NUTRIENT DIGESTIBILITY, HAEMATOLOGICAL AND SERUM BIOCHEMICAL INDICES OF RABBITS FED GRADED LEVELS OF *Acacia Albida* PODS

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ABSTRACT

In a 12-week feeding trial, the nutrient digestibility and blood parameters of crossbred (Dutch x New Zealand white) rabbits fed graded levels of *Acacia albida* pods (AAP) were investigated during weeks 8 and 12 of the study period. The AAP were included at 0, 10, 20, 30 and 40% levels in diets 1, 2, 3, 4 and 5, respectively. The digestibility for dry matter (DM), crude protein (CP) and ether extract (EE) were 66.69 to 75.69% Vs 68.16 to 77.19%, 74.62 to 82.74 % Vs 71.06 to 80.38% and 68.95 to 81.23% Vs 75.45 to 86.35% for weeks 8 and 12, respectively. DM and crude fibre (CF) digestibility did not differ significantly (P>0.05) among the treatments in week 8 but differed in week 12 of the study. CP and nitrogen-free extract (NFE) of 82.14 and 81.23% respectively for diet 1 were higher and significantly (P<0.05) different from the other treatments in week 8. CF and ash did not show any clear cut trend in week 12. DM digestibility increased with age while CP decreased. Packed cell volume (PCV), red blood cell (RBC), white blood cell (WBC), haemoglobin concentration (Hb), mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV) and mean corpuscular haemoglobin concentration (MCHC) did not differ significantly (P>0.05) among the treatments in week 8. A similar trend was observed in week 12 except for RBC, Hb and MCH. Hb and MCH (9.75g/100ml and 13.01pg) for diet 1 were significantly (P>0.05) different from the other treatments and lower than reference values. Globulin, uric acid, urea and cholesterol did not differ significantly (P>0.05) throughout the duration of the experiment and were consistent with reference values. Total protein (6.13 to 7.33g/dl), albumin (3.53 to 4.20g/dl) and glucose (86.25 to 127.50mg/dl) were significantly (P<0.05) different among the treatments but with no clear cut trend except for glucose which increased with increasing levels of AAP beyond the 20% inclusion level. Thus, up to 40% AAP can be included in rabbit's diet without adverse effect on nutrient digestibility and blood parameters.

Keywords: rabbits, pods, feed, digestibility, blood, Acacia albida, growth.

INTRODUCTION

Feeding of livestock during the long dry season in the semi-arid area of Nigeria is a serious challenge to livestock farmers. During this period feed is scarce in both quantity and quality. Options explored to solve this problem are the use of crop residues, by-products and browse plants that abound during this period. An example is *Acacia albida* (*Faidherbia albida* Del. A. Chew).

Acacia albida is one of the dominant trees in the semi arid areas of Nigeria. They are hardy plants which produce abundant foliage and pods during the dry season. The significance of the pods as feed for ruminants has been established [23,17]. The few documented efforts on the use of the pods for rabbit feeding recommended the inclusion of 20% of the pods in the diets of growing rabbits. The current study is to investigate the nutrient digestibility and blood parameters of growing rabbits receiving up to 40% *Acacia albida* pods in their diet.

MATERIALS AND METHODS

Sixty crossbred (Dutch x New Zealand white) rabbits between 7 and 8 weeks old with an average live weight of 790.09g were divided into 5 groups of 12 rabbits each. They were housed individually in wire netting cages and used for the study which lasted for 12 weeks (84 days) at the University of Maiduguri, Livestock and Research Farm, Maiduguri, Borno State, Nigeria. The rabbits were given the experimental diets and clean drinking water *ad libitum* throughout the experimental period. The composition of the experimental diets is shown in Table-1. The dried *Acacia albida* pods (AAP) were ground and incorporated at levels of 0, 10, 20, 30 and 40% in diets 1 (control), 2, 3, 4 and 5, respectively. The protein content of the diets were maintained at about 18% while each diet contained at least 3100kcal/kg of metabolisable energy (ME) calculated according to the formula of [19]:

ME (Kcal/Kg) = 37 x %CP + 81x %EE + 35.5 x %NFE
Where, CP = Crude protein;
EE = Ether extract and
NFE = Nitrogen-free extract.

Four rabbits (2 males and 2 females) per treatment were selected for the determination of apparent digestibility of the nutrients in the 5 diets as well as haematological and serum biochemical indices of rabbits fed the various diets. The faecal collection for apparent digestibility was done for a period of seven days during week 8 and 6 days during week 12 of the study. The fresh faeces were collected daily per animal with a fine wire mesh tray, weighed and oven-dried at 80^0C for 24 hours. At the end of the collection period, the samples from each animal were thoroughly mixed, ground and an aliquot sample taken for chemical analysis. The apparent digestibility was calculated according to the formula

ARPN Journal of Agricultural and Biological Science

proposed by [10]. Proximate analysis of the diets and faecal samples were carried out according to [4].

Blood samples for the determination of haematological and biochemical indices were collected by venipuncture from the ear veins of each rabbit. Samples for haematological parameters such as packed cell volume (PCV), red blood cell counts (RBC), white blood cells counts (WBC) and haemoglobin concentration (Hb) were collected into sample bottles containing dipottassium salts of ethylene diamine tetraacetic acid - an anticoagulant. Samples for biochemical indices such as serum glucose, urea, total cholesterol, serum protein, albumin, globulin and uric acid were collected in anticoagulant-free tubes, allowed to stand for 2 hours at room temperature, centrifuged and the serum collected for analysis. The blood samples were analysed by methods expounded by [7]. PCV was determined using Wintrobe's microhaematocrit method, RBC and WBC by improved Neubauer haemocytometer and haemoglobin concentration by Sahli method. Erythrocytic indices such as MCV, MCH and MCHC were calculated according to the formula of [8]. Serum glucose and urea were estimated by methods described by [25] while total cholesterol and uric acid were determined by Colorimetric enzyme method as outlined by [7]. Similarly, total serum protein, albumin and globulin were determined by Biuret reactions [7].

Data collected were subjected to analysis of variance (ANOVA) using the randomized block design. Means for digestibility study were transformed (arc sine transformation) before carrying out the ANOVA. Significant means were separated by Duncan's multiple range tests as outlined by [22].

RESULTS

The nutrient digestibility of the rabbits receiving the various levels of untreated AAP during weeks 8 and 12 of the experiment are presented in Table-2. During week 8, the dry matter (DM) and crude fibre (CF) digestibility did not differ significantly ($P>0.05$) among the treatments. Diet 1 had significantly ($P<0.05$) higher CP and NFE digestibility than the other treatments. However, diet 1 had lower EE digestibility than diets 2, 4, and 5, except for diet 3 which recorded a significantly lower total ash digestibility. The other diets did not differ significantly ($P>0.05$). During week 12, the DM digestibility of rabbits on diets 1 and 2 were significantly ($P<0.05$) different from those on diets 3, 4 and 5. The CP, CF and ash digestibility on the other hand did not show any clear cut trend, though treatment 1 recorded significantly higher CF and ash digestibility than the other diets. The CF digestibility of diets 1 and 3 were significantly different from those of 2 and 4 while NFE digestibility of diet 1 was significantly different from the other treatments. EE was uniformly digested in all the treatments.

The haematological data obtained during weeks 8 and 12 of the experiment are presented in Table-3. During week 8, the PCV, RBC, WBC and Hb of the rabbits did not differ significantly ($P>0.05$) among the treatments. Similarly, the derived absolute values such as MCV, MCH and MCHC were not significantly ($P>0.05$) different for the treatments. During week 12 of the study, the PCV, WBC, MCH and MCHC did not differ significantly ($P>0.05$) among the treatments but RBC and Hb were significantly ($P<0.05$) different with rabbits on diet 2 and 4 recording significantly ($P<0.05$) higher Hb than those on diet 1. RBC of rabbits on diet 1 was better and significantly different from those on diets 4 and 5. MCH for rabbits on diet 4 and 5 were higher and significantly different from those on diet 1. When the two periods were considered, WBC, MCV and MCH were higher in week 8 than week 12.

The serum biochemical indices of rabbits fed various levels of untreated AAP during weeks 8 and 12 of the experiment are presented in Table-4. During week 8, globulin, urea and cholesterol did not show any significant difference among the treatments. However, total protein showed significant ($P<0.05$) difference with rabbits on diet 2 recording the highest value (7.33g/dl) which was significantly ($P<0.05$) different from the other treatments which did not differ significantly among themselves. Similarly, serum glucose differed significantly among the treatments with diets 3, 4 and 5 being significantly different from 1 and 2. There seems to be a gradual increase in blood glucose with increasing levels of AAP beyond 20% inclusion of AAP in the diets.

During week 12, serum protein, albumin and globulin did not differ significantly ($P>0.05$) among the treatments though the values of total protein and globulin recorded in week 12 were lower than the corresponding values obtained in week 8 of the study. Similarly, uric acid, urea and cholesterol contents of serum did not differ significantly ($P>0.05$) among the dietary treatments. The serum glucose tended to increase with increasing levels of AAP and fibre in the diets, though not significant ($P>0.05$).

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Table-1. Ingredients and chemical composition of the experimental diets.

Ingredients (%)	**Diets**				
	1	**2**	**3**	**4**	**5**
Maize	41.93	35.41	29.21	22.97	16.57
AAP[1]	0.00	10.00	20.00	30.00	40.00
Maize bran	20.00	15.00	10.00	5.00	0.00
Groundnut haulms	10.00	10.00	10.00	10.00	10.00
Groundnut cake	24.92	25.44	25.64	25.88	26.28
Palm oil	0.00	1.00	2.00	3.00	4.00
Bone meal	2.50	2.50	2.50	2.50	2.50
Salt (Na Cl)	0.50	0.50	0.50	0.50	0.50
Premix*	0.15	0.15	0.15	0.15	0.15
Total	**100**	**100**	**100**	**100**	**100**
Analyzed chemical composition (%)					
ME(Kcal/kg) [2]	3239.45	3287.56	3212.99	3184.54	3145.76
Dry matter	94.60	95.40	95.40	95.20	95.20
Crude protein	18.12	18.10	17.94	17.64	18.14
Crude fibre	11.22	11.87	12.42	13.15	14.84
Crude fat (Ether Extract)	4.78	6.47	6.74	6.78	6.91
Ash	4.42	4.58	6.47	6.58	6.14
Nitrogen-free extract	61.46	58.98	56.43	55.85	53.94
Calcium (Ca)	1.06	0.92	1.21	1.29	1.15
Phosphorus (P)	0.60	0.60	0.84	0.74	0.65
Ca : P ratio	1.77	1.53	1.44	1.74	1.77
Energy : protein ratio	210.46	213.19	210.43	212.39	205.45
Tannins (%)	0.099	0.23	0.53	0.73	1.09
Phytins (mg/100g)	128.88	142.86	142.86	182.15	285.71

[1]AAP = *Acacia albida* pods.
[2]ME = Metabolisable energy (calculated according to Pauzenga, 1985)
*Premix (VitaDIZ B.P.); Manufactured by DIZPHARM (NIG), LAGOS. Contain the following (per kg): Vitamin A = 6250000IU; Vitamin D_3 = 1250000IU; Vitamin E = 15000IU; Vitamin K = 1,250mg; riboflavin = 3000mg; pantothenic acid = 500mg; pyridoxine = 1750mg; vitamin B_1 =1000mg; niacin = 15000mg; vitamin B_{12} = 10mg; biotin = 25mg; folic acid = 500mg; choline chloride = 150g; antioxidant = 62.5g; iron = 50g; manganese = 50g; Zinc = 50g; iodine = 0.78g; cobalt = 0.25g; selenium = 0.05g; copper = 5.0g.

VOL. 3, NO. 4, JULY 2008 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science

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Table-2. Nutrient digestibility by rabbits fed graded levels of *Acacia albida* pods during weeks 8 and 12 of the study.

		Diets/treatment number					
Nutrients (%)		**1**	**2**	**3**	**4**	**5**	
Levels of AAP (%)		**0**	**10**	**20**	**30**	**40**	**SEM**
Number of rabbits		**4**	**4**	**4**	**4**	**4**	**-**
Dry matter	I	75.69	70.75	66.69	69.47	73.00	1.99 ns
	II	77.19 a	79.49 a	70.82 b	68.16 b	68.20 b	1.75*
Crude protein	I	82.74a	75.21 b	74.62 b	76.36 b	76.37 b	1.76*
	II	80.38 a	71.06 c	77.65 ab	71.96 bc	71.58 c	1.85*
Crude fibre	I	58.85	56.03	55.53	49.65	52.24	2.43 ns
	II	48.74 a	28.40 c	50.29 a	34.80 bc	42.95 ab	3.79*
Ether extract	I	79.78 b	84.95 a	80.94 b	84.53 a	85.89 a	0.69*
	II	84.34	83.78	82.54	82.60	82.09	1.35ns
Ash	I	51.46 a	46.38 a	31.70 b	43.87 a	45.58 a	2.44*
	II	53.26 a	28.33 b	38.60 ab	35.01 b	35.62 b	5.32*
Nitrogen-free extract	I	81.23 a	70.36 b	68.95 b	69.21 b	70.78 b	1.71*
	II	86.35 a	77.30 b	76.31 b	75.81 b	75.45 b	1.58*

AAP = Untreated *Acacia albida* pods
SEM = Standard error of the means
a, b,c = Means in the same row bearing different superscripts differ significantly (P<0.05)
* = Significant (P<0.05)
ns = Not significant (P>0.05)
I = Digestibility values for week 8
II = Digestibility values for week 12

VOL. 3, NO. 4, JULY 2008 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science

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Table-3. Haematological indices in rabbits fed graded levels of *Acacia albida* pods during weeks 8 and 12 of the experiment.

		Diets/treatment number					
Indices		**1**	**2**	**3**	**4**	**5**	
Levels of AAP (%)		**0**	**10**	**20**	**30**	**40**	**SEM**
Haematocrit (PCV, %)	I	41.25	38.25	38.75	38.25	38.00	2.83^{ns}
	II	32.75	39.75	32.75	33.00	33.00	2.35^{ns}
Haemoglobin (Hb, g/100ml)	I	10.50	11.00	11.00	11.05	10.60	0.22^{ns}
	II	9.75^{b}	10.65^{a}	10.25^{ab}	10.55^{a}	10.10^{ab}	0.19*
RBC (x 10^6/ µl)	I	5.50	6.50	5.49	5.66	4.65	0.66^{ns}
	II	7.68^{a}	7.61^{ab}	6.13^{ab}	4.76^{c}	5.64^{bc}	0.61*
WBC (X 10^3/ µl)	I	7.30	9.05	7.15	6.48	5.28	1.03^{ns}
	II	2.63	3.06	1.76	1.87	1.67	0.47^{ns}
MCV (fl)	I	80.55	59.98	73.23	69.43	82.25	9.98^{ns}
	II	43.61	53.88	54.67	69.44	60.22	6.47^{ns}
MCH (Pg)	I	20.48	17.25	20.60	20.58	23.10	2.41^{ns}
	II	13.01^{c}	14.59^{bc}	17.08^{bc}	22.21^{a}	18.34^{ab}	1.56*
MCHC (%)	I	25.63	28.85	28.65	30.18	28.60	2.12^{ns}
	II	29.95	27.12	31.41	32.74	30.74	1.89^{ns}

a, b, c = Means in the same row bearing different superscripts differ significantly ($P<0.05$)
* = Significant ($P<0.05$) MCHC = Mean Corpuscular Haemoglobin Concentration
AAP = Untreated *Acacia albida* pods PCV = Packed Cell Volume
SEM = Standard error of the means RBC = Red Blood Cells
ns = Not significant ($P>0.05$) WBC = White Blood Cells
I = Digestibility values for week 8 MCV = Mean Corpuscular Volume
II = Digestibility values for week 12 MCH = Mean Corpuscular Haemoglobin

Table-4. Serum biochemical indices in rabbits fed graded levels of *Acacia albida* pods during weeks 8 and 12 of the experiment.

		Diets/treatment number					
Indices		**1**	**2**	**3**	**4**	**5**	
Levels of AAP (%)		**0**	**10**	**20**	**30**	**40**	**SEM**
Total protein (g/dl)	I	6.13^{b}	7.33^{a}	6.13^{b}	6.83^{ab}	6.20^{b}	0.32*
	II	6.0	5.84	4.95	5.70	5.80	0.58^{ns}
Albumin (g/dl)	I	3.88^{ab}	4.20^{a}	4.00^{ab}	4.00^{ab}	3.53^{b}	0.14*
	II	3.85	3.54	3.58	3.20	3.63	0.33^{ns}
Globulin (g/dl)	I	2.25	3.15	2.15	2.85	2.67	0.26^{ns}
	II	2.15	2.30	1.37	2.50	2.15	0.30^{ns}
Uric acid (mg/dl)	I	1.13	1.21	1.16	1.18	0.97	0.12^{ns}
	II	1.50	1.61	1.72	1.62	1.65	0.06^{ns}
Urea nitrogen (mg/dl)	I	41.25	41.10	41.00	41.53	42.00	0.69^{ns}
	II	41.36	40.19	37.48	36.71	40.85	1.68^{ns}
Glucose (mg/dl)	I	89.50^{d}	86.25^{d}	101.00^{c}	127.50^{a}	109.63^{b}	2.76*
	II	92.65	94.25	93.38	94.85	94.75	0.87^{ns}
Cholesterol (mg/dl)	I	50.25	50.25	51.00	49.25	50.50	3.74^{ns}
	II	41.60	41.95	38.74	40.86	41.83	1.12^{ns}

AAP = Untreated *Acacia albida* pods
SEM = Standard error of the means
* = Significant (P<0.05)
a, b,c,d = Means in the same row bearing different superscripts differ significantly (P<0.05)
ns = Not significant (P>0.05)
I = Digestibility values for week 8
II = Digestibility values for week 12

DISCUSSIONS

The DM digestibility of rabbits on the various treatments during week 8 of the experiment were relatively high (66.67 to 75.69%) and close to values (52.0 to 79.80%) reported by [1] for rabbits fed concentrate diets. The significantly (P<0.05) higher CP and NFE digestibility of rabbits on diet 1 compared to other diets could be attributed to better utilization of nutrients by rabbits on corn-based diets as reported by (18). Despite the observed differences, the CP digestibility (74.62 to 82.74%) was high indicating efficient utilization of concentrate feed protein by rabbits. Similar results were reported by [9]. The similarities in the CF digestibility despite the lower CF contents of diet 1 could be due to lower lignin contents of legumes as reported by [12]. In addition, [16] reported that non-lignified materials could have CF digestibility as high as 60%. With the exception of diet 3, the non-significant (P>0.05) difference in ash digestibility between the diets agrees with previous observations that diets with adequate mineral supplementation hardly vary in their total mineral digestibility [18]. The high EE digestibility (79.78 to 85.89%) attested to the good ability of rabbits to utilize dietary fat [5].

During week 12, DM digestibility of rabbits in diets 3, 4 and 5 were significantly (P<0.05) lower than those of rabbits on diets 1 and 2. This may be due to the higher fibre levels of diets 3, 4 and 5. The negative influence of CF on DM digestibility was previously reported by Lang [15]. CP digestibility though lower in diet 2, 4 and 5 compared to 1 and 3 were generally high (71.06 to 80.38%) further confirming the assertion that proteins in concentrate diets (11) and in forage [9] are efficiently utilized by rabbits. [18] made similar observations. The CF digestibility showed some variations that could not be consistently attributed to levels of AAP in the diets. Diets 1, 3 and 5 were not significantly (P>0.05) different but were significantly superior to diets 2 and 4. These digestibilities vary from 28.40% in diet 2 to 50.29% in diet 3. Such wide variation in CF digestibility (24 to 44%) of concentrate diets was reported by [3]. [15] observed that differences between individual rabbits appear to be large especially in digesting fibre and legumes. The high digestibility of EE is in agreement with the observation of [9] and [18]. The significantly (P<0.05) higher NFE digestibility in diet 1 is expected since [11], [9] and [18] noted that the high digestibility of corn-based diets was due to the high availability of their carbohydrates.

Furthermore, digestibility of DM increased with age while CP decreased. This agrees with the report of [21]. This could be attributed to the fact that the first eight weeks of the study coincided with the rapid growth phase of the rabbits and animals make better use of their dietary CP during this phase. The lower digestibility of DM, CP, ash and NFE especially in diets 4 (30% AAP) and 5 (40% AAP) during week 12 of the experiment may be attributed to the adverse effect of tannins on nutrient digestibility. [14] reported that tannins depress nutrient digestibility by forming indigestible complexes with nutrients and inhibiting the activities of digestive enzymes.

The PCV and Hb during week 8 fall within the normal ranges of 31 to 50% and 8 to 17g/100ml respectively reported by [2] for healthy young rabbits. The similar and normal values obtained for all the rabbits fed various dietary levels of AAP in week 8 indicated nutritional adequacy. [13] reported a strong influence of diets on haematological traits. In addition, PCV and Hb were shown to indicate nutritional status of subjects. The slightly lower values of RBC (4.65 x10^6µl) and WBC (5.28 x 10^3µl) of rabbits on diet 5 did not differ significantly (P>0.05) from those of other treatments. The RBC and WBC obtained in this study fall within the normal range of 5 to 8.0 x 10^6 µl and 3.0 to 12.5 x 10^3 µl respectively reported by (2). There was no significant (P>0.05) difference among the dietary treatments with respect to the erythrocytic indices (MCV, MCH and MCHC). The MCV, MCH and MCHC values obtained here are close to reference values of 60 to 73 fl, 16 to 23pg and 26 to 34% (Anon, 1980) respectively. Though PCV values of 32.75 to 39.75% obtained during week 12 falls within the normal range of 31 to 50% [2], they were slightly lower than the corresponding values for week 8. This may be linked to the reduced feed intake observed during the last 4 weeks of this study. The lowered feed intake normally leads to reduced nutrient intake including iron needed for the formation of haemoglobin. WBC values did not differ significantly among the treatments but were lower than the mean values of 5.28 to 9.05 x 10^3µl obtained during week 8 and lower than the reference values of 3.0 to12.5 x 10^3 µl reported by [2]. This observation may be age related since (20) observed two distinct peaks with WBC counts while working with New Zealand white rabbits of various ages. The first peak was at 3 months corresponding to week 8 of this study and a second higher peak at over one year of age. Another factor may be the high ambient temperature (37.06^0 C) prevalent at the time of this study. MCHC which was not significantly (P>0.05) different between the treatments fall within the range of 26 to 34% [2] and close to the range of 28.4 to 32% reported by (20) for healthy young rabbits.

During week 8 of the study, the total protein, albumin and globulin contents of the serum were similar to the value of 5.81 to 6.75g/dl, 3.07 to 4.50g/dl and 1.94 to 2.26g/dl, respectively reported by [18] and in consonance with reference values [2]. Since total protein, globulin and albumin are averagely responsive to total protein intake [18], the normal values obtained during week 8 of this study indicates nutritional adequacy of the dietary protein. [20] reported that the concentration of serum protein at any given time is a function of the nutritional status, water balance and other factors affecting the state of health of the animal. Therefore, the levels of AAP in the diet did not adversely affect biochemical parameters. The higher blood glucose levels in diet 3, 4 and 5 were in agreement with previous observations [18]. The uric acid, serum urea and cholesterol levels were similar in all the treatments and fall within the range reported for normal healthy rabbits [2,18].

During week 12, the serum protein, 4.95 to 6.00g/dl was in agreement with the mean values 4.96g/dl reported by [6] but inferior to the 6.80g/dl reference value [2] and 6.27g/dl [18]. The albumin and globulin followed a similar trend. These observations may be due to the reduced feed intake of rabbits which invariably translates to lowered protein intake during the last phase (week 9 to 12) of the study. [24] reported that restricted dietary protein intake in chickens led to depressed levels of total serum protein due to decreased albumin while globulin levels were less severely affected. The uric acid and urea were in agreement reported values by [18]. The cholesterol levels fall within the reference range of 20 to 83mg/dl [2]. No defined change in cholesterol level was produced by the various levels of AAP incorporated in the diets. Since cholesterol levels are within the normal range, the problems of severe liver dysfunction, nephrosis, debility or malabsorption of fat [7] observed in abnormal levels are ruled out.

CONCLUSIONS

The high nutrient digestibility recorded in this study showed that including up to 40% AAP in rabbits diet did not affect the digestibility of the diets. Similarly, the haematological and serum biochemical parameters were not adversely affected by the level of AAP in their diets. Therefore, growing rabbits can tolerate 40% AAP in their diets without adverse effect on nutrient digestibility and blood parameters.

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