J. Agric. Sci. Mansoura Univ., 33 (7): 4911 - 4925, 2008

THE USE OF COMMERCIAL ENZYMES TO IMPROVE DIETS CONTAINED PEANUT HAY ON PERFORMANCE OF GROWING RABBITS.

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ABSTRACT

This experiment was conducted to evaluate the effects of partial or complete replacement of clover hay by PNH (33.3, 66.7 and 100%) with or without adding enzymes in the diets of growing rabbits. A total number of 72 unsexed, weaned New Zealand White rabbits of 6 weeks old were randomly divided into six experimental groups (12 rabbits/group). Six pelleted experimental diets were formulated to be approximately isocaloric and isonitrogenous to cover the recommended nutrient requirements of rabbits. Clover hay was replaced by peanut hay (PNH) at the rate of 0, 15, 30 without or with 1gm adding commercial enzymes per kg diet. The experimental period extended for 8 weeks. Results showed that, rabbit groups fed 15% PNH diets either with or without enzyme addition had significantly higher final live body weight (LBW), daily body weight gain (DBWG), daily feed consumption (DFC), performance index and protein content of carcass meat as compared to 30% PNH and control diets with or without enzyme. Rabbits fed diet contained 15% PNH with enzyme had the best one for feed conversion ratio (FCR) compared with the other experimental groups. Higher economic efficiency was found with all diets contained PNH as compared to control diet without enzyme. Digestibility coefficients of the DM, OM, CP, CF, and TDN were significantly increased for rabbits group received 15% PNH diet with enzyme addition while, the lower values were recorded with those fed control diet without enzyme. NFE digestibility increased by partial or complete substitution of clover hay with PNH with or without enzyme addition in the rabbit diets. Insignificant differences were found among dietary treatments in EE digestibility and DCP. Dressing percentage was significantly increased and hot carcass weight (%) was insignificantly increased obtained with rabbits fed 30% PNH with enzyme than other groups. Lower fat and ash content of carcass meat were noticed with rabbits fed control and 15% PNH diets both with enzyme. However, adding the enzyme was resulted in lowering percentage of total non-carcass fat weight. Ammonia-N were significantly higher for rabbits fed 15% PNH diet without enzyme. Higher TVFA's was noticed with rabbits fed 15% PNH containing diet with enzyme. Insignificant differences were found among rabbits fed the experimental diets in total protein, albumin and enzymes activity of liver (AST & ALT). Higher globulin and Total cholesterol levels found for rabbits fed 30% PNH diet with enzyme than other groups. Glucose level was significantly higher for the control diets compared with diets containing PNH. Urea and creatinine levels in the blood were comparable for all diets except for control diets with enzyme, as it recorded lower concentration. It might be safe to conclude that, growing rabbits fed diets containing PNH supplemented with commercial enzymes could be used as feed supplement in the diet of rabbits. So, it can be used 15% PNH as a good replace of clover hay without any adverse effect on rabbit performance.

Keywords: peanut hay, clover hay, rabbit, performance, carcass traits, economic efficiency.

INTRODUCTION

Rabbits are characterized by high feed efficiency for producing animal protein for human consumption. The shortage of feedstuffs is one of the major limiting factors for increasing the animal production. The wild rabbits, being a herbivorous, consume a high proportion of plant as an integral part of their diet. Moreover, rabbits have the advantage of utilizing forages and by-products as a major the diet components since forages represent an important part of the rabbits diet. Rabbits meat production using local sources especially forages can help to overcome the dietary protein gap (lebas, 1983). Incorporation of cheap un-conventional feedstuffs such as agro-industrial by-products in the animal diets participate in solving the problem of feed shortage, decrease the feeding cost and alleviate the polllution problems. Therefore, attempts have been carried out to search for alternative non-conventional low price by-products, which could be used in animal feeding. Especially, many attempts made to introduce some forages which suit the Egyptian climate and conditions in newly reclaimed lands.

Peanut hay is one of the most important crop by-products in summer especially in the reclaimed sandy soil land. Peanut hay (PNH) is available in Egypt but it use is sometimes limited due to the poor understanding of their nutritional and economic value as well as proper use in ruminant diets. Peanut hay can be used as a good substitution for either alfalfa or clover hay in ruminant due to its high protein ratio as reported by Awadalla *et al.*. (1997). Peanut hay is as an excellent feed for rabbits. EL-Adawy and Borhami (2001) and Ibrahim (2000) who reported that, partial or complete replacement of clover hay with Peanut hay (PNH) resulted in higher growth performance, economic efficiency, nutrients digestibility and viability of growing rabbits. Enzymes are additives used to improve the performance of rabbits through the reducing viscosity of intestinal contents and improving nutritive value of the diet (Bedford and Morgan, 1996 and El-Tantawy *et al.*., 2001). The present study was carried out to evaulate the effects of partial or complete replacement of clover hay by PNH (33.3, 66.7 and 100%) with or without adding enzymes in the diets of growing rabbits on growth performance, economic efficiency, nutrients digestibility coefficients, carcass traits, caecum activity and some blood components.

MATERIALS AND METHODS

The present study was carried out at EL-Nubaria Research Station of the Animal Production Research Institute, Egypt, during the period from January 2007 till April 2007. A total number of 72 unsexed, weaned New Zealand White (NZW) of 6 weeks old were randomly divided into six experimental groups (12 rabbits/group). Each group was subdivided into four replicates, each of 3 rabbits and the initial live body weights of all experimental groups were almost equal 959±0.05g.

Six pelleted experimental diets were formulated to be approximately isocaloric and isonitrogenous. All experimental diets were formulated to cover the recommended nutrient requirements of rabbits according to NRC (1977)

and Cheeke (1987). Clover hay was replaced by peanut hay (PNH) at the rate of 0, 15, and 30 without or with 1 gm adding commercial enzymes per kg diet. Samples of experimental roughages (clover hay and peanut hay) were used for proximate analysis using the A.O.A.C methods (1995) and the results are presented in Table (1). Ingredients and chemical composition of the experimental diets are summarized in Table (2). The enzymatic composition of the utilized commercial enzyme product (CAPLIX): contained the following concentrations (IU) of enzymes,$100x10^6$ Cellulase, $250x10^3$ Amylase, $7x10^3$ Arabinase, $30x10^3$ Pectinase, $150x10^3$ Phytase, $10x10^3$ Lipase, $4x10^3$ Protease,$1.5x10^6$ Xylanase, $10x10^3$ Alpha Galactosidase and $10x10^3$ Beta Glucosidase. Rabbits were housed in galvanized metal wire cages (60 x 50 x 40 and provided with feeders and automatic watering system, (3 rabbits per each cage). Rabbits were individually weighed at the beginning of the experiment, then at weekly intervals until the end of the experiment. The experiment was lasted for 8 weeks.

Table (1): Chemical composition of Clover hay (CH) and Peanut hay (PNH) :

Item	Clover hay (CH)	Peanut hay (PNH)
Dry matter (DM)	89.67	88.41
Organic matter (OM)	86.75	89.13
Crude protein (CP)	12.18	12.22
Crude fiber (CF)	26.45	29.54
Ether extract (EE)	1.67	2.85
Nitrogen free extract (NFE)	46.45	44.52
Crude ash	13.25	10.87
Fiber fractions		
NDF	59.12	31.87
ADF	36.43	20.12
ADL	7.26	4.68
Cellulose	22.69	11.75
Himecellulose	29.17	15.44

At the last week of the experiment, digestibility trials were conducted using 18 rabbits (3 rabbits from each treatment). Rabbits were housed individually in metabolism cages that allow faeces and urine separation. The preliminary period continued for 7 days and the collection period extended for 3 days. Feed intake was exactly determined. Faeces were daily collected, weighed and dried at 60-70°C for 24 hours, bulked, finely ground and stored for chemical analysis. The apparent digestibility coefficients of DM, OM, CP, CF, EE and NFE for the tested diets were estimated. The chemical composition of the clover hay, peanut hay (PNH), experimental diets and faeces were analyzed according to A.O.A.C.(1995). The total digestible nutrients (TDN) were calculated according to the classic formula (Cheeke *et al.*., 1982). The digestible energy (DE) of peanut hay (PNH) was calculated according to Fekete and Gippert (1986) by applying the equation:- DE (kcal/kg) = 4253-32.6 (CF%) -144.4 (total ash%).

Table (2): Composition of the experimental diets and their chemical analysis.

Ingredients (%)	Control	15% peanut hay	30% peanut hay
Yellow corn	26.5	٢٧,٠	24.0
Soy bean meal (44% CP)	١٤,٨	١٥,٠	١٥,٠
Clover hay	٣٠,٠	١٥,٠	٠,٠
Wheat bran	٢٥,٥	٢٤,٨	٢٧,٨
Peanut hay	٠,٠	15.0	30.0
Limestone	٠,٩٠	٠,٩٠	٠,٩٠
Di-calcium phosphate	1.30	1.30	1.30
Salt (NaCl)	0.50	0.50	0.50
Vit.&Min premix*	0.30	0.30	0.30
DL-Methionine	0.20	0.20	0.20
Total	100.00	100.00	100.00
Chemical analysis#			
A- Determined analysis			
Organic matter (OM%)	٩٣,٠٢	٩٣,٢٦	٩٢,٦٨
Crude protein (CP%)	16.25	16.23	16.48
Crude fiber (CF%)	12.40	12.78	13.53
Ether extract (EE%)	٣,٢٨	٣,٢٦	٢,٨٤
Nitrogen free extract (N.F.E. %)	61.09	60.99	59.83
Crude ash (%)	7.00	8.36	8.45
B- Calculated analysis			
DE (kcal/kg)	2601	2587	2554
Methionine + cystine (%)	0.76	0.71	0..66
Lysine (%)	0.91	0.79	0.69
Calcium (%)	1.14	1.05	1.00
Total phosphorous (%)	0.70	0.69	0..65

- **One kilogram of premix provides: 2000.000 IU vit. A, 150.000 IU vit. D, 8.33g vit. E, 0.33g vit k, 0.33g vit. B1, 1.0g vit. B2, 0.33g vit. B6, 8.33g vit. B5, 1.7 mg vit. B12, 3.33g pantothenic acid, 33mg Biotin, 0.83g folic acid, 200g choline chloride, 11.7g Zn, 12.5g I, 16.6 mg SE, 16.6 mg Co, 66.7g Mg and 5g Mn.**

 # As DM basis

At the end of the growth trial, four randomly chosen rabbits (14 weeks of age) representing each group were slaughtered according to the standard technique of Cheeke *et al.*. (1982). Dressing percentage included relative weights of carcass, giblets and head. Blood samples were collected at slaughtering time in heparinized glass tubes (4 samples per each treatment group). Blood plasma was separated by centrifugation at 3000 rpm for 15 minutes. The collected plasma was stored at -20°C until assay. Values of total protein, albumin, total cholesterol, glucose, urea-N, creatinine and liver enzyme activities (AST and ALT) were determined by commercial kits (Boi-diagnostics Company, Egypt). The globulin values were calculated. Values of pH for stomach and caecum contents were measured immediately by using a digital pH meter. The volatile fatty acids were determined according to Conway (1958).

The economic efficiency (EEf) was calculated according to the following equation: EEf = A-B/B X 100. where A is selling cost of obtained gain (LE per kg) and B is the feeding cost of this gain. The performance index

(PI) was calculated according to the equation described by North (1981) as follows: PI = Live body weight (Kg)/ Feed conversion x 100

Data were analyzed according to statistical analysis system User's Guide, (SAS, 1998). Separation among means was carried out by using Duncan's multiple range test (Duncan,1955). The model was as follows: $Y_{ij} = \mu + T_i + e_{ij}$

Where: Y_{ij} = The observation on the I^{th} treatment μ = Overall mean T_i = Effect of the I^{th} treatment e_{ij} = Random error treatment.

RESULTS AND DISCUSSION

1- Growth performance:

1.1- Live body weight (LBW) and daily weight gain (DWG):

Results presented in Table (3) revealed that, LBW at 6th week of rabbits age was insignificantly differed (P>0.05) among experimental treatments. At the 14th week of age, rabbits group received diet containing 15% PNH with enzyme addition gave the highest LBW (2784.4g), followed by those fed on the same diet without enzyme addition (2700.0 g) and either 30% PNH containing diets with or without enzyme (2520 and 2505.6 gm, respectively) when compared with control diets with or without enzyme (2425.3 and 2417.7 gm, respectively). However, statistical analysis for LBW at 14 weeks of age showed highly significant (P≤0.01). This may be due to an increase of most nutrients digestibility and nutritive value for groups received 15% PNH diets with or without enzyme when compared to any of the other groups.

During the period of 6-14 weeks of age, rabbits group fed diet contained 15% PNH with enzyme was recorded the higher (P≤0.01) DBWG (34.23, g/h/d), followed by the same diet but without enzyme (31.15, g/h/d). While all rabbits in other groups had significantly lower (P<0.01) DBWG. However, groups fed 30% PNH containing diets were showed to had higher DBWG (27.66 and 27.95, g/h/d, respectively) than the control groups (26.07 and 26.21, g/h/d, respectively) without significant differences. Qnetiek *et al.*. (1999) reported improved weight gains in goats when legumes were used to supplement roughage based diet, as PNH considered to be one of the legume plants. These results are in agreement with those obtained by Afifi (1999) and Ibrahim (2000) who noticed higher body weight gain by substituting 66.7 or 100% of the clover hay with PNH in diets of growing rabbits. EL-Adawy and Borhami (2001) showed that replacement of clover hay with PNH up to 50% resulted in higher growth performance compared with the control group. It was also noticed that adding the enzyme had no significantly effect in the DBWG for the control and 30% PNH containing diets.

- Daily feed consumption (DFC) and feed conversion ratio (FCR):

Through the overall period (6-14 weeks of age) of the experiment, rabbits fed diets contained 15% PNH with or without enzyme were showed higher (P≤0.01) DFC compared to other groups (100.01and 99.26,g/h/d, respectively), with insignificant of adding enzyme. No significant effect of enzyme was noticed with diets contained 30% PNH (94.07 and 93.70,g/h/d, respectively) with insignificant differences with the control diet with enzyme.

No significant effect of enzyme was noticed with rabbits fed diets contained 30% PNH, as DFC was 99.43 and 98.70 (g/h/d) for the diet without and with enzyme, respectively. The enzyme had positive effect with rabbits fed the control diet, as adding the enzyme was increased DFC by about 11.21%. The increase of DFC with rabbits fed PNH diets may be due to the higher digestibility of most nutrients (El-Adawy and Borhami, 2001).

Through the overall period (6-14 weeks), whereas rabbits fed diet contained 15% PNH with enzyme found to have the better one for FCR (2.95, g feed/g gain), but with significant differences (P≤0.01) compared with the other experimental groups. In the meantime, the control groups with enzyme was found to the worst one (3.77, g/g gain) but with insignificant differences with group of rabbits fed 30% PNH with enzyme (3.42, g/g gain). Other groups were significantly comparable to each others, as FCR were 3.32, 3.21 and 3.41 (g feed/g gain) for control diet without enzyme, that contained 15% PNH without enzyme and that contained 30% PNH without enzyme as well, respectively. The improvements in FCR value with 15% PNH compared to other diets may due to first to the increase in feed intake, secondly to the more digestible nutrients intake by rabbits (Afifi, 1999 and Ibrahim, 2000). These results are in agreement with those reported by Amber and Osman (2001) found that, LBW, DBWG and FCR significantly improved with supplementing enzyme into rabbits diet or water when compared to control diet. Similarly, Sarhan (2001) observed that, addition of enzyme into rabbit's diets improved LBW, BWG and FCR. Therefore, enzymes addition could improve the digestion efficiency by increasing carbohydrates digestibility before the caecum which could avoid its effect on the diarrhea, as suggested by Sequeira *et al.* (2000). This study may be proved that, PNH can be as a replacer to clover hay as a source of fiber without adverse on health rabbits.

1.3- Economic evaluation

Higher (P≤0.01) total revenue and net revenue were recorded by rabbits fed 15% PNH diet with enzyme, followed by same diet without enzyme when compared to the other groups. Higher (P≤0.01) economic efficiency was found with all diets contained PNH without significant differences among themselves and control diet without enzyme. However, from the economic point of view, the profitability of using PNH in partial substitution for berseem hay in rabbit diets are depending on the price of these feedstuffs. Increase berseem hay substitution with PNH decreased the economic efficiency value. Such decrease may be due to the observed decrease in most nutrients digestibility and the nutritive values (Table, 3) which negatively affected growth performance and economic efficiency of growing rabbits. The results of economic efficiency support those obtained by Ibrahim (2000) who reported that the economic efficiency of feeding diets at morale age was higher with PNH substitution of clover hay. The same trend of these results were reported by El-Adawy and Borhami (2001), who found same trend of feed efficiency with substitution berseem hay with PNH (50%).

Performance index was significantly (P≤0.01) higher for 15% PNH diet with enzyme (66.26), followed by the same diet without enzyme (55.14), compared to any of the other groups. However, the enzyme had positive

effect for either economic efficiency or performance index only with 15% PNH level, and not for 30% or nil level of PNH.

1.4- Mortality rate:

It is interesting to notice that, the morality rate during the experimental period of growth was zero among dietary treatments. This may be an indication that growing rabbits can tolerate (utilized) different dietary levels of PNH in the diet. This result agreed with those reported by Adawy and Borhami (2001).

2- Nutrients digestibility coefficients and nutritive values:

Concerning digestibility coefficients of the DM, OM and CP, the results showed that the higher (P≤0.01) values recorded for rabbits group received diet containing 15% PNH with enzyme addition while, the lower values were recorded with rabbits given control diet without enzyme. Insignificant differences were found among dietary treatments in EE digestibility coefficients. Digestibility coefficients of CF were significantly (P≤0.01) increased with rabbits group fed on diet contained 15% PNH plus enzyme and also those given diet contained 30% PNH plus enzyme when compared with other groups.(Table, 4).

The apparent digestibility coefficients of NFE increased by partial or complete substitution of clover hay with PNH with or without enzyme addition in the rabbit diets.

The average nutritive values in terms of TDN ranged from 60.79 to 65.58 being the highest value for rabbits given 15% PNH plus enzyme diet (65.58) followed by 15% PNH without enzyme or 30% PNH with enzyme diets (63.90 and 63.70) but, the lowest value (60.79) for control diet. It was observed that, there were improvements markedly in TDN by dietary PNH increased in the growing rabbit diets. Also, it was obvious that, the values of TDN increased were good indicator for improvements of rabbit performance (especially, feeding PNH up to 15% with enzyme addition). The response of adding enzyme to diets was clearly noticed as well for TDN values, except for the control diet, it had no effect. Nutritive values expressed as DCP (%) were insignificant difference (P>0.05) among diets. However, it was more for 15% PNH with enzyme (9.71%) and less for 30% PNH without enzyme (9.13%). The enzyme had improved DCP values for all diets but without significant differences. These results coincided with reported by Hassan (1999) who found that the nutrient digestibility coefficients increased as the level of PNH increased up to 50% of dietary clover hay in growing rabbit's diets. Also, the findings reported herein agree with those of Awadalla *et al.*. (1997) when PNH was added to lambs diets. In the same trend, El-Adawy and Borhami (2001) found that increasing level of PNH in rabbit diets to replace berseem hay was increased apparent digestibility coefficients. Also, Afifi (1999) was reported same results as it found in this study. However, Ibrahim (2000) reported that the partial or complete substitution of clover hay with PNH diet not significantly increased TDN and DCP values of diets compared to the control diet.

T3-4

The present data were cleared that adding the enzyme to the diets was positive in improving the nutrients digestibility coefficients, except for DM, OM, CF and NFE of the control diet. Similar results were reported by Ibrahim *et al.* (1999) who found that, adding enzymes into rabbits diets significantly improved the digestibility coefficient of DM, CP and EE. Sarhan (2001) indicated that, addition of commercial enzymes to rabbit diets significantly increased DM, OM, CP, CF and EE as well as nutritive values. The benefits results from dietary addition of enzymes could be attributed to the partial degradation of the soluble glucan chain, reducing the viscosity of the intestinal contents and improving nutrient absorption (Bedford and morgan, 1996 and El-Tantawy *et al.*, 2001). Generally, the results showed that, nutrients digestibility coefficients and nutritive values increased when fed animals 15% PNH plus enzyme diet compared to any of the other diets. These results, may be explain the increase in daily weight gain by rabbits which fed 15% PNH plus enzyme diets during the period of growth (10-14 weeks of rabbits age).

3-Carcass traits, caecum activity and chemical analysis of rabbits meat:

Higher (P≤0.05) dressing percentage was obtained with rabbits fed 30% PNH with enzyme (67.48%), followed by those fed diet contained same diet without enzyme and 15% PNH with enzyme (64.80 %) and (64.63%). Control diet with and without enzyme and that contained 15% PNH without enzyme were recorded intermediate values. Hot carcass weight (%) was insignificantly increased for rabbits fed diet containing 30% PNH with enzyme followed by those received diet containing 15% PNH plus enzyme and 30% PNH without enzyme. While, the lowest carcass weight (%) for rabbits group 15% PNH without enzyme. (Table, 5). These results were confirmed by Afifi (1999) who reported that groups of rabbits fed diets including PNH (33.33 and 66.67%) in place of clover hay were somewhat higher in dressing weight and the total edible parts weight than in those fed the control diet.

No significant differences (P>0.05) for relative weights of head, giblets and blood among experimental treatments. El-Adawy and Borhami (2001) who found that constituents of berseem hay with PNH (50%) had significantly higher hot and cold carcass weight. Afifi (1999) reported that no significant differences in carcass characteristics were obtained in rabbits fed diets contained 33.33% PNH in place of clover hay.

Rabbits fed diet contained 15% PNH without enzyme was recorded higher (P≤ 0.05) total non-carcass fat weight percentage. Lower (P<0.05) weight percentage was found with rabbits fed the control diet with enzyme. However, adding the enzyme was resulted in lowering percentage weight of total non-carcass fat (Table, 5). The obtained results of enzyme addition effect agreed with those of Amber and Osman (2001) who reported that, dressing percentage of rabbits was significantly increased when the enzymes added to diet or water. On the other hand, Sarhan (2001) showed that, there were no significant differences increase traits of rabbits fed diets supplemented with commercial enzyme.

Values of caecum and stomach pH were insignificantly different among the experimental rabbits. These values of pH are within the normal ranges reported by Lebas *et al.* (1997) and Abdel-Azeem *et al.* (2004 and 2006).

Ammonia-N values were significantly differed (P≤0.05) among rabbit groups, whereas it was 28.89 (mg/100 ml RL) for rabbits fed diet contained 15% PNH without enzyme, while it lower (P≤0.05) for control diets (24.58 and 23.37, mg/100 ml RL) with and without enzyme. Total VFA's were also significantly differed (P≤0.05) among rabbits fed the experimental diets. Higher (P≤ 0.05) TVFA was noticed with rabbits fed 15% PNH containing diet with enzyme (115.67, meq/ 100 ml RL).

No significant differences (P>0.05) were found among carcasses meat of rabbits fed the experimental diets for DM content (Table 6). Diets contained 15% PNH with or without enzymes were showed higher (P≤0.01) protein content of carcass meat of rabbits fed such diets (66.98 and 67.02%, respectively as compared to the other groups. Fat content of carcasses meat was higher (P≤0.01) for rabbits fed all experimental diets except for those fed control or 15% PNH both with enzyme. Ash content of rabbits meat fed diets 15 and 30% PNH without enzyme was higher (P≤0.01) compared to other diets (17.78 and 18.44%, respectively). Lower (P<0.01) ash content was noticed with rabbits fed control and 15% PNH diets with enzyme (16.01 and 16.30%, respectively). However, the chemical composition of rabbits meat studied herein was in the same range by Blaso *et al.*. (1992). Results of Ngodigha *et al.*. (1994), Afifi (1999) and Ibrahim (2000) are in harmony with the obtained results in this study. And also, the present results agreed with those reported by Amber and Osman (2001) who found that, addition of enzyme to diet or water did not significantly any component of the meat composition (DM, CP, EE and Ash content).

4- Blood biochemical components:

No significant differences (P>0.05) were found among rabbits fed the experimental diets for their blood concentration of both total protein and albumin (g/dl) (Table, 6). Total protein was ranged from 6.79 and 7.20 (g/dl) for rabbits fed the control and 30% PNH without enzyme. And also, albumin was ranged between 4.29 and 4.55 (g/dl) for rabbits fed the control and 30% PNH without enzyme as well. Higher (P≤0.01) globulin level (g/dl) was found for rabbits fed 30% PNH diet with enzyme (2.88). Lower (P≤0.01) globulin level was noticed with rabbits fed 15% PNH diets without enzyme (2.45). Results obtained in this study were in agreement with findings of Melby and Altman (1974) found that, normal values of some blood components in rabbits, total protein (g/dl) from 4.9 to 7.20, albumin (g/dl) from 3.3 to 5.1 and globulin (g/dl) from 1.85 to 2.7 or 1.9 to 3.6. Total protein in the blood may reflect the nutritional status of the animal (O'kelly, 1973). Kumar *et al.*. (1980) found positive correlation between total protein content in the blood and dietary protein. Positive correlation between digestible protein intake and plasma albumin (Hewett, 1974).

Total cholesterol level was showed to be higher (P≤0.01) with rabbits fed 30% PNH diet without enzyme (92.32, mg/dl). Lower (P≤0.01) level was noticed with the control diet with enzyme (81.96, mg/dl). Enzyme had negative effect on the concentration of blood cholesterol, especially with 30% PNH, it had higher effect as it decreased from 92.32 to 85.34 (7.56%).

T5-6

Concentration of blood glucose (mg/dl) was significantly higher for the control diet with enzyme (81.04, mg/dl) compared with 30% PNH diets (74.77 and 77.65, mg/dl) and 15% PNH diet without enzyme (77.98, mg/dl). However, enzyme had positive effect with significant effect for 30% PNH diets. Urea blood concentration (mg/dl) was comparable for all diets except for control diets with enzyme, as it recorded lower (P≤0.01) concentration (39.01, mg/dl). The same trend was noticed for creatinine levels.

Higher (P≤0.01) hemoglobulin level (g/dl) was recorded for rabbits fed control and 15% PNH diets, hemoglobulin level was ranged from 13.28 and 13.56 (g/dl) for15% PNH diet without enzyme and the control diet with enzyme, respectively. Insignificant differences (P>0.05) were found among rabbits for their blood AST and ALT concentrations which was due to feeding PNH. Values of blood urea, AST and ALT were far less than that reported by Zanaty (2002), especially with enzyme supplementation. This could be due to the active effect of Biogen level used in this study compared to the enzyme used in our study. The results of AST and ALT are in good agreement with those reported by Chiericato *et al.* (1985) and lie within the normal level. The present results of blood components are in agreement with those of Amber and Osman (2001) reported that, the glucose and triglycerides were significantly increased by adding enzyme to diet or water. This increase may be due to the role of the effective amount of Amylase, Beta glucanase and Xylanase. On the other hand, Sarhan (2001) observed that, there were not significant differences total protein with its fractions, total lipids, total cholesterol, creatinine and ALT. While, glucose level was significantly decreased and AST was significantly increased with adding enzymes into rabbit. Generally, the obtained results of blood components in the present study were within the normal values reported by Hillyer and Quesenberry (1994).

The general conclusion indicated that, PNH could be successfully for feeding growing rabbits up to 30% level without any deleterious effects on the rabbit performance and economic evaluation. And concluded from this study that substitution of clover hay with about 15% PNH with adding enzyme can be recommended in formulating rabbits diet in order to have a good performance with less feeding cost.

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استخدام الإنزيمات التجارية لتحسين العلائق المحتوية علي دريس الفول السوداني علي أداء الأرانب النامية

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أجريت هذه التجربة لتقييم تأثيرات الإحلال الجزئي أو الكامل من دريس البرسيم بدريس الفول السوداني (١٠٠% أو٦٦.٧ ,33.3) مع أو بدون إضافة الإنزيماتِ في علائق الأرانبِ النامية. تم توزيع عدد ٦٠ أرنب نيوزيلاندى أبيض مفطوم وغير مجنس عمر٦ أسابيع توزيعا عشوائيا إلى ٦ معاملات (١٢ أرنب/ معاملة). دريس البرسيم أستبدل بدريس الفول السوداني (PNH) بنسبة ٠, ١٥, ٣٠ مع أو بدون إضافة ١ جرام إنزيماتِ تجارية لكل كيلو جرام من العليقة. استمرت فترة التجربة لمدة ٨ أسابيع. وكانت المقاييس المدروسة هي الأداء الإنتاجي والمعاملات

الهضمية للعناصر الغذائية ومواصفات الذبيحة وبعض مكونات الدم وأخيرا الكفاءة الاقتصادية.

وكانت أهم النتائج المتحصل عليها كالآتي:-

- أظهرت التجربة أن الأرانب التي غذيت علائق بها ١٥% دريس الفول السوداني مع أو بدون إضافة إنزيماتِ أعلي القيم في الوزن الحي و معدل النمو اليومي و معدل الاستهلاك اليومي من العلف ودليل كفاءة النمو ومحتوي لحم الأرانب من البروتين الخام إذا ما قورنت بعلائق الكنترول أو ٣٠% دريس الفول السوداني.
- حققت الأرانب التي غذيت علائق بها ١٥% دريس الفول السوداني في وجود الإنزيم أفضل معدل تحويل غذائي مقارنة بالمجاميع الأخرى.
- سجلت العلائق المحتوية علي دريس الفول السوداني أعلي كفاءة اقتصادية إذا ما قورنت بعلائق الكنترول.
- أظهرت النتائج تحسنا معنويا في كلا من هضم المادة الجافة والعضوية ومعامل هضم للبروتين الخام و معامل هضم الألياف وكذلك قيمة مجموع المركبات الغذائية المهضومة مع الأرانب المغذاة علائق بها ١٥% دريس الفول السوداني في وجود الإنزيم و بينما كانت أقل القيم السابق ذكرها مع عليقة الكنترول بدون إضافة الإنزيم. وجد زاد في معامل هضم المستخلص الخالي من الازوت بالإحلال الجزئي أو الكاملِ من دريس البرسيمِ بدريس الفول السوداني مع أو بدون إضافة إنزيماتِ في علائق الأرانبِ النامية. ولا توجد فروق معنوية في معامل هضم مستخلص الأثير والبروتين المهضوم بين المجاميع التجريبية.
- زادت نسبة التصافي زيادة معنوية والوزن النسبي للذبيحة زاد زيادة غير معنوية مع الأرانب المغذاة ٣٠% دريس الفول السوداني في وجود الإنزيم مقارنة بالمجاميع المجاميع التجريبية الأخرى.
- سجلت ذبائح الأرانب أفل محتوي من الدهن و الرماد مع العلائق بها ١٥% دريس الفول السوداني أوعلائق الكنترول كلا في وجود الإنزيم . وعلاوة علي ذلك إضافة الإنزيم أدي إلي خفض محتوي الدهن(Total non-carcass fat). وجود زيادة معنوية في مستوي الامونيا لمحتويات أعور الأرانب والمغذاة ١٥% دريس الفول السوداني في عدم وجود الإنزيم. بينما زادت الأحماض الدهنية الطيارة مع الأرانب المغذاة ١٥% دريس الفول السوداني في وجود الإنزيم.
- لا توجد فروق معنوية في مستوى كلا من البروتين الكلى والالبيومين في بلازما الدم وكذلك إنزيمات نشاط الكبد (AST&ALT) بين المجاميع التجريبية.
- سجل مستوي عالي من الجلوبيولين والكولسترول الكلى في بلازما الدم مع الأرانب المغذاة ٣٠% دريس الفول السوداني مع إضافة الإنزيم عند مقارنتها بالمجاميع المجاميع التجريبية الأخرى.
- علائق الكنترول سجلت أعلي مستوي من الجلوكوز عند مقارنتها بالعلائق التي تحتوي علي دريس الفول السوداني . بينما سجلت مستويات متقاربة من اليوريا والكرياتينين ماعدا عليقة الكنترول بالإنزيم كانت أقل.

من هذه الدراسة نوصي باستبدال دريس البرسيم في علائق الأرانب بدريس الفول السوداني مع أو بدون إضافة الأنزيم للحصول على أداء جيد للأرانب وتحسين في القيمة الاقتصادية. وخاصية إذا ما استخدم بمستوي ١٥% دريس الفول السوداني مع إضافة الأنزيم كإحلال جيد لدريس البرسيم المصري بدون أي تأثيرات عكسية علي أداء الأرانب النامية.

Table(3) : Effect of feeding different levels of peanut hay (PNH) on growth performance of rabbits.

Items	Control	Control +E	15% PNH	15% PNH+E	30% PNH	30% PNH+E	Sig.
Live body weight (gm) at:							
6 weeks	957.78±38.3	957.78±24.9	$^{955.56}$±43.94	957.78±21.00	956.67±29.63	954.44±25.66	NS
14 weeks	2417.8^{c}±66.9	2425.3^{c}±123.2	2700.0^{b}±35.1	2874.4^{a}±66.52	2505.6^{bc}±61.1	2520.0^{bc}±88.2	**
Daily weight gain (gm) from:							
6-14 weeks	26.07^{c}±1.22	26.21^{c}±1.78	31.15^{b}±1.11	34.23^{a}±1.06	27.66^{c}±0.79	27.95^{c}±1.32	**
Daily feed consumption (gm/rabbit):							
14 weeks	85.93^{c}±2.44	95.56^{b}±1.39	99.26^{a}±1.08	100.01^{a}±1.24	94.07^{b}±1.98	93.70^{b}±1.17	**
Feed conversion ratio (FCR) from							
6-14 weeks	3.32^{b}±0.09	3.77^{ab}±0.25	3.21^{c}±0.10	2.95^{c}±0.11	3.4 ^{ab}±0.07	3.42^{ab}±0.18	**
Total return (LE)	21.90±1.02	23.08±1.20	23.7±0.88	18.4±1.04	18.45±1.04	18.36±0.34	**
Net return (LE)	14.61 ^{c}±0.88	14.4 ^{c}±41.09	18.22^{b}±0.88	20.19^{b}±0.92	16.2^{bc}±0.58	15.9^{bc}±1.09	**
Economic efficiency (%)	199.9 ^{b}±8.96	166.1 ^{c}±10.6	229.0^{ab}±9.9	236.4^{ab}±12	231.7^{ab}±7.3	213.1^{ab}±14	**
Performance index	44.63 ^{c}±3.39	42.6 ^{c}8±4.47	55.14^{b}±3.44	66.28^{a}±4.27	45.7^{bc}±2.14	47.52^{b}±4.17	**

Means within the same row with different superscripts are significantly different, Sig. = Significance, NS = Not significant, * (P≤0.05), ** (P≤0.01).
Control +E= Control with enzyme , PNH= peanut hay, PNH+E= Peanut hay with enzyme .
Selling price of one kg live body weight=15.0 LE

Table (4) Effect of dietary peanut hay (PNH) levels on nutrients digestibility coefficients and nutritive values of growing rabbits.

Items	Control	Control +E	15% PNH	15% PNH+E	30% PNH	30% PNH+E	Sig.
Nutrients digestibility coefficients:-							
Dry matter (DM)	58.79^{c}±0.22	59.38^{c}±0.59	61.40^{b}±0.38	63.85^{a}±0.23	59.09^{c}±0.11	61.65^{ab}±0.57	**
Organic matter (OM)	61.99^{c}±0.21	62.74^{c}±0.31	65.09^{b}±0.28	66.95^{a}±0.23	62.85^{c}±0.10	65.32^{b}±0.49	**
Crude protein (CP)	59.30^{c}±0.35	61.18^{b}±0.57	61.35^{b}±0.48	63.32^{a}±0.38	59.55^{c}±0.17	61.09^{b}±0.5	**
Ether extract (EE)	77.00±0.77	78.08±0.89	78.29±0.27	79.34±0.15	77.47±0.11	78.00±0.73	NS
Crude fiber (CF)	34.79^{c}±0.42	34.61^{b}±0.51	37.64^{b}±0.83	41.70^{a}±0.03	31.85^{d}±0.16	39.42^{b}±0.55	**
Nitrogen free extract (NFE)	66.92^{d}±0.55	66.77^{d}±0.58	70.36^{b}±0.19	71.71^{a}±0.29	68.85^{c}±0.21	70.58^{ab}±0.50	**
Nutritive values:-							
Total digestible nutrients (TDN)	60.79^{C}±0.17	61.46^{c}±0.28	63.90^{b}±0.27	65.58^{a}±0.21	61.70^{c}±0.12	63.70^{b}±0.49	**
Digestible crude protein (DCP)	9.24±0.06	9.34±0.05	9.48±0.07	9.71±0.06	9.13±0.01	9.30±0.08	NS

Means within the same row with different superscripts are significantly different. NS = Not significant.
Control +E= Control with enzyme , PNH= peanut hay, PNH+E= Peanut hay with enzyme

Table (5) : Effect of dietary peanut hay (PNH) levels on carcass traits and ceacum activity of rabbits.

Traits	Control	Control +E	15% PNH	15%PNH+E	30% PNH	30%PNH+E	Sig
Dressing percentage #	$62.43^{b}\pm0.81$	$63.22^{b}\pm1.55$	$61.08^{b}\pm0.73$	$64.63^{b}\pm1.51$	$64.80^{b}\pm2.52$	$67.48^{a}\pm1.06$	*
Hot Carcass weight (%)	52.17±1.36	53.34±1.62	50.94±1.28	55.15±2.43	54.96±2.66	57.15±0.99	NS
Giblets weight (%)	4.01±0.36	3.98±0.13	3.57±0.50	3.73±0.16	3.30±0.13	4.18±0.08	NS
Head weight (%)	6.25±0.35	5.90±0.14	6.57±0.39	5.72±0.21	6.54±0.14	6.15±0.14	NS
Blood weight (%)	3.50±0.57	3.57±0.52	4.24±0.10	3.43±0.32	4.05±1.51	3.10±0.52	NS
Total non-carcass fat (%)	$0.45^{b}\pm0.04$	$0.36^{c}\pm0.02$	$0.59^{a}\pm0.03$	$0.43^{b}\pm0.01$	$0.69^{b}\pm0.02$	$0.48^{b}\pm0.01$	*
Caecum activity:-							
pH caecum (%)	6.48±0.04	6.46±0.06	6.42±0.03	6.39±0.06	6.49±0.02	6.49±0.02	NS
pH stomach (%)	3.25±0.19	3.47±0.07	2.26±0.06	3.55±0.03	3.68±0.02	3.68±0.02	NS
$^{NH}3$(mg/100 ml)	$24.58^{bc}\pm0.81$	$23.37^{c}\pm0.59$	$28.89^{a}\pm1.24$	$25.88^{b}\pm0.09$	$26.17^{b}\pm0.31$	$26.17^{b}\pm0.31$	*
TVFA(mq/100 ml)	$99.53^{b}\pm0.98$	$103.33^{b}\pm1.81$	$105.47^{b}\pm2.43$	$115.67^{a}\pm4.70$	$101.90^{b}\pm0.81$	$101.90^{b}\pm0.81$	*
Proximate analysis of rabbits meat:-							
Dry matter (DM)	33.1±0.41	33.2±0.35	33.3±0.24	33.8±0.15	34.1±0.23	34.43±0.25	NS
Crude protein (CP)	$64.69^{bc}\pm0.6$	$65.33^{b}\pm0.59$	$66.98^{a}\pm0.18$	$67.12^{a}\pm0.14$	$64.85^{bc}\pm0.3$	$63.99^{c}\pm0.23$	**
Ether extract (EE)	$16.74^{b}\pm0.36$	$15.92^{c}\pm0.13$	$17.70^{a}\pm0.09$	$16.69^{b}\pm0.26$	$18.08^{a}\pm0.23$	$17.47^{a}\pm0.21$	**
Crude ash	$16.57^{cd}\pm0.3$	$16.01^{d}\pm0.36$	$17.78^{ab}\pm0.1$	$16.30^{cd}\pm0.3$	$18.44^{a}\pm0.23$	$17.17^{bc}\pm0.4$	**

Means within the same row with different superscripts are significantly different. NS = Not significant * (P<0.05) ** (P<0.01)
Dressing percentage# included relative weights of carcass, giblets and head.
Control +E= Control with enzyme , PNH= peanut hay, PNH+E= Peanut hay with enzyme.

Table (6) : Effect of dietary peanut hay (PNH) levels on some blood biochemical components of growing rabbits.

Traits	Control	Control +E	15% PNH	15% PNH+E	30% PNH	30%PNH+E	Sig.
Total protein (g/dl)	6.79±0.13	7.00±0.08	6.84±0.19	7.19±0.05	7.20±0.13	7.19±0.07	NS
Albumin (g/dl)	4.29±0.09	4.37±0.07	4.39±0.12	4.51±0.04	4.55±0.10	4.31±0.14	NS
Globulin (g/dl)	$2.50^{bc}\pm0.04$	$2.63^{bc}\pm0.001$	$2.45^{c}\pm0.18$	$2.68^{b}\pm0.01$	$2.65^{b}\pm0.03$	$2.88^{a}\pm0.08$	**
A/G ratio	$1.71^{a}\pm0.01$	$1.67^{a}\pm0.03$	$1.73^{a}\pm0.02$	$1.69^{a}\pm0.01$	$1.72^{a}\pm0.02$	$1.49^{b}\pm0.09$	**
Cholesterol (mg/dl)	$86.69^{c}\pm1.4$	$81.96^{d}\pm0.11$	$89.50^{b}\pm0.57$	$85.24^{c}\pm0.55$	$92.32^{a}\pm0.93$	$85.34^{c}\pm0.80$	**
glucose (mg/ dl)	$79.32^{ab}\pm0.84$	$81.07^{a}\pm0.46$	$77.98^{b}\pm1.09$	$79.51^{ab}\pm0.29$	$74.77^{c}\pm0.42$	$77.65^{b}\pm0.74$	**
Urea (mg/dl)	$41.03^{a}\pm0.97$	$39.01^{b}\pm0.25$	$41.94^{a}\pm0.95$	$41.38^{a}\pm0.43$	$40.99^{a}\pm0.52$	$42.28^{a}\pm0.21$	**
Creatinine (mg/dl)	$0.94^{bc}\pm0.02$	$0.87^{c}\pm0.02$	$1.02^{ab}\pm0.04$	$1.00^{ab}\pm0.03$	$0.97^{ab}\pm0.02$	$1.04^{a}\pm0.03$	**
Hemoglobulin (g/L)	$13.55^{a}\pm0.14$	$13.56^{a}\pm0.04$	$13.28^{ab}\pm0.07$	$13.30^{ab}\pm0.09$	$13.02^{b}\pm0.15$	$13.11^{b}\pm0.07$	**

AST(µ/L)	30.14±0.94	31.34±1.12	31.55±2.18	31.43±1.94	32.47±1.26	32.66±1.53	NS
ALT (µ/L)	36.65±0.45	39.19±0.24	38.09±0.75	38.18±1.18	38.91±1.18	40.33±0.27	NS

Means within the same row with different superscripts are significantly different. NS = Not significant * (P<0.05) ** (P<0.01)
Control +E= Control with enzyme , PNH= peanut hay, PNH+E= Peanut hay with enzyme.