Egyptian J. Nutrition and Feeds (2019), 22 (2): 359-373

REPLACEMENT OF DIETARY YELLOW CORN BY WHEAT BRAN WITH OR WITHOUT MULTI-ENZYMES OR PREBIOTIC SUPPLEMENTATION ON NUTRIENT DIGESTIBILITY AND BLOOD PARAMETERS IN GROWING RABBITS

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(Received 5/6/2019, accepted 23/7/2019)

SUMMARY

The present study was performed to investigate the influence of feeding diets contained three levels of yellow corn (YC) without or with enzymes and/or prebiotics on the nutrient digestibility and blood parameters of growing New Zealand White (NZW) rabbits. A feeding trial (3x4) with factorial arrangement of treatment was carried out. The chemical analyses for experimental diets and faces and blood constituents were run. One hundred and eight, 6 weeks old weaning NZW rabbits were used in this study. Rabbits were randomly distributed into 12 equal experimental groups; each contained three equal replicates. The digestibility coefficients of dry matter (DM), organic matter (OM), crude fiber (CF), ether extract (EE), nitrogen free extract (NFE), non-ditrgant fiber (NDF), ADF and hemicellulose were increased with feeding on 15 % YC diets than those of rabbits fed on 5 % or 10 % YC rations, but there was no significant effect of dietary treatments on DMI and CP digestibility. Rabbits fed enzyme-supplemented diets displayed significantly lower DM, OM, CF, EE, NFE, NDF, ADF and hemicellulose than those of other dietary treatments. There was no significant effect of these supplements on DMI (g/d) and CP digestibility, compared with the control diet (without supplements). The digestible DCP (%), TDN% and DEI (kcal/d) were significantly higher ($P \leq 0.05$) for animals fed diets containing 15 % YC than feeding on 5 or 10 % YC diets, while there were no significant effect on TDNI (g/d), CPI (g/d) and DEI (kcal/d). Rabbits fed the enzyme-supplemented diets exhibited significantly lower TDN (%) and DE (kcal/kg) than did those fed other experimental diets. Similarly, significantly lower means of DEI (kcal/d) were recorded by rabbits fed enzyme- or enzyme plus prebiotics-supplemented diets compared with other experimental groups of rabbits, but DCP % and CPI (g/d) were not affected. The plasma levels of triglycerides and total cholesterol were significantly lower for rabbits fed diets with 10 % or 15 % YC than those of rabbits fed the lowest level of YC,, while there was no significant effect on ALT, AST, total protein or urea concentration. Rabbits fed the diets fortified with enzymes plus prebiotics exhibited significantly lower ($P \leq 0.05$) levels of plasma urea and triglycerides and significantly higher cholesterol concentration than did the control group. In conclusion, using YC to partially replace wheat bran in growing rabbits diets had no negative effect on the nutritive value of diets. The nutritive value of the experimental diets for growing rabbits could increase by supplementing enzymes plus prebiotics. The present study showed that feeding growing rabbits on diets contained 10 % YC without supplements or feeding on diets contained 15 % YC with enzymes and prebiotics are effective for nutrient digestibility, nutritive value and health status of rabbits.

Keywords: *Rabbits, digestibility, yellow corn (YC), blood status, enzymes and prebiotics.*

INTRODUCTION

The meat of growing rabbit is low in cholesterol and has good protein. In developing countries, rabbit production is considered of economic importance. Several studies had shown that poor quality feeds, can be enhanced by addition of exogenous feed enzymes (Cowan *et al.*, 1994).

Rabbits may also benefit from prebiotic feed additives to utilize their feed efficiently. However, the use of such feed additives has not been extensively studied in growing rabbits. Rabbit diets high in grain can cause overload in the hindgut leading to enteritis. Fiber is important for overall gut health and motility. The bacterial population in the hindgut allows rabbits to digest dietary non-starch polysaccharides (NSP) to some extent.

The digestibility of starch and NSP in grains is the current domain of developments in this area. Enzymes work on NSP causing their hydrolysis, decrease the viscosity of the contents inside gut, improve nutrient availability and improve the absorption of nutrients (Abo Egla *et al.,* 2013). Several investigations have been attempted to improve nutrients digestibility by added enzymes. Eiben *et al*. (2004) tested the response to dietary supplementation with cellulase and got improvements in the feed conversion rate (FRC) and the mortality rate in rabbits weaned at the age of 23 days, while the average daily gain (ADG) remained unaffected. Increasing the digestibility of fiber is interesting. Bolis *et al* (1996) had demonstrated that adding cellulase and a multienzyme preparation (acid and neutral protease, β-glucanase, β-glycosidase, amyloglucosidase, pentosanase and xylanase) to rabbit diets led to significant improvements, in digestibility nutrients and they noticed some reductions in digestible and metabolizable energies and nitrogen balance in comparison with control diets.

Microbial fermentation of carbohydrates leads to the production of short chain fatty acids (SCFA). The SCFA limit growth of pathogenic microbes by decreasing caecal pH. Dietary fiber plays an important role in the diet of rabbit because of its influence on caecal microbial activity (Gidenne *et al.,* 2010). Dietary fiber level affects the digestibility of the nutrients in the diet and can also influence the growth rate of rabbits (Gidenne and Licois, 2005). The optimal dietary fiber level for growing rabbits is variable and may depend largely upon other factors such as type of fiber, age and breed of rabbit, and/or digestible energy content of the diet (Gidenne *et al.* 2010). In this context, the dietary crude fiber requirement recommended by the National Research Council (NRC, 1977) for normal growth of rabbits is 10-12%. De Blas *et al.* (1986) concluded that a minimum of 10% dietary crude fiber is necessary for maximum growth rate of rabbits, while levels in excess of 17% depress growth by restricting energy intakes. De Blas and Mateos (2010) indicated that the dietary crude fiber requirement of intensively reared fattening rabbits is 15.5%. The present study was performed to investigate the influence of feeding diets without or with enzymes, prebiotics or both on the nutrient digestibility, blood parameters of growing New Zealand White rabbits.

MATERIALS AND METHODS

The experimental work of the present study was carried out at the Poultry Research Unit, Agricultural Research and Experimental Center, Faculty of Agriculture, Mansoura University, while, the chemical analyses of experimental rations and feces, and procedures of blood analysis were run at the laboratory of Regional Center for Food and Feed, Agricultural Research Center, Cairo, Egypt.

Experimental animals and management:

One hundred and eight, 6 weeks old weaning New Zealand White (NZW) rabbits were used in this study. Rabbits were randomly distributed into 12 equal experimental groups; each contained three equal replications. Each replicate group (3 rabbits) was housed in a separate cage with the dimensions of (50×50×45cm) for length, width and height, respectively. Rabbits were fed their respective experimental diets from 6 to 15 weeks of age. Feed and water were offered *ad libitum* throughout the experimental period. The mean values of live body weight (LBW) and feed intake (FI) were recorded on a replicate group basis and thus daily weight gain (DWG) and feed conversion (FCR) were also calculated.

Feed supplements:

In the present study, the multi-enzymeextra and prefect were performance in aquaculture and agriculture (KIOTECHAGIL). The specific wall stabilized enzymes combination of German origin (xylanase, Betaglucanase, Alpha amylase, protease and phytase). Prefect is a buffered blend of specific acids on a unique mineral carrier system combined with a fructo-oligosaccharide (FOS) to promote a healthy gut microflora.

Experimental rations and design:

An experiment was conducted with factorial arrangement of treatments (3×4), being three levels of yellow corn (YC) without or with enzymes, prebiotics or both. Thus, twelve experimental rations were formulated and used. The experimental groups of rabbits were fed their respective experimental rations in pelleted form. Three basal rations were used in this study; the first containing 5% YC (R1), the second contained 10% YC (R5) and the there'd 15% YC (R9). The composition and calculated analysis of the basal diets are presented in Table (1), according to (NRC, 1977). Thus, twelve experimental rations were formulated and used, as follows:

R1= experimental basal diet A1
R 2= experimental basal diet A1 +0.05% enzyme
R 3= experimental basal diet A1 +0.05% prebiotic
R 4= experimental basal diet A1 + 0.05% enzyme + 0.05% prebiotic
R 5= experimental basal diet A2
R 6= experimental basal diet A2 +0.05% enzyme
R 7= experimental basal diet A2 +0.05% prebiotic
R 8= experimental basal diet A2 + 0.05% enzyme + 0.05% prebiotic
R 9= experimental basal diet A3
R 10= experimental basal diet A3 +0.05% enzyme
R 11= experimental basal diet A3+0.05% prebiotic
R 12= experimental basal diet A3 + 0.05% enzyme + 0.05% prebiotic

Table (1): Ingredients and chemical composition of the basal diets.

Feed ingredient	Basal diet		
	Diet1 (control) 5% YC	Diet2 10% YC	Diet3 15% YC
Barley	12	10	9
Yellow Corn	5	10	15
Wheat bran	35	30	25
Soybean meal, 44%	7.5	8.5	9.5
Alfalfa hay	35.7	36.7	36.7
Molasses	2.0	2.0	2.0
Limestone	1.0	1.0	1.0
Dicalcium phosphate	1.2	1.2	1.2
Sodium chloride	0.3	0.3	0.3
Vit. Min. premix	0.3	0.3	0.3
Total	100	100	100
Calculated analysis (as fed, NRC, 1977)			
Digestible energy (Kcal/kg)	2597	2600	2615
Calcium (%)	1.24	1.25	1.24
Total phosphorus (%)	0.77	0.74	0.70
Lysine (%)	0.70	0.71	0.72
Methionine (%)	0.19	0.20	0.20
Methionine+cysteine (%)	0.50	0.50	0.51
Determined analysis (as DM, basis)			
DM, %	89.62	90.37	90.53
OM, %	79.24	80.74	81.06
CP, %	16.39	16.08	16.97
CF, %	14.56	16.85	14.17
EE, %	2.15	2.39	2.44
NFE, %	56.51	55.05	56.95
Ash , %	10.38	9.63	9.47
NDF, %	30.54	28.80	29.66
ADF, %	17.97	19.00	19.33
Hemicellulose, %	12.57	9.79	10.34
NFC, %	42.37	42.34	44.27

**Premix: Each 3 kg of the premix contained Vit A, 10.000000 IU; Vit D_3, 2000000 IU, Vit E, 10000 mg; Zinc, 3000 mg, Manganese, 2000 mg; Iron, 4000 mg; Copper, 1000 mg; Iodine, 100 mg; Selenium, 10 mg; Cobalt, 10 mg; Sodium, 23000 mg; Magnesium, 2000 mg and $CaCo_3$: added to 3.0 kg .*

Digestibility trials:

Three rabbits were chosen at the last week in a growth trial from each treatment with an average live body weight of about 2.0 kg and 14 weeks old to determine the digestibility coefficients of nutrients and feeding values of the tested rations. The FI and the total fecal output were separately recorded for each group for a 5-day period. Composite samples of each ration were taken for analysis at the beginning of experimental period. A composite sample from daily feces voided for each group was also taken. It was firstly dried at 60˚C overnight, and then finally dried at 105˚C for 3 hours.

Chemical analysis and procedures:

The official methods of the AOAC (1995) were used for determining the nutrient contents of feed and feces using triplicate samples of 1–2 g. Feed and feces samples were analyzed for Dry matter (DM), organic matter (OM), crude protein (CP) or nitrogen (N), crude fiber (CF), ether extract (EE), ash, and fiber fractions, (non-ditrgant fiber (NDF) and ADF) and expressed on a dry matter basis. The factor 6.25 was used for calculating crude protein. The amount of nitrogen free extract (NFE) was obtained by the following equation:

NFE % = [100 – (moisture % + Ash % + CP % + EE % + CF %)].

VanSoest’s method:

Samples of rations and feces were also analyzed for fiber fractions (NDF, ADF ADL, hemi. and cell.) according to Goering and Van Soest (1970), by using Tecator Fibertic System.

Calculation of total digestible nutrients (TDN) and digestible energy (DE) :

The procedure and conversion factors for **TDN** reported by Cheeke *et al.* (1982) as: TDN% =DCP% + DCF% + DNFE% + DEE% ×2.25.; while DE (kcal / kg DM) was calculated by the following equation according to Schiemann *et al*., (1972): [DE (kcal/kg DM) = (5.28 × DCP) + (9.51 × DEE) + (4.20 × DCF) + (4.20 × DNFE)].

Blood Sampling and analysis:

At the end of the experimental period, three rabbits from each experimental treatment were randomly chosen and slaughtered to examine certain blood parameters. Tow blood samples were collected from each rabbit and put into non-heparinized and heparinized test tubes. These blood samples were centrifuged at 4000 rpm for 20 minutes and then stored at –20°C until analysis for the different blood parameters. The plasma samples were used for determination of total proteins, (Doumas *et al*., 1981); triglycerides (Fossati, *et al*., 1980); urea-N, (Freidman *et al*., 1980) and cholesterol, (Allain *et al*., 1974) and aspartate aminotransferase (AST) and alanine aminotransferase (ALT), as described by using commercial kits..

Statistical analysis:

Statistical analysis of data was carried out using the General Linear Model Program of SAS (2000). Differences among means of treatments were identified by Duncan’s Multiple Range Test (Duncan, 1955). The obtained data for nutrient digestibility and nutritive value of diets of different groups of rabbits were subjected to factorial analysis of variance according to the following mathematical model:

$$Y_{ijk} = \mu + T_i + L_j + TL_{ij} + e_{ijk}$$

Where; Y_{ijk} = Observation of the tested factor, μ = Overall mean, T_i = the effect of dietary YC level, L_j = the effect of dietary supplements, TL_{ij} = the interaction between dietary YC level and supplements and e_{ijk} = experimental random error.

RESULTS AND DISCUSSION

Digestibility trials:

Effect of the experimental diets on dry matter intake (DMI) and nutrient digestibility coefficients.

Effect of YC levels:

Table (2) and Fig. 1 to 3 showed the means of dry matter intake, nutrient digestibility coefficients as affected by dietary YC levels and feed supplements. The digestibility coefficients of DM, OM, CF, EE, NFE, NDF, ADF and hemicellulose were increased (P≤0.05) with the highest level of YC (15 %) than those of rabbits fed on 5 or 10 % YC rations, but there was no significant effect of dietary YC level on DMI and CP digestibility.

In this respect, the DM digestibility was lower in low starch diets than in high starch diets (Xiccato *et al*., 2002). Previous studies found that digestibility of YC starch are somewhat lower than barley starch (Blas *et al*., 1990). However, digestive problems can hardly be related to the major ileal starch overflow that results when rabbits are fed YC (Gidenne *et al*., 2000). They did not observe any significant difference in mortality or morbidity rate in rabbits receiving YC, wheat bran or YC-wheat bran diets.

Table (2): Effect of dietary YC level supplemented with enzyme and/or prebiotic on dry matter intake and nutrient digestibility of the experimental rations.

Treatment	DMI	Nutrient digestibility								
		DM	OM	CP	CF	EE	NFE	NDF	ADF	Hime.
YC levels % (A):										
5% (A1)	129.5	86.35[b]	87.96[b]	94.73	68.94[c]	90.84[b]	90.78[b]	76.66[b]	71.82[b]	83.57[b]
10% (A2)	144.4	86.53[b]	88.14[b]	94.75	73.81[b]	92.06[b]	90.42[b]	75.01[b]	72.44[b]	79.97[b]
15% (A3)	139.8	91.55[a]	92.57[a]	94.44	81.26[a]	95.11[a]	94.72[a]	85.09[a]	83.52[a]	88.04[a]
SEM	8.23	0.65	0.57	0.77	1.47	0.66	0.45	1.22	1.30	1.28
Significance	NS	**	**	NS	**	**	**	**	**	**
Supplements (B):										
0.0 % (B1)	141.78	89.61[a]	90.95[a]	95.62	78.06[a]	92.12[b]	93.02[a]	82.21[a]	78.75[a]	87.99[a]
0.05% E (B2)	131.96	84.26[b]	86.12[b]	93.87	66.89[b]	90.96[b]	88.96[b]	71.84[b]	68.40[b]	77.36[b]
0.05% P (B3)	146.03	88.97[a]	90.28[a]	95.47	75.76[a]	93.05[ab]	92.58[a]	79.85[a]	77.59[a]	83.79[a]
0.05%E+0.05%.P(B4)	131.89	89.71[a]	90.87[a]	93.61	77.96[a]	94.57[a]	93.33[a]	81.78[a]	78.97[a]	86.28[a]
SEM	9.49	0.75	0.66	0.89	1.70	0.77	0.51	1.40	1.50	1.48
Significance	NS	**	**	NS	**	**	**	**	**	**
AB Interaction:										
A1B1 = T1	129.69	86.00	87.76	94.09	68.82	88.08	90.78	76.99	71.68	84.57
A1B2 = T2	136.98	85.31	87.12	96.50	64.75	90.59	90.03	75.69	69.23	84.92
A1B3 = T3	123.86	89.29	90.59	96.65	75.78	93.29	92.55	81.14	78.82	84.45
A1B4= T4	127.51	84.76	86.37	91.69	66.41	91.37	89.77	72.82	67.56	80.33
A2B1 = T5	142.59	88.84	90.35	97.29	79.00	91.96	91.73	80.66	76.46	88.78
A2B2= T6	121.44	76.43	79.12	92.79	55.07	87.62	82.11	55.32	53.41	58.99
A2B3 = T7	153.90	87.44	88.87	93.14	74.27	92.05	91.95	76.18	73.27	81.81
A2B4= T8	159.74	93.39	94.22	95.79	86.90	96.62	95.90	87.87	86.63	90.28
A3B1 = T9	153.06	94.00	94.75	95.46	86.35	96.32	96.56	88.99	88.12	90.64
A3B2= T10	137.47	91.03	92.11	92.32	80.88	94.59	94.74	84.52	82.57	88.18
A3B3= T11	160.32	90.18	91.39	96.62	77.23	93.80	93.25	82.22	80.67	85.13
A3B4= T12	108.45	90.99	92.02	93.35	80.58	95.72	94.32	84.64	82.73	88.23
SEM	16.45	1.30	1.14	1.54	2.95	1.33	0.89	2.43	2.61	2.56
Significance	NS	**	**	NS	**	**	**	**	**	**

*a-b: For each of the main effects, means within the same column with different superscripts differ significantly (P≤0.05). SEM=standard error of means;NS: not significant; *: significant at (P≤0.05); **: highly significant at (P≤0.01)*

Effect of feed supplements:

As shown in Table (2) and Fig 4 to 6; the digestibility coefficients of DM, OM, CF, EE, NFE, NDF, ADF and hemicellulose and were increased (P≤0.05) with diet without any supplements (B1) or supplemented with prebiotics (B3) or with enzymes plus prebiotics (B4) than diet supplemented with enzymes (B2). There was no significant effect from these supplements on DMI (g/d) and CP digestibility, compared with the control diet (without supplements). Enzymes in the feed industry have been mostly been used for poultry to neutralize the effects of the viscous, non-starch polysaccharides in cereals such as barley, wheat, etc…, these anti-nutritive carbohydrates are undesirable, as they reduce digestion and absorption of all nutrients in the diet (Khattak *et al*., 2006). Benefits of using feed enzymes to poultry diets include; reduction of digesta viscosity, enhanced digestion and absorption of nutrients, especially fat and protein. The degree of improvement obtained by adding enzymes to the diet depends on many factors (Bedford, 1996).

Abo El-Maaty *et al.* (2018) reported that dietary prebiotic had a positive effect on the digestibility coefficients of DM, OM, CP, EE, CF and NFE of growing rabbits. They also noticed that added prebiotic had a positive effect on caecal fermentation activities of growing rabbits. They also found that the pH value, ammonia-N level, total bacteria and *Lactobacillus* counts of rabbits fed prebiotic-supplemented diets were significantly higher but *E. coli* count was reduced as compared to control ones. The reduction of the mortality during the fattening period with enzyme supplementation was associated with a decrease in ileal starch concentration that might limit the growth of the pathogenic flora (*E.Coli and Clostridium*) (Gidenne, 1992). Concurrent administration of *Lactobacillus acidophilus, Streptococcus faecium* and *S. serevisia* increases the digestibility of the diet (Kamra *et al*., 1996).

Effect of dietary YC level by feed supplements interaction:

There was no significant effect of the experimental treatments on DMI (g/d) and CP digestibility, while digestibility coefficients of DM, OM, CF, EE, NFE, NDF, ADF and hemicellulos were increased ($P \leq 0.05$) with feeding on the treatments designated as T8 and T9 than the other rations as shown in Table (2).

Wyatt and Goodman (1993) reported that YC-based diet exhibited better feed efficiency than those fed enzyme supplemented barley-based diets. Microbes also have the ability to metabolize xylan and pectin (De Blas and Gidenne, 1998). The products of this metabolism are their body proteins and by-products of microbial fermentation refered to collectively as volatile fatty acids (VFA) such as acetic, propionic and butyric acids. These VFA are actively absorbed through the cecal and colonic wall and utilized by the rabbit as energy sources. Abo Egla *et al.* (2013) showed that supplementation of multi-enzyme or prebiotic containing into growing rabbits diet containing 30% cucumber vines straw (CVS) significantly neutraliesed (similar to control) the adverse effects occurred by this feed material on all studied nutrient digestibility and nutritive values.

Effect of experimental treatments on the feeding values of the experimental diets:

Effect of YC levels:

Table (3) showed the effect of dietary treatments on the feeding values of the experimental diets. As shown in Tables (3) and Fig. (7), means of TDN% and DE (kcal/kg) were significantly ($P \leq 0.05$) increased in diet of 15, 5 % or 10 % YC diets, while there were no significant effect on CPI (g/d) and DEI (kcal/d). The optimal content of starch in diets for growing rabbit ranges from 10 to 15% but may overpass 15% in the last phases of fattening (De Blas and Mateos, 2010).

Effect of feed supplements:

As shown in Table (3) and Fig (8), TDN % and DE (kcal/kg) were significantly reduced for rabbits fed the enzyme-supplemented diets compared with other experimental groups. Starch digestion takes place, mainly in the small intestine, and the most important enzyme involved is pancreatic amylase. Amylase activity increases rapidly between weeks 2 and 7 of life (Gidenne *et al*., 2007) and is still increasing in 3-month-old rabbits. Similarly, the amyloglucosidase activity of the Jejunal mucosa generally increases between 37 and 60 days of age (Otutumi *et al* ., 2005) . Undigested starch in the small intestine is in principle very quickly hydrolyzed and fermented by the microbiota in the caecocolic segment to lactate and volatile fatty acids. Stable high counts of amylolytic bacteria in the caecal contents of 2-7 weeks old rabbits have been reported (Padilha *et al*., 1995).

Effect of interaction between dietary levels of YC and feed supplements:

The interactions between dietary YC level and feed supplements were significant only for DE, TDN and DEI of rabbits, but other variable were not affected by the two main factors. Lockyer and Nugent (2017) and Xiccato *et al*., (2002) found that the DE concentration when the average starch to ADF ratio was 0.84 for low starch diet and 1.17 for high starch diets, respectively. The DE/DP ratio was similar in the two groups of diets and consistent with recommendations. Rabbits have a high feed intake (65 – 80 g/kg body weight) and a rapid feed transit time (4-5 hours) and thus are able to consume lower quality forages and still meet their nutritional needs (De Blas and Wiseman, 2003) . Low energy diets also cause an increase in caecotrophs production and ingestion (Jenkins, 1999). Rabbits increase their amino acid intake from the consumption of their caecotrophs or soft feces. Thus their total protein intake is supplied by the dietary intake plus the ingestion of the soft feces. Preventing caecotrophy can reduce protein digestibility by as much as 20%. The caecal microbiotas are able to use non-protein compounds (such as urea) and that caecotrophy helps to improve N digestion and retention. However, the studies also affirm that this extra N cannot compensate for a low dietary level or the use of low quality protein sources to meet growth requirements (Carabano *et al.*, 2000). Current commercial levels of dietary protein for fatteners and reproductive does range from 16 to 18 % CP. These levels exceed the recommendations in several circumstances, such as final phased of growth or lactation (Xiccato *et al.*, 2006) .

Maintenance (2100-2200 kcal/kg) requirements comprise the majority of the rabbit's energy needs. Healthy rabbits will consume sufficient amounts of feed to meet their DE requirements. Rabbits will consume more feed if they are fed a low energy diet, and will consume less feed if they are fed a high energy diet. Increase in DE can affect the composition of body gain and the percentage of energy retained as protein and fat in the body (Jenkins, 1999). For growth, a wide range of protein and energy levels are needed, which may depend on slaughter weights or weaning age (De Blas *et al.*, 1981 and Fraga *et al.* 1983). From these results, it was concluded that DE to digestible protein ratio is a more reliable unit as it has a higher and direct impact on body nitrogen and energy retention than the dietary content of fiber. Hence, the optimal level of crude protein in a diet depends on its digestibility and the DE content. A recommended ratio of 23.5 kcal DE/g DP was suggested to optimize growth rate and mortality in growing rabbits.

Table (3): Effect of dietary YC level supplemented with enzyme and/or prebiotic on some digestible nutrients and feeding values of the experimental rations.

Item	Digestible nutrients and feeding values					
	DCP (%)	TDN (%)	TDNI (g/d)	CPI (g/d)	DE (kcal/kg)	DEI (kcal/d)
YC levels % (A):						
5% (A1)	15.53^{b}	81.27^{b}	105.24	20.15	2700.1^{b}	349.53
10% (A2)	15.23^{b}	81.68^{b}	118.36	22.03	2710.2^{b}	392.89
15% (A3)	16.03^{a}	86.70^{a}	121.38	22.40	2883.5^{a}	403.82
SEM	0.13	0.67	7.02	1.29	25.83	23.44
Significance	**	**	NS	NS	**	NS
Supplements (B):						
0.0 % (B1)	15.77	84.72^{a}	120.48	22.39	2822.2^{a}	401.35^{a}
0.05%E (B2)	15.47	80.30^{b}	106.25	20.40	2649.8^{b}	350.92^{a}
0.05%P (B3)	15.74	84.11^{a}	122.96	23.00	2796.6^{a}	408.69^{b}
0.05%E+0.05%P (B4)	15.42	83.74^{a}	110.29	20.31	2789.6^{a}	367.36^{b}
SEM	0.15	0.77	8.10	1.49	29.83	27.06
Significance	NS	**	NS	NS	**	**
AB Interaction:						
A1B1 = T1	15.45	81.04	105.15	20.11	2697.7	349.73
A1B2 = T2	15.81	80.51	110.26	21.67	2658.0	364.00
A1B3 = T3	15.84	83.68	103.74	19.62	2786.4	345.47
A1B4= T4	15.03	79.85	101.82	19.18	2658.3	338.90
A2B1 = T5	15.64	84.40	120.30	22.31	2809.6	400.44
A2B2= T6	14.92	74.12	89.96	18.17	2411.9	292.53
A2B3 = T7	14.97	83.06	127.44	23.06	2777.7	425.90
A2B4= T8	15.40	85.14	135.74	24.62	2841.4	452.73
A3B1 = T9	16.20	88.71	135.98	24.76	2959.4	453.87
A3B2= T10	15.67	86.28	118.55	21.37	2879.6	396.24
A3B3= T11	16.39	85.59	137.69	26.33	2825.7	454.72
A3B4= T12	15.84	86.23	93.30	17.14	2869.1	310.45
SEM	0.26	1.83	14.03	2.58	51.66	46.87
Significance	NS	**	NS	NS	**	**

*a,b and c: For each of the main effects, means within the same column with different superscripts differ significantly (P≤0.05). SEM=standard error of means; NS: not significant; *: significant at (P≤0.05); **: highly significant at (P≤0.01)*

Effect of feeding the experimental diets on some blood parameters:

Effect of dietary YC levels:

Table (4) and Fig. (9) showed the blood constituents as affected by dietary YC level and feed additives to growing rabbits.. The blood plasma levels of triglycerides was significantly higher increased (P≤0.05) with feeding on 5 % than with feeding on 10 % or 15 % YC in the diet, while there was no significant effect of dietary treatments on ALT and AST or total protein or urea concentrations. Rabbits fed the diets of 5 or 10% YC displayed significantly higher (P≤0.05) levels of plasma cholesterol than did those fed the 15% YC-diets.

Table (4): Effect of dietary YC levels supplemented with enzyme and/or prebiotic on some blood constituents of growing rabbits.

Item	ALT (U/L)	AST (U/L)	Total protein (g/dl)	Urea (mg/dl)	Triglycerides (mg/dl)	Total chol. (mg/dl)
YC levels % (A):						
5% (A1)	31.83	46.92	5.19	28.58	130.95[a]	58.55[a]
10% (A2)	35.58	43.42	5.16	27.71	115.58[b]	63.63[a]
15% (A3)	33.67	40.00	4.87	29.20	101.80[c]	52.92[b]
SEM	1.78	2.48	0.21	1.25	3.79	1.82
Significance	NS	NS	NS	NS	**	**
Supplements (B):						
0.0 % (B1)	36.67	41.22	5.22	30.96[a]	127.11[a]	53.73[b]
0.05% E (B2)	34.22	46.00	5.96	28.79[ab]	119.9[ab]	57.73[b]
0.05%P (B3)	31.33	46.44	4.96	28.49[ab]	107.28[b]	56.61[b]
0.05%E+0.05%P (B4)	32.56	40.11	5.16	25.76[b]	110.16[b]	65.38[a]
SEM	2.05	0.24	0.24	1.44	4.38	2.10
Significance	NS	NS	NS	*	**	**
AB Interaction:						
A1B1 = T1	38.67	44.67	5.77	34.50	149.77	71.83
A1B2 = T2	33.00	49.00	5.23	29.53	143.03	67.10
A1B3 = T3	30.67	53.33	4.77	26.77	120.77	41.23
A1B4= T4	25.00	40.67	5.00	23.53	110.23	54.03
A2B1 = T5	34.33	40.33	5.07	29.60	144.60	48.67
A2B2= T6	33.33	48.67	4.73	28.17	104.80	61.17
A2B3 = T7	36.00	38.67	5.33	28.77	95.20	74.10
A2B4= T8	38.67	46.00	5.50	24.30	117.73	70.57
A3B1 = T9	37.00	38.67	4.38	28.77	86.97	40.70
A3B2= T10	36.33	40.33	4.90	28.67	111.87	44.93
A3B3= T11	27.33	47.33	4.77	29.93	105.87	54.50
A3B4= T12	34.00	33.67	4.97	29.43	102.50	71.53
SEM	3.55	4.76	0.42	2.49	7.58	3.64
Significance	NS	NS	NS	NS	**	**

*a,b and c: For each of the main effects, means within the same column with different superscripts differ significantly (P≤0.05). SEM=standard error of means; NS: not significant; *: significant at (P≤0.05); **: highly significant at (P≤0.01)*

Effect of feed supplements:

As shown in Table (4) and Fig. (10), blood plasma was significantly lower urea concentration in rabbits fed the diets supplemented with enzymes plus prebiotics compared with other experimental diets. However, level of plasma cholestrerol was significantly higher (P≤0.05) in rabbits fed the enzyme plus prebiotic supplemented diets compared with other dietary treatments. There was a significant decrease in plasma levels of triglycerides due to feeding the diets supplemented with prebiotics- or enzyme plus prebiotics compare with other treatments.

Effect of interaction between dietary YC level and feed supplements:

The interactions between dietary YC level and feed supplements were significant only for blood plasma concentrations of total cholesterol and triglycerides (TG) but other blod parameters were not affect by the interaction between the two dietary factors.. Blood examination gives the opportunity to investigate the presence of several metabolites and other constituents and helps detect conditions of stress, which can be nutritional, environmental or physical (Aderemi, 2004). Aspartate aminotransferase and alanine aminotranferase values overlapped those reported by other authors in laboratory rabbits (Wolford *et al.* 1986). Proper nutrition is one of the important aspects of broiler rabbit production (Sinha *et al.*, 2008). The protein and energy contents of the diet play a vital role in rabbit nutrition. Biochemical characterization physiology and metabolic process of rabbit will help in better understanding of rabbit in relation to growth and meat. The increase in total serum cholesterol level might be due to increase in its synthesis or reduction of its catabolism (West *et al.*, 1966). Triglyceride is transported in blood via macromolecular particles called lipoprotein.

Chylomicrons and very low- density lipoprotein (VLDL) are the predominant carriers of TG and are often referred to lipoprotein (Kleppe *et al.*, 1988). It is well established that liver regulated plasma levels of cholesterol and TG by secretion and transport of these lipids in the VLDL and by removal of lipoproteins by receptor–mediated endocytosis and changes in nutritional and hormonal statues which alter the rate of assembly and secretion of VLDL particles (Thomas *et al.*, 1992). Insulin inhibits breakdown of fat in adipose tissue by inhibiting the intracellular lipase that hydrolyses TG to release fatty acids. Insulin facilitates entry of glucose into adipocytes, and within those cells, glucose can be used to synthesize glycerol. This glycerol along with the fatty acids delivered from the liver, is used for synthesis TG within the adipocyte. By these mechanisms, insulin is involved in further accumulation of TG in fat cells. Low insulin facilitates lipolysis while high insulin stimulates *de novo lipogenesis* (Rommers *et al.*, 2004). In conclusion, using YC to partially replace wheat bran in rabbit ration had no negative effect on the nutritive value of diets. The nutritive value of the experimental diets for growing rabbits can increase by supplementing their diets with enzymes plus prebiotics. The present study showed that feeding growing rabbits on diets contained 10 % YC without supplements or feeding on diets contained 15 % YC supplemented with enzymes and prebiotics are effective for regard to nutrient digestibility, nutritive value and health status of rabbits.

ACKNOWLEDGEMENT

This study was performed at Faculty of Agriculture, Mansoura University, Egypt. We would like to thank everyone helped us.

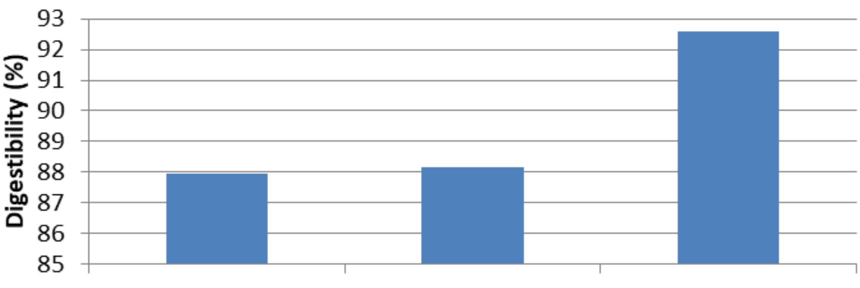

Fig (1): Effect of corn level (%) on DM digestibility

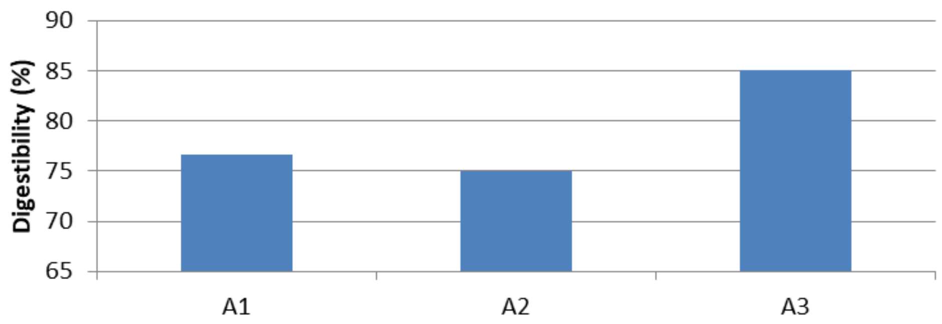

Fig (2): Effect of corn level (%) on NDF digestibility

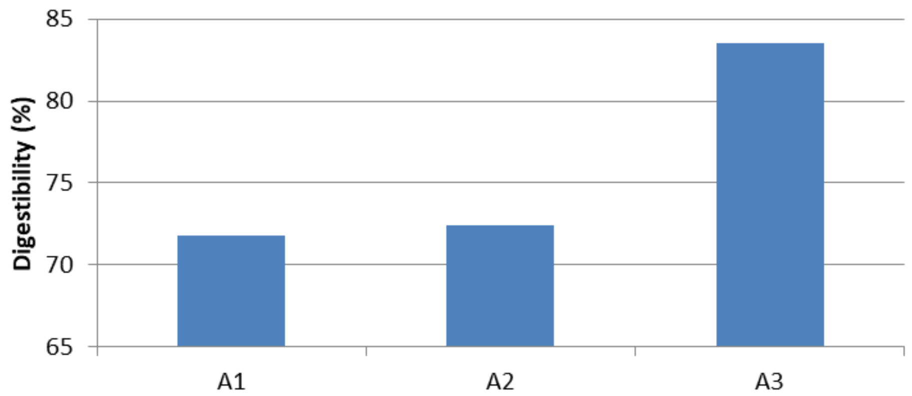

Fig (3): Effect of corn level (%)) on ADF digestibility

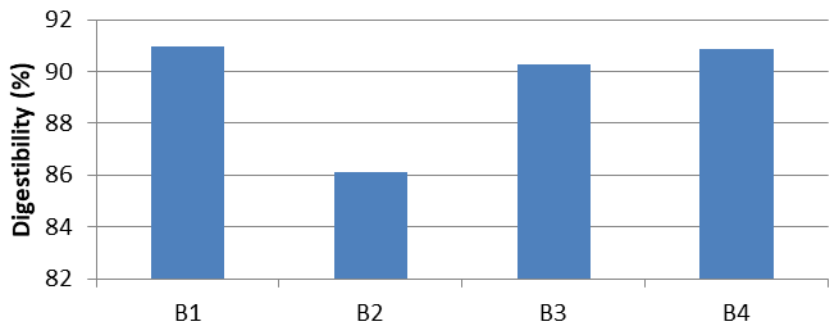

Fig (4): Effect of supplements on DM digestibility

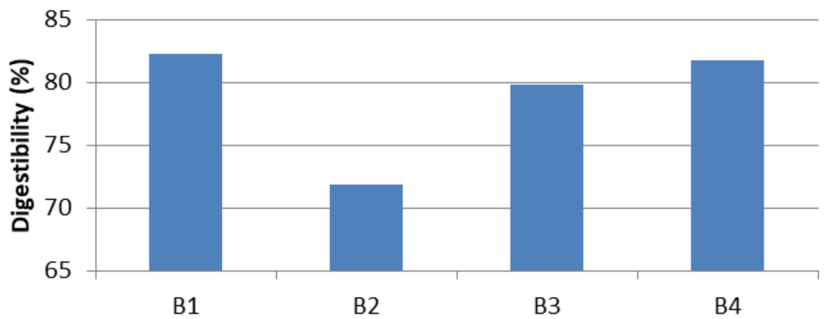

Fig (5): Effect of supplements on NDF digestibility

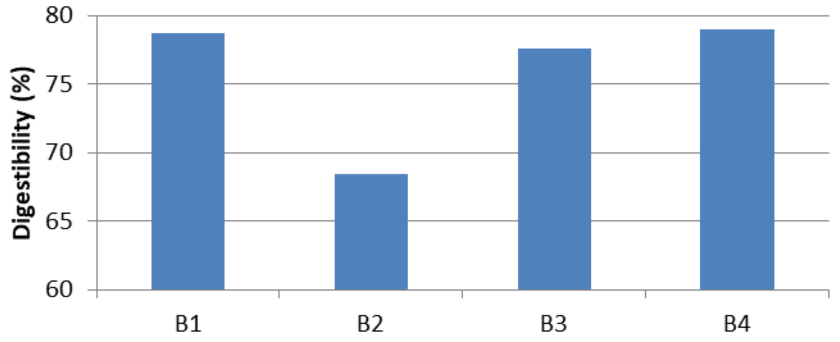

Fig (6): Effect of supplements on ADF digestibility

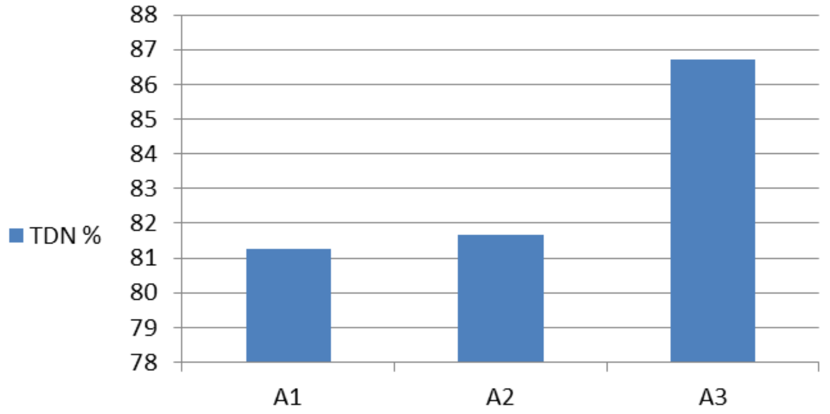

Fig (7): Effect of corn level (%) on TDN %

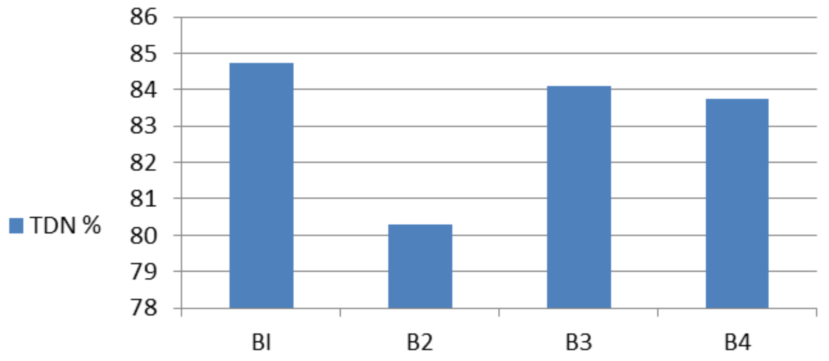

Fig (8): Effect of supplemented enzymes or perbiotic or both on TDN %

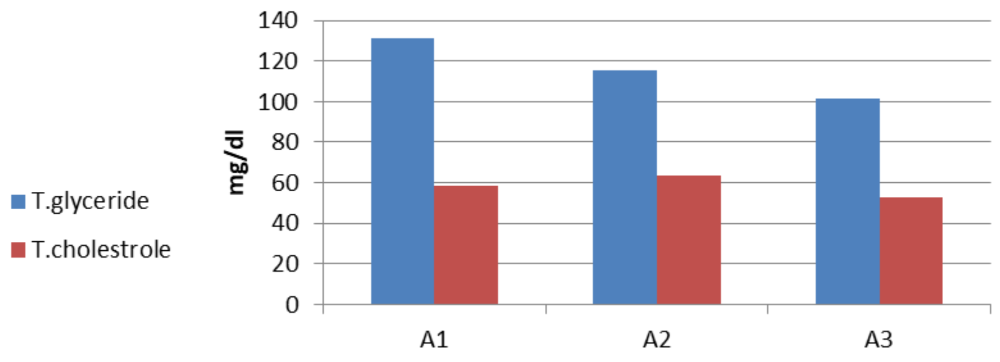

Fig (9) Effect of corn levels % on Triglycerides (mg/dl) and Total cholestrole (mg/dl)

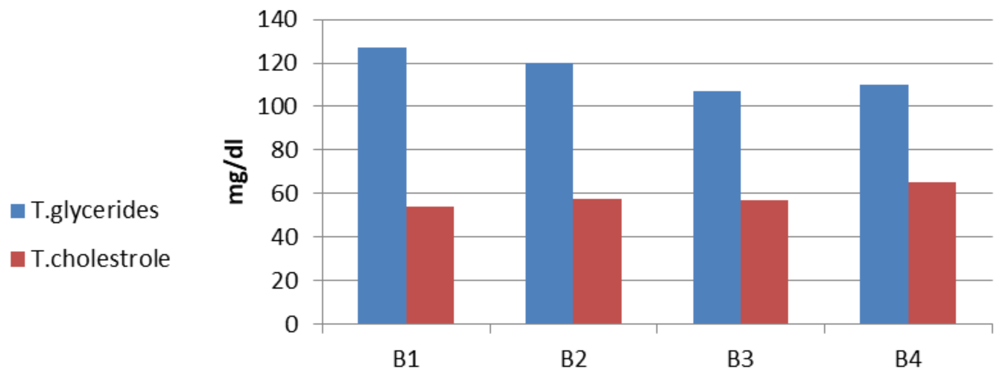

Fig (10) Effect of supplemented enzymes or perbiotics or both on Triglycerides (mg/dl) and Total cholestrole (mg/dl)

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إحلال الذره الصفرا محل نخالة القمح مع أو بدون مخلوط إنزيمات أو منشط نمو حيوى على معاملات هضم العناصر الغذائية وبعض قياسات الدم للأرانب النامية

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تم إجراء هذه الدراسة لمعرفة تأثير التغذية على علائق تحتوي على ثلاثة مستويات من الذرة الصفراء كبديل لنخالة القمح فى علائق الأرانب النامية بدون أو مع إنزيمات و / أو منشط نمو حيوية (البربيوتك) على معاملات هضم العناصر الغذائية وبعض قياسات الدم لأرانب النيوزيلندا الأبيض (NZW) النامية. وزعت المعاملات الغذائية فى تصميم عاملى (3*4). تم إجراء التحليلات الكيميائية للعلائق التجريبية والروث وبعض مكونات الدم. تم استخدام عدد مائة وثمانية أرنب على عمر الفطام (6 أسابيع) من الأرانب NZW. تم توزيع الأرانب بشكل عشوائي في 12 مجموعة تجريبية متساوية بكل معاملة ثلاثة مكررات بمعدل ثلاث أرانب بكل مكرر. وقد أوضحت النتائج زيادة معاملات الهضم للعناصر الغذائية (المادة الجافة و المادة العضوية و الألياف و المستخلص الاثيري ومستخلص خالى الأزوت و NDF و ADF و الهيميسليلوز مع التغذية على العلائق المحتوية على 15 ٪ ذرة مقارنة بمجموعات الأرانب التي يتم تغذيتها على العلائق المحتوية على 5 ٪ أو 10 ٪ من الذرة ، ولكن لم يكن هناك تأثير كبير للعلائق التجريبية على المأكول من المادة الجافة وهضم البروتين الخام. كما أوضحت النتائج أن تغذية الأرانب على العلائق التجريبية المدعمة بمخلوط الأنزيمات أدى لإنخفاض معنوى فى معاملات هضم المادة الجافة و المادة العضوية و الألياف و المستخلص الاثيري ومستخلص خالى الأزوت و ADF و الهيميسليلوز مقارنة بالمعاملات الغذائية الأخرى بينما لم يكن هناك تأثير كبير لهذه الإضافة على DMI (g/d) وهضم CP ، مقارنة مع باقى المعاملات التجريبية.

كما اتضح من نتائج هذه الدراسة أن معامل هضم البروتين DCP ، (٪) وTDN ٪ و DEI أعلى بكثير (P≤0.05) بالنسبة للأرانب التي تتغذى على العلائق التي تحتوي على 15٪ ذرة مقارنة بمستويات الإحلال الأخرى (الذرة 5٪ أو 10٪) ، بينما لم يكن هناك تأثير كبير على(TDNI (g/d ، CPI (g/d) و .DEI (kcal/d) ، كما أظهرت الأرانب التي تغذت على العلائق المدعمة بالإنزيم أداء منخفض بشكل ملحوظ فى معامل هضم % TDN و DE (kcal/d) مقارنة مع باقى المعاملات الغذائية التجريبية الأخرى. وبالمثل أوضحت النتائج أن التغذية على العلائق المدعمة بمخلوط الإنزيمات فقط أو العلائق المدعمة بمخلوط الإنزيمات مع المنشط النمو الحيوى أدت لانخفاض معنوى فى DEI (kcal/d) مقارنة مع المجموعات التجريبية الأخرى، ولكن لم يتأثر كلا من DCP و CPI .

كانت مستويات البلازما من الدهون الثلاثية والكوليستيرول الكلي فى البلازما أقل بشكل ملحوظ بالنسبة للأرانب التي تغذت على العلائق التجريبية المحتوية على الذرة الصفراء بنسبة 10 أو 15 ٪ مقارنة مع عليقه الكنترول، بينما لم يكن هناك تأثير كبير على ALT؛ AST، البروتين الكلي أو تركيز اليوريا . أظهرت الأرانب التي تغذت العلائق التجريبية المدعمة بالأنزيمات بالإضافة إلى البريبيوتك مستويات أقل بكثير (P≤0.05) من اليوريا والدهون الثلاثية في البلازما وبينما كان تركيز والكوليستيرول أعلى بكثير من مجموعة الكنترول

وقد خلصت هذه الدراسة إلى إمكانية استخدام الذرة الصفراء لتحل جزئيا محل نخالة القمح في علائق الأرانب النامية دون وجود تأثير سلبي على القيمة الغذائية للعلائق التجريبية. وكذلك يمكن أن تزداد القيمة الغذائية للعلائق التجريبية المغذاة للأرانب النامية عن طريق إضافة إنزيمات بالإضافة إلى البريبيوتك، كما أظهرت الدراسة الحالية أن تغذية الأرانب النامية على علائق تحتوي على 10٪ ذرة صفراء دون إضافات أو التغذية على علائق تحتوي على 15٪ ذرة صفراء مع الإنزيمات البريبيوتك أدت إلى تحسن معنوي لمعاملات هضم العناصر الغذائية والقيمة الغذائية للعلائق والحالة الصحية للأرانب.