_1), 200mg; Riboflavin (B_2), 600mg; Pyridoxine (B_6), 600mg; Niacin, 40.0mg; Vitamin B_{12}, 2mg; Pantothenic acid, 10.0mg; Folic acid, 100mg; Biotin, 8mg; Choline chloride, 50g; Anti -oxidant, 12.5g; Manganese, 96g; Zinc, 6g; Iron, 24g; Copper, 0.6g; Iodine, 0.14g; Selenium, 24mg; Cobalt, 214mg. ME kcal/ kg = 37 X %CP + 81.1 X %EE + 35.5 X %NFE.
**Pauzenga (1985).

days. Faecal droppings were collected daily using the total collective method in aluminum foils and weighed, preserved with boric acid and oven dried at 80°C for 24 hours.

At the expiration of the experiment, the dry matter, crude protein, crude fibre, ether extract, nitrogen free extract and ash content of the experimental diets, collected faecal samples were determined using the procedures of AOAC (2002).

The nutrient digestibility were calculated using the formula:

$$\text{Apparent nutrient digestibility (\%)} = \frac{\text{Nutrients in feed consumed x Nutrients in faeces voided}}{\text{Nutrient in feed consumed}} \times 100$$

Haematological and serological parameters

At the end of the experiment 2-5ml of blood samples from 3 randomly selected rabbits per treatment were collected for haematological and biochemical analyses. The first set of blood samples were collected and emptied into labeled sterile universal bottles containing anti-coagulant, ethylene diamine tetra acetic acid (EDTA) for the determination of haematological components while the other set of blood labeled sterile bottles without EDTA for the determination of serum biochemical components. The packed cell volume (PCV) was determined using the micro-haematocrit technique, the red blood cells

(RBC) and white blood cells (WBC) counts using the improved Neubauerhematocytometer method, and haemoglobin (Hb) using the Cyanomethemoglobin method as described by Kelly (1979). Serum total protein was determined using Biuret method as described by Kohn and Allen (1995). Albumin was determined using Bromoscresol Green (BCG) method as described by Peter *et al.,* (1982). The globulin concentration was obtained by subtracting albumin from the total protein while the albumin/globulin ratio was obtained by dividing the albumin value by the calculated globulin value.

Data analysis

All data obtained from the experiment were subjected to Two Way Analysis of Variance (ANOVA) and where significant differences are observed the means were separated using Duncan's Multiple Range Test (DMRT) using the Statistical Package for Social Sciences (SPSS) software.

Results and discussion

Presented in Table 2 are main and interactive effects of sunflower seed meal and enzyme supplementation on nutrient digestibility in grower rabbit. There were significant (P<0.05) effects of sunflower seed meal in all the parameters measured. Crude fibre (84.58%), neutral detergent fibre (72.24%), acid detergent fibre (67.16%) and cellulose (64.27%) were significantly (P<0.05) higher in rabbit fed 20% diet than the other groups 0% (64.20%, 66.68%,59.40% and 57.81%) and 10%(76.88%, 70.63%, 64.04% and 61.90%) respectively. While 10% diet (76.88%, 70.63%, 64.04% and 61.90%) was significantly higher than 0% diet (64.20%, 66.68%, 59.40% and 57.81%) in crude fibre, neutral detergent fibre, acid detergent fibre and cellulose digestibility respectively. Ether extract, nitrogen free extract, and hemicellulose were significantly (P<0.05) higher in 10% (76.63%, 79.44% and 78.02%) and 20%(77.05%, 79.53%, 78.13% than 0% (73.73%,66.68% and 74.93%) sunflower seed diet. Digestibility of crude protein and dry matter were significantly (P<0.05) higher in 0% (87.00% and 89.80%)and 10% (87.78% and 90.20%) than 20% (86.34% and 89.15%) diets.

The range of dry matter, crude protein and crude fibre digestibility in this study were above the values earlier reported by Shaahu *et al.* (2014) for growing rabbit fed raw and processed lablab seed meal. This variation might be attributed to the differences in the type/nutrient composition of the seed between this study and theirs. This work utilized sunflower whereas they used lablab seed in their studies. The reduction in dry matter and crude protein digestibility whereby 10% was greater than 15% recorded diets during the growing phase indicates that the animal cannot digest parameters beyond 15% level. The resulting improvement in the digestibility of the energy and fibrous part of these diets at 20% inclusion of sunflower seed meal might be attributed to the increase level of sunflower in the diets. According to Shaahu *et al.* (2014) digestion of a diet may be high but the utilization can be poor due to impaired absorption. This suggests that adequate quality and quantity diets are less digested than unbalanced and insufficient quantity of feed given to rabbits. This may probably be due to extra efforts made by the rabbits to maximize what is available to them in order to obtain their required nutrients. All the digestibility parameters measured were not significantly (P>0.05) affected by enzyme supplementation except crude fibre where there was significant (P<0.05) difference. Rabbit fed on 150ppm of enzyme supplementation had significantly lower crude fibre digestibility than those on 0ppm and 250ppm. The non variation between the control diet and enzyme supplemented one indicates that the rabbit utilized the diets at the same level irrespective of addition of enzyme. This is similar to the work of Salama *et al.* (2019) who reported that digestion coefficients of crude protein, crude fiber, ether extract, nitrogen free extract and nutritive value in terms of digestible crude protein, total digestible nutrients did not significantly differ between control diets and enzymes supplementation. The improved digestibility of crude fibre at 150ppm might be due to enzyme supplementation. This is in agreement with Eiben *et al*. (2004) who said that in some trials enzymes improved fiber digestibility. Previous studies reported that incorporating exogenous enzymes in rabbits' diets improve nutrients availability, however in most trials, rabbits appeared less responsive and variable effects were observed on their performances (Garcia et al., 2005). Eiben *et al*. (2004) testing cellulase, got improvements in feed conversion and mortality of rabbits weaned at 23 days of age.

The interactive effect of sunflower seed meal and enzyme showed significantly (P<0.05) higher digestibility of crude fibre (86.33%), acid detergent fibre (66.96%) and cellulose (64.85%) in T9 although it was not significantly (P>0.05) different from T7 (85.66%, 66.82% and 63.46%) and T8 (81.75%, 66.96% and 64.85%). This showed that crude fibre was better utilized at this treatment levels than the rest. Digestibility of Neutral Detergent Fibre (NDF) was significantly (P<0.05) higher in T4(69.46%)T5(71.38%), T6(71.05%), T7(71.95%), T8 (72.45%)and T9(72.33%) than T1(65.58%), T2(66.53%) and T3(67.92%). This indicates that NDF was better digested at higher levels of sunflower inclusion. The inability to observe any difference between T1, T2 and T3; T4 T5 and T6 and subsequently T7, T8 and T9 diets in this study indicates that the significant digestibility in main effect of sunflower fed rabbits was not influenced by enzyme addition but rather as a result of increasing levels of sunflower.

Haematological parameters are good indicators of the physiological status of animals (Adenkola and Durotoye, 2004). Main and Interactive effects of sunflower seed meal and enzyme supplementation on haematological parameters of grower rabbit is presented in Table 3. Red blood cell count, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration were significantly (P<0.05) affected by varying dietary levels of sunflower meal. There was no significant (P>0.05) difference between the sunflower levels in packed cell volume, white blood cell count, haemoglobin and mean cell volume of the rabbits. Rabbits on 0% ($5.62x10^{12}$/L) and 20%($5.57x10^{12}$/L sunflower meal had significant (P<0.05) higher Red blood cell count than those on 10%($5.15\ x10^{12}$/L) sunflower meal. Mean Corpuscular Haemoglobin (MCH) was significantly (P<0.05) higher in 10% (20.03 Pg) and 20%(21.11 Pg) sunflower although, 0%(19.06Pg) and 10%(20.03Pg) were not significantly (P>0.05) different. Sunflower containing diets 10% (32.31 g/dl) and 20% (33.19 g/dl) had significant (P<0.05) higher Mean Corpuscular Haemoglobin Concentration (MCHC) than the 0% (30.26 g/dl). The improved MCH and MCHC level might be related to the increased level of up to 20% of sunflower in the diets.

The results of the effect of the enzyme(RonoxymeHiPhos®) supplementation on blood parameters of grower rabbits fed SFS meal (Table 3) show that enzyme supplementation significantly (P<0.05) improved RBC. The values

Table 2: Main and interactive effects of sunflower and enzyme supplementation on nutrient digestibility in rabbits

Parameters	Dry matter	Crude protein	Ether extract	Crude fibre	Ash	Nitrogen free extract	Neutral detergent fibre	Acid detergent fibre	Acid detergent lignin	Hemicellulose	Cellulose
Sunflower											
0SF	89.80^{ab}	87.00^{ab}	73.73^{b}	64.20^{c}	75.83^{c}	76.84^{b}	66.68^{c}	59.40^{c}	61.97^{c}	74.93^{b}	57.81^{c}
10SF	90.20^{a}	87.78^{a}	76.63^{a}	76.88^{b}	78.80^{b}	79.44^{a}	70.63^{b}	64.04^{b}	67.44^{b}	78.02^{a}	61.90^{b}
20SF	89.15^{b}	86.34^{b}	77.05^{a}	84.58^{a}	80.68^{a}	79.53^{a}	72.24^{a}	67.16^{a}	71.68^{a}	78.13^{a}	64.27^{a}
SEM	0.28	0.31	0.32	1.03	0.31	0.29	0.37	0.44	0.51	0.35	0.44
LOS	*	*	*	*	*	*	*	*	*	*	*
Enzyme											
0ppm	89.7	86.85	75.6	77.21^{a}	78.42	78.37	69.78	63.74	67.47	76.75	61.33
150ppm	89.6	87	75.85	73.43^{b}	78.57	78.68	69.8	63.24	66.1	77.17	61.55
250ppm	89.85	87.26	75.96	75.02^{ab}	78.33	78.76	69.97	63.62	67.51	77.16	61.09
SEM	0.28	0.31	0.32	1.03	0.31	0.29	0.37	0.44	0.51	0.35	0.44
LOS	Ns	ns	ns	*	ns	ns	ns	ns	Ns	ns	Ns
Sunflower*Enzyme											
T_1	89.35	86.6	72.93	59.00^{e}	75.25^{e}	76.16	65.58^{e}	57.73^{f}	59.58^{f}	74.38	56.64^{d}
T_2	90.41	87.53	73.88	60.43^{e}	75.13^{e}	77.03	66.53^{de}	58.64^{f}	60.63^{f}	75.29	57.49^{d}
T_3	89.65	86.88	74.4	73.16^{cd}	77.10^{d}	77.32	67.92^{cd}	61.82^{e}	65.70^{de}	75.13	59.31^{c}
T_4	90.31	87.56	75.83	72.80^{d}	77.70^{cd}	78.77	69.46^{abc}	62.57^{de}	64.82^{e}	77.18	61.24^{bc}
T_5	90.10	87.86	77.1	79.54^{b}	79.50^{ab}	79.83	71.38^{ab}	65.05^{bc}	68.17^{cd}	78.51	63.16^{ab}
T_6	90.19	87.93	76.96	78.29^{bc}	79.21^{bc}	79.73	71.05^{ab}	64.52^{cd}	69.33^{bc}	78.38	61.30^{bc}
T_7	89.12	86.12	76.57	85.66^{a}	80.46^{ab}	79.02	71.95^{a}	66.82^{abc}	71.88^{ab}	77.96	63.46^{ab}
T_8	89.36	86.55	77.52	81.75^{ab}	80.95^{a}	80.05	72.45^{a}	66.96^{ab}	70.56^{abc}	78.62	64.85^{a}
T_9	88.97	86.33	77.05	86.33^{a}	80.64^{ab}	79.52	72.33^{a}	67.69^{a}	72.59^{a}	77.81	64.50^{a}
SEM	0.49	0.54	0.55	1.78	0.53	0.5	0.64	0.76	0.89	0.61	0.77
LOS	Ns	ns	ns	*	*	ns	*	*	*	ns	*

abcd means on the same row having different superscript differ significantly ($p<0.05$); NS = not significantly different($p>0.05$); SEM = standard error of mean increased from 5.23 x10^{12}/l for non-enzyme supplementation to 5.38 -5.73 x10^{12}/l for enzyme supplemented diets. These observations are in tandem to the earlier findings of Alu *et al.,* (2014) who reported significant improvement in some blood parameters such as, Packed cell volume (PCV), White blood cells (WBC), Haemoglobin (Hb), Mean corpuscular volume (MCV) of finisher quails fed enzyme supplemented diets. The values obtained in the present study fell within the normal range of PVC (30-50%), WBC (4-10X10^{3}/uL) for mature rabbits (Olomu *et al.,* 2019; Alu, 2018). There was significant (P<0.05) interactive effect between sunflower seed and enzyme supplementation in Red blood cell count of the animals. Packed cell volume, white blood cell, haemoglobin, mean cell volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration were not significant (P>0.05). Red blood cell was significantly (P<0.05) lower in rabbits fed T4 (4.53 x10^{12}/L) diet than the other groups. The resulting higher red blood cell in T5 (5.25 x10^{12}/L) and T6 (5.66 x10^{12}/L) than T4 (4.53 x10^{12}/L) might be attributed to addition of enzyme in the diets.

Main and interactive effects of sunflower seed meal and enzyme supplementation on haematological parameters of grower rabbits

Parameters	PCV(%)	RBC(X10^{12}/l)	WBC(X10^{9}/l)	Hb(g/dl)	MCV(fl)	MCH(pg)	MCHC(g/dl)
0%SF	35.00	5.62^{a}	9.82	11.83	62.25	19.06^{b}	30.26^{b}
10%SF	34.17	5.15^{b}	11.20	11.44	64.17	20.03^{ab}	32.31^{a}
20%SF	35.00	5.57^{a}	10.13	11.52	63.25	21.11^{a}	33.19^{a}
SEM	0.52	0.12	0.61	0.17	0.67	0.37	0.41
LOS	NS	*	NS	NS	NS	*	*
0PPM	33.83	5.23^{b}	10.08	11.42^{b}	62.5	19.78	31.59
150PPM	34.58	5.38^{b}	9.59	11.37^{b}	64.17	20.18	31.68
250PPM	35.75	5.73^{a}	11.48	12.01^{a}	63	20.25	32.48
SEM	0.52	0.12	0.61	0.17	0.67	0.37	0.41
LOS	NS	*	NS	*	NS	NS	NS
T_1	35.00	5.78^{a}	9.40	11.75	62.75	19.75	30.13
T_2	34.25	5.36^{a}	9.95	11.38	63.25	19.25	29.63
T_3	35.75	5.74^{a}	10.10	12.38	60.75	18.18	31.03
T_4	32.50	4.53^{b}	11.88	11.23	62.00	19.35	32.50
T_5	34.50	5.25^{a}	9.00	11.35	65.25	20.45	31.38
T_6	35.50	5.66^{a}	12.73	11.75	65.25	20.30	33.05
T_7	34.00	5.38^{a}	8.95	11.28	62.75	20.23	32.15
T_8	35.00	5.52^{a}	9.83	11.38	64.00	20.83	34.05
T_9	36.00	5.80^{a}	11.60	11.90	63.00	22.28	33.38
SEM	0.89	0.20	1.05	0.30	1.16	0.64	0.72
LOS	NS	*	NS	NS	NS	NS	NS

ab means on the same row having different superscript differ significantly (p<0.05); NS = not significantly different(p>0.05); SEM = standard error of mean

Presented in Table 4 are the main and interactive effects of sunflower seed meal and enzyme supplementation on serum biochemistry of grower rabbit. Cholesterol, and Total protein were significantly (P<0.05) affected by the varying dietary sunflower seed meal. However,

Presented in Table 4 are the main and interactive effects of sunflower seed meal and enzyme supplementation on serum biochemistry of grower rabbit. Cholesterol, and Total protein were significantly (P<0.05) affected by the varying dietary

sunflower seed meal. However, Triglyceride, Albumin, Creatinine and Glucose were not significantly (P>0.05) affected. Rabbits on 10% (4.47 mmol/L) and 20% (4.13 mmol/L) were having similar cholesterol. Moreover, there was no significant (P>0.05) different in the Cholesterol level of 0% (3.88 mmol/L) and 20% (4.13 mmol/L) sunflower meal fed rabbits. There was significant (P<0.05) higher Total protein in rabbit fed 20% (46.08 g/L) sunflower than those on 0% (40.33 g/L) and 10% (40.58 g/L) diets.

There was significant (P<0.05) difference between the different enzyme supplementation levels in Cholesterol and Triglyceride of the animals. Total protein, Albumin, Creatinine and Glucose were not significantly (P>0.05) affected by the enzyme supplementation levels. Hemoglobin (11.42 vs. 11.37 and 12.01 g/dl), cholesterol (3.83 vs. 4.33 and 4.31mmol/l) and triglyceride (0.95 vs. 1.16 and 1.03mmol/l) were significantly (P<0.05) improved as the level of enzyme supplementation increased in the diets.

The result showed significant (P<0.05) interactive effect of sunflower and enzyme supplementation on Cholesterol, Total protein and Albumin contents of the rabbits. However, Triglyceride, Creatinine and Glucose showed no significant (P>0.05) interactive between sunflower and enzyme supplementation. Rabbits on diet T2 (4.18 mmol/L), T4 (3.96 mmol/L), and T7 (3.83 mmol/L) had significant (P<0.05) lower Cholesterol than those on T5 (4.73 mmol/L) and T8 (4.10 mmol/L) although are not significantly (P>0.05) different from animals on T1 (3.78 mmol/L), T3 (3.68 mmol/L), T6 (4.78 mmol/L) and T9 (4.48 mmol/L) diets. The resulting increased T5 than T4 and T8 than T7 might be due to enzyme supplementation which was earlier reported to increase the blood values of growing rabbit (Alu *et al*. 2014).

Table 4: Main and interactive effects of sunflower seed meal and enzyme supplementation on serum biochemistry of grower rabbits

Parameters	Cholesterol (mmol/l)	Triglyceride (mmol/l)	Total protein (g/L)	Albumin (g/L)	Creatinine (mmol/L)	Glucose (mmol/l)
0%SF	3.88^{b}	1.00	40.33^{b}	23.17	152.83	9.24
10%SF	4.47^{a}	1.05	40.58^{b}	21.00	157.92	8.97
20%SF	4.13^{ab}	1.09	46.08^{a}	21.50	153.92	8.02
SEM	0.12	0.05	1.36	0.79	4.32	0.49
LOS	*	NS	*	NS	NS	NS
0Enz	3.83^{b}	0.95^{b}	41.00	23.00	155.08	9.19
150Enz	4.33^{a}	1.16^{a}	42.92	21.75	157.17	8.23
250Enz	4.31^{a}	1.03^{ab}	43.08	20.92	152.42	8.80
SEM	0.12	0.05	1.36	0.79	4.32	0.49
LOS	*	*	NS	NS	NS	NS
T_1	3.78^{bc}	1.08	41.25^{abc}	28.50^{a}	151.50	9.78
T_2	4.18^{abc}	0.90	39.25^{c}	20.75^{b}	152.25	8.95
T_3	3.68^{c}	1.03	40.50^{abc}	20.25^{b}	154.75	9.00
T_4	3.90^{bc}	0.90	34.25^{bc}	20.50^{b}	155.50	9.28
T_5	4.73^{ab}	1.25	41.50^{abc}	22.25^{b}	165.75	7.93
T_6	4.78^{ab}	1.00	46.00^{ab}	20.25^{b}	152.50	9.70
T_7	3.83^{c}	0.88	47.50^{a}	20.00^{b}	158.25	8.53
T_8	4.10^{a}	1.33	48.00^{a}	22.25^{b}	153.50	7.83
T_9	4.48^{abc}	1.08	42.75^{ab}	22.25^{b}	150.00	7.70
SEM	0.21	0.09	2.36	1.37	7.48	0.85
LOS	*	NS	*	*	NS	NS

abc means on the same row having different superscript differ significantly (p<0.05); NS = not significantly different(p>0.05); SEM = standard error of mean

Conclusion and recommendation

In view of the significant improvement in the nutrient digestibility and some blood parameters recorded in the present studies and the lack of difference in the 150 and 250 PPM of enzyme supplemented diets, rabbit farmers can use the 150 PPM of the ronoxymeHiPhos® in SFS meal based diets without affecting the nutrient digestibility and health status of the rabbits.

References

Adenkola, A. Y. and Durotoye, L. A. 2004. Haematological study during pre-partum periods in brown Savanna does in Zaria, Nigeria. Proc. of the 38th Annual Conf. of the Agric. Soc. of Nig. 538-540.

Aduku, A. O. 2004. Animal nutrition in the tropics: Feeds and feeding, pasture management, monogastric and ruminant nutrition. Pp. 17-18.

Alu, S. E. 2018. Response of rabbits fed toasted kidney bean seed (Phaseolus vulgaris) meal (TKBSM) as a replacement for soybean meal. ISSN 0189-0514 J. Anim. Prod. Res. (2018) 30(1):188-203.

Alu, S. E., Kaankuka, F. G. Carew, S. N. and Tuleun, C. D. 2014. Response of finisher Japanese quails (*Cortunixcortunix japonica*) to enzyme-supplemented sugarcane scrapping meal-based dietsand cost implication. NSUK Journal of Science and Technology (NJST) 1&2: pp 19-30, 2014.

Alu, S.E., Tuleun, C. D., Kaankuka, F. G. and Carew, S. N. 2012. Meat quality of female quails (*Cortunix cortunix japonica*) fed low or high fibre diets supplemented with Maxigrain® enzyme. Pakistan Journal of Nutrition 11 (12): 1101-1106.

AOAC, 2002. Association of official Analytical Chemists. Official methods of Analysis. (17th Ed). A Publication of the Association of official Analytical chemists, Washington, D.C. Pp 52-157.

Eiben, C. S., Mēzes, M., Zijártó, N., Kustos, K., Gódor-Surmann, K. and Erdēlyi 2004. Dose dependent effect of cellulose supplementation on performance of early-weaned rabbit. In proceeding: 8th World Rabbit Congress, Puebla, Méxićo, 799-804.

Esonu, B. O., Azubuike, J. C., Ukwu, H. O. and Nneji, C. S. 2004. Effect of enzymes supplementation on the performance of broilers finishers fed Microdesmispubercula leaf meal. International Journal of poultry science. 3: 112-114.

Kelly, W. R. 1979. Veterinary Clinical Diagnosis. 2nd edition, London.BailliereTindall publishers. Pp 47-56.

Khan, T. A. and Zafar, F. 2005. Haematological study in response to various doses of estrogen in broiler production. *International Journal of Poultry Science*, 40(10):748-751.

Kohn, R. A. and Allen, M. S. 1995. Enrichment of proteolitic activity relative to nitrogen in preparation from the rumen for Vitro studies. Animal feeds science and technology, 52 (1/2): 1-14.

NIMET, 2017. Nigerian Meteorological Agency, Lafia, Nasarawa State.

Olomu, J. M., Bamikole, M. A. and Olomu, C. E. B. 2019. Rabbit production and nutrition: Principles and practice. First Edition. A Jachem Publication. Pp.158.

Pauzenga, U. 1985. Feeding parent stock.Zootecnica International. December 1985 PP.22 –24.

Peter, T., Biamonte, G. T. and Doumas, B. T. 1982. Protein (Total protein) in serum, urine and cerebrospinal fluids; Albumin in Serum. In: Selected method of clinical chemistry. Vol. 9 (PaulknerWr, Meites S Eds) American Association for clinical chemistry, Washington, D.C. Ruminant nutrition. Pp. 17-18.

Salama, W. A., Amira, M., Refaie and. El-Shora, M. A. 2019. Performance of growing rabbits fed diets containing fennel seed meal without or with enzyme mixture. Egyptian Journal of Rabbit Science, 29 (1): 45 -60.

Shaahu, D. T., Dzungwe, E. N. and Akpe, M. E. 2014. Digestibility and growth performance of rabbits fed raw or processed lablab purpureus seed in diets. International Journal of Advances in Agricultural Science and Technology, 2(6), 01-07.

Received: 27th July, 2019
Accepted: 19th December, 2019