Vet.Med.J.,Giza. Vol.51, No.1. (2003) : 71-82.

EFFECT OF DIETARY FIBRE SOURCES ON GROWTH PERFORMANCE, NUTRIENTS DIGESTIBILITY, BLOOD SERUM CONSTITUENTS AND CARCASS TRAITS IN GROWING RABBITS

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Received: 10.11.2002.
Accepted:31.12.2002.

SUMMARY

The present study was carried out to evaluate the possibility of decreasing the feeding cost of growing meat rabbits by dietary inclusion of agro-industrial by products such as peanut hulls (PH) and peanut skins (PS) as partial or total substitutes for the traditional fibrous feedstuffs.

Eighty growing New Zealand white (NZW) male rabbits, about 48 days of age and 1077+ 35 g average live body weight were used in the present experiment. Animals were allotted to five experimental groups and were fed five different complete pelleted diets. The 1st diet (Diet 1) served as a control and contained 48% berseem hay (BH) as a main source of roughage, while the other four diets contained : 12% BH + 12% PH (Diet 2); zero % BH+ 18% PH (Diet 3); 24% BH +36% PS (Diet 4) and 24% BH+ 6% PH+ 18% PS (Diet 5), respectively. In Diets 2, 4 and 5, crude fibre (CF) of peanut by-products substituted about 50% of the total CF in the control diet, while in Diet 3, CF of PH substituted about 75% of the total dietary CF. All diets were formulated to be nearly iso-nitrogenous (16% crude protein), nearly iso-caloric (2700 Kcal. DE/kg. diet) and nearly iso-fibrous (about 14% crude fibre).

Feed intake were higher ($P< 0.05$) by rabbits fed the peanut by-products diets than those fed the control diet. Averages of live body weight at 15 weeks of age, daily weight gain, feed conversion and economical efficiency were the best ($P< 0.05$) for rabbits fed Diet 2 (Containing 12% PH) and the worst ($P<0.05$) for rabbits fed Diet 4 (Containing 36% PS) compared with those fed the other diets. Apparent digestion coefficients of

DM, OM, CF, EE and NFE and feeding values of diets expressed as DE, TDN or DCP were the most highly ($P<0.05$) for Diet 2 and the lowest for Diet 4, with no statistical differences among the other diets. Levels of serum total protein and albumin were lower ($P<0.05$), while urea-N level was higher ($P < 0.01$) in rabbits fed Diet 4 than the control rabbits. The previous blood serum parameters had the opposite trend with rabbits fed Diet 2. Carcass weight (%) tended to be lower ($P < 0.05$), while visceral fat was higher ($P < 0.05$) in the rabbits fed Diet 4 than those fed the control diet, with no significant differences among the other groups of rabbits. Inclusion of peanut hulls up to 12% of the diet (to replace about 50% of the dietary crude fibre content), decrease the feeding cost without any adverse effects on growth performance parameters of growing rabbits. More studies are required to ascertain the optimum level of peanut skin in the diets of growing rabbits.

INTRODUCTION

Although fibrous feedstuffs are poorly digested by rabbits when compared with horses and ruminant animals, a certain level of fibre in the diet is required for normal digestion and adequate growth (1,2). In this respect, (3) found a relationship between a low level of fibre in the diet and high diarrhea incidence through its effect on cecal fermentation traits which affect proliferation of cecal pathogenic flora (high pH and ammonia level and low volatile fatty acids concentration lead to high proliferation of *E. coli*). (4) found that the minimal crude fibre requirements in daily ration of growing NZW x California rabbits to avoid digestive disorders and to maximize their profit was 10.5% during 4-8 weeks of age and 14.1% during 8-12 weeks of age and that of the maximal crude fibre one was 14.0% versus 17.5% during the same ages. There are differences in crude fibre digestibility among feeds due to the variation in the chemical composition (degree of lignification) and physical structure of its fibre content (5,6). Some variations are also related to the level of inclusion of ingredients in substitution of the basal diet (7).

Alfalfa (Medicago Sativa) and clovers (Trifolium spp.) are the main roughages used in the rations of rabbits. In areas where these forages do not grow or their price is high, it is important to search for alternatives. There are great amounts of agro-industrial by-products that most of them are lost without utilization while can be used in the diets of rabbits to replace the traditional feeds in order to decrease the cost of feeding .

Peanut hulls and peanut skins (testa) are by-products of peanut industry. The amount of peanut by-products was estimated in Egypt to be about 2500 tons yearly Report of Ministry of Agriculture (8). Peanut hulls are high in fibre, but they have about 8% crude protein on a moisture free basis. Peanut hulls may constitute up to 10%

of cattle and lamb finishing rations, and up to 30% of the rations of stocker beef cattle (9). Peanut skin was found to be a valuable feed ingredient for growing finishing cattle when incorporated at level up to 10% of the total pelleted diet (10). Evaluation of such by products in the diets of rabbits as cheap sources of fibre has not been performed yet.

The objectives of this work were to:

1) Study the effects of dietary inclusion of different levels of peanut hulls and peanut skins as fibre sources on growth performance, nutrients digestibility, blood serum and carcass traits in growing rabbits.

2) Determine the optimum level of inclusion of peanut by-products in the diet of rabbits in order to decrease the cost of feeding.

MATERIALS AND METHODS

The present study was carried out at the rabbit Research Unit, Faculty of Veterinary Medicine, Zagazig University, Zagazig, Egypt.

Eighty growing NZW male rabbits about 48 days of age and 1077+35 g average live body weight were used in the present study. Animals were allocated into five experimental groups and were fed five different complete pelleted diets. The 1st diet (Diet 1) served as a control and contained 48% berseem hay (BH) as the main source of roughage, while, the other four diets contained 12% BH+ 12% PH (Diet 2); Zero% BH+ 18% PH (Diet 3); 24% BH+ 36% PS (Diet 4); 24% BH+ 6% PH+ 18% PS (Diet 5), respectively. In Diets 2, 4 and 5 , crude fibre (CF) of peanut by-products substituted about 50% of the total CF of the control diet, while in Diet 3, CF of peanut hulls substituted about 75% of the total CF of the control diet. All diets were formulated to be nearly iso-nitrogenous (containing about 16% crude protein), nearly iso-caloric (2700 Kcal.DE/kg. diet) and nearly iso-fibrous (about 14% crude fibre). Tafla (clay mineral) was added to the diets at level of 1% to protect the growing rabbits against aflatoxicosis (11). Chemical composition (%) of ingredients and diets used in the experiments are shown in Tables 1 and 2.

Table (1): Chemical composition (%) of ingredients used in formulation of the experimental diets.

Ingredients	Chemical composition (%)						DE Kcal/kg*
	DM	CP	CF	EE	Ash	NFE	
Wheat bran	89.5	13.50	10.30	4.60	6.80	54.30	2740
Yellow corn	88.70	8.10	1.90	4.10	1.42	73.18	3446
Soybean meal	88.50	41.00	5.90	1.20	6.00	34.40	3160
Berseem hay	89.20	14.00	23.80	2.55	10.00	38.85	2125
Barley	89.20	11.70	5.70	1.65	3.25	66.90	3115
Peanut hulls	88.50	5.80	59.00	1.30	4.40	18.00	1661**
Peanut skin	90.00	12.50	19.20	10.00	2.20	46.10	3316***

* Digestible energy (DE) values were calculated according to NRC (12).
, * These values were calculated according to Feket and Gippert (2).

Rabbits were housed in galvanized wire cages (60 X 55 X 45 cm) provided with feeders and nipple drinkers. The experimental diets were offered to rabbits ad libitum and fresh tap water was available all the time. All rabbits were kept under the same managerial, hygienic and environmental conditions. The rabbits were vaccinated against snuffle using haemorrhagic septicemia vaccine and injected with Ivomac preparation to combate external and internal parasites.

Individual live body weight, feed consumption and feed conversion ratio were weekly recorded during the experimental period. A digestibility trial was conducted at the 7th week of the experimental period using four male rabbits from each dietary experimental group. The animals were housed individually in metabolic cages for 11 days (6 days as preliminary period and 5 days as a collection period). Samples of feeds and feces of each animal were taken daily throughout the collection period and were chemically analyzed for CP, CF, EE, Ash and NFE according to **A.O.A.C (13)**.

Table (2): Ingredients and chemical composition (%) of the experimental diets

Items	Chemical composition (%)				
	D_1	D_2	D_3	D_4	D_5
Ingredients (%):					
Yellow corn	--	--	28.00	--	8.00
Barley	28.00	27.00	--	--	20.00
Soybean meal	14.00	20.00	23.00	13.00	17.00
Wheat bran	3.00	22.00	24.00	20.00	--
Berseem hay	48.00	12.00	--	24.00	24.00
Peanut hulls	--	12.00	18.00	--	6.00
Peanut skin	--	--	--	36.00	18.00
Venas	3.50	3.50	3.50	3.50	3.50
Limestone	1.50	1.50	1.50	1.50	1.50
Common salt	0.50	0.50	0.50	0.50	0.50
Vit. & min. Premix	0.35	0.35	0.35	0.35	0.35
DL-Methionine	0.15	0.15	0.15	0.15	0.15
Tafla	1.00	1.00	1.00	1.00	1.00
Chemical composition (%):					
DM	83.25	84.06	83.72	84.40	83.93
CP	16.08	16.30	16.10	16.02	16.17
CF	14.12	14.90	15.00	15.45	14.75
EE	1.99	2.20	2.76	5.29	3.39
NFE	43.83	44.25	44.67	41.25	43.78
Ash	7.23	6.41	5.19	6.39	5.84
DE (Keal/kg)	2665	2640	2699	2694	2694

1) Each one kilogram of premix contains: Vit A, 2000000 IU; Vit D_3 150000 IU; Vit E, 8.33 g; Vit K, 0.33 g; Vit B_1, 0.33; Vit B_2, 1.0g; Vit B_5; 0.33g; Vit B_6; 1.70 g; Vit B_{12}; 8.33 g; Pantothenic acid, 3.33g; Biotine, 33.0 mg; Folic acid, 0.83 g; Choline chloride, 200g; Zn, 11.79; Fe, 12.50g; Cu, 0.50 g; I, 33.3 mg; Se, 16.6 mg; Mn, 5.0 g and Mg, 66.7g.

The digestible energy (DE) value of peanut hulls and peanut skins was calculated according to the equation of (2), where DE kcal/kg) = 4253 - 32.6 (% Ash).

The TDN (%) of the diets was calculated according to the classic formula of (14). The economic efficiency of the experimental rabbit was calculated by the following equation : Y = [(A-B) /B] X 100, where A is the selling price of one kilogram of live body weight and B is the feeding cost to obtain this unit of weight .

At the end of the experimental period, five fasted rabbits from each group were randomly taken for slaughter to study the effect of dietary treatments on carcass traits. Blood samples were taken from each rabbit at the time of slaughter to estimate the levels of serum total protein, albumin, total lipids, creatinine, urea-N and activity levels of glutamic oxaloacetic transaminase (GOT) and glutamic pyruvic transaminase (GPT), using commercial calorimetric assay kits (Purchased from Egyptian-American Company for Laboratory Services, Cairo, Egypt, following the methodology suggested by the producers). The globulin values were calculated by subtracting albumin from total protein values.

Data of all variables in the present study were statistically analyzed as a completely randomized design according to (15). All data percentages were transformed to their arc-sin values before analysis The significant differences between means were tested by Duncan's, Multiple Range Test (16).

RESULTS AND DISCUSSION

1- Growth performance of rabbits

As shown in Table 3, the dietary treatments had significant effect ($P< 0.05$) on all parameters of growth performance. Averages of feed intake (FI) were higher ($P< 0.05$) by rabbits fed the peanut by-products containing diets than those fed the control diet (containing berseem hay as main source of fibre) indicating a good palatability of these ingredients in the diets of growing rabbits.

Averages of final live body weight (LBW) at 15 weeks of age, daily weight gain (DWG), feed conversion and economic efficiency were better ($P<0.05$) in rabbits fed Diet 2 and lower ($P< 0.05$) in rabbits fed Diet 4 than those fed the control diet. Although LBW and DWG values were statistically similar for rabbits fed Diet 3 or Diet 5 and those fed the control one, feed conversion and economic efficiency for the control rabbits were better ($P<0.05$) than those fed the indicated two diets. Mortality rate (%) of the experimental animals was very low. Four rabbits died, one from both of dietary group 3 and 5 and two rabbits from dietary group 4, and these animals died during the first week of the experiment. Necropsy findings showed that these dead animals suffered from enteritis.

The decrease of averages of final LBW and DWG in rabbits fed Diet 4 (containing 36% peanut skin) may be attributed to the high content of lignin and tannins in peanut skins (17,18,19) which decrease its digestibility and nutrient utilization. Moreover, the increased amount of feed intake observed by rabbits fed peanut skins-diets (Table 3) compared to the control rabbits may resulted in high rate of digesta passage through the intestine and this action decreased the digestibility of organic matter, which led to a decrease in the available energy and protein for growth of rabbits (6, 20). Data of growth performance (Table 3) indicate that the inclusion of peanut hulls in the diet up to 12% could serve as an inexpensive source of fibre in the diets of growing rabbits.

Table (3): Growth performance parameters (X-- + SE) of growing rabbits fed pelleted diets containing different levels of peanut hulls and peanut skins for 8 weeks (from 7-15 weeks of age).

Items	Dietary groups				
	D_1(Control)	D_2	D_3	D_4	D_5
No of rabbits	16	16	16	16	16
Initial live body weight (g)	1067.8 ± 55.4	1081.3 ± 25.8	1065.0 ± 30.3	1080.0 ± 26.7	1090.0 ± 36.7
Final live body weight (g)	2422.5 ± 41.3^b	2668.8 ± 40.9^a	2385.0 ± 74.5^b	2246.3 ± 65.0^c	2402.5 ± 55.4^b
Total weight gain (g)	1354.5 ± 22.9^b	1587 ± 24.1^a	1320 ± 41.4^b	1166.3 ± 34.2^c	1312.5 ± 30.g^b
Daily weight gain (g)	24.19 ± 0.88^b	28.35 ± 0.34^a	23.57 ± 0.14^b	20.83 ± 0.62^c	23.44 ± 0.55^b
Total feed intake (g)	532.0 ± 37.0d	5880 ± 65.0^c	6720.0 ± 93.8^b	6832 ± 76.2^b	7280 ± 53.8^a
Daily feed intake (g)	95.00 ± 4.69d	105.0 ± 5.7^c	120.0 ± 6.71^b	122.0 ± 5.43^b	130.0 ± 3.84^a
Feed conversion (g feed/g gain)	393.0 ± 0.05^e	3.70 ± 0.07^d	5.09 ± 0.13^c	5.86 ± 0.07^a	5.54 ± 0.12^b
Mortality rate (%)	0.00	0.0	6.25	12.50	6.25
Economical efficiency (%)	233	270	182	156	188

* Means in the same row with different letters, differ significantly (P< 0.05).
The price of one tone of the experimental diets, D_1, D_2, D_3, D_4 and D_5 were 610, 584, 558, 532 and 500 Egyptian pounds (LE), respectively. The price of one kilogram of live body weight at selling was 8.0 LE.

2-Nutrients digestibility and feeding values of the experimental diets .

Table 4 shows that feed intake, nutrients digestibility and feeding values of some experimental diets were significantly ($P < 0.05$) affected by dietary inclusion of peanut by-products. Feed intake by rabbits fed Diet 4 or Diet 5 was higher ($P< 0.05$) than those fed the other diets. This indicate that peanut hulls and peanut skin are palatable for rabbits. Apparent digestion coefficients (%) of OM, CP, CF, EE and NFE were the highest ($P< 0.05$) for Diet 2 and the lowest ($P< 0.05$) for Diet 4, with no statistical differences between the other diets. Feeding value of diets expressed as DE, TDN or DCP had the same trend of digestibility of nutrients. The indicated results mean that Diet 2 containing 12% peanut hulls (PH) + 12% berseem hay (BH) as a main source of fibre was the most efficient diet for growing rabbits in this experiment. This result agrees with the obtained results of growth performance (Table 3).

The decrease of nutrients digestibility of Diet 4 may be due to the high content of peanut skins (36%) in this diet, since peanut skin contains high levels of lignin and tannins which impair the digestion of most of nutrients (17, 21, 22). With this respect, many workers (5, 23, 24) showed that the differences in digestion of nutrients among diets are due to the variation in the chemical composition and physical structure of its fibre content. Some variations could be also related to the level of inclusion of ingredients in substitution of the basal diet. The above mentioned results indicate that peanut hulls can be included in the diet up to 12% to replace about 50% of the diet crude fibre without adverse effects on nutrients utilization by growing rabbits. More studies are required to ascertain determination of the optimum level of peanut skin in the diets of growing rabbits .

Table (4): Apparent nutrients digestibility and feeding values (X ± SE) of the experimental diets containing different levels of peanut hulls and peanut skins.

Items	Dietary groups				
	D_1(Control)	D_2	D_3	D_4	D_5
Feed intake g/head/day	128.0 ± 3.44^{b}	123.0 ± 4.4^{bc}	127.89 ± 3.75^{b}	138.38 ± 4.5^{a}	137.89 ± 3.75^{a}
Apparent digestion coefficients (%):					
DM	65.1 ± 1.1^{b}	68.3 ± 0.9^{a}	64.0 ± 1.2^{b}	60.3 ± 0.8^{c}	63.0 ± 1.2^{b}
OM	67.4 ± 0.7^{b}	70.1 ± 1.0^{a}	66.6 ± 1.2^{b}	62.8 ± 1.2^{c}	65.5 ± 1.2^{b}
CP	73.8 ± 0.6^{b}	76.9 ± 0.5^{a}	70.6 ± 1.0^{bc}	65.6 ± 0.8^{cd}	67.5 ± 1.2^{d}
CF	26.8 ± 1.2^{b}	29.3 ± 1.0^{a}	23.5 ± 1.1^{c}	20.6 ± 1.2^{d}	23.5 ± 1.1^{c}
EE	73.7 ± 1.9^{bc}	78.9 ± 2.4^{a}	74.3 ± 1.7^{b}	70.9 ± 1.3	71.3 ± 1.7
NFE	79.7 ± 2.0^{b}	85.8 ± 1.1^{a}	75.1 ± 1.1^{c}	72.5 ± 1.0^{de}	73.1 ± 1.1^{d}
Feeding values (%) :					
DE*	2404 ± 55^{b}	2647 ± 43^{a}	2331 ± 62^{bc}	2301 ± 35^{d}	2297 ± 71^{d}
TDN	54.17 ± 1.5^{b}	58.77 ± 1.3^{a}	53.05 ± 1.6^{bc}	52.04 ± 1.2^{d}	51.84 ± 1.6^{de}
DCP	$11.90 \pm 0.0.3^{b}$	12.53 ± 0.3^{a}	11.37 ± 0.2^{c}	10.51 ± 0.4^{de}	10.93 ± 0.2^{d}

Means in the same row bearing different letters differ significantly (P<0.05)

* DE (Kcal/kg) was calculated according to equation described by **Schiemann et al. (25)**, where, DE (Kcal/kg) = 5.28 (DCP, g/kg) + 9.51 (DEE, g/kg) + 4.2 (DCF +DNFE, g/kg) +0.3

3- Blood serum constituents

Data presented in Table (5) show that dietary treatments had significant effects (P < 0.05) on concentrations of serum total protein, albumin and urea-N, while the levels of the other blood components were statistically similar among the dietary groups. Levels of serum total protein and albumin were lower (P < 0.05), while urea-N level was higher (P < 0.01) in rabbits fed Diet 4 (containing 36% peanut hulls) compared with those fed the control diet. The former blood serum parameters had the opposite trend with rabbits fed Diet 2 (containing 12% PH). The lower levels of serum total protein and albumin and elevation level of urea - N indicate a reduction of protein synthesis in the body. This finding support the finding of decreasing final live body weight and daily weight gain of rabbits fed Diet 4 compared with those fed the other experimental diets (Table 3).

4- Carcass traits

As shown in Table 5, dietary inclusion of peanut by-products had significant effects (P < 0.05) on percentages of carcass and visceral fat weights. Carcass weights (%) tended to be lower (P< 0.05), while visceral fats was higher (P< 0.05) in rabbits fed Diet 4 compared with the control rabbits, with no statistical differences among the other groups. These results indicate that inclusion of 36% of peanut skin in the diet to replace about 50% of the total dietary crude fibre had adverse effects on carcass quality of rabbits.

Table (5): Some blood serum constituents and carcass traits (X--+SE) of growing rabbits fed pelleted diets containing different levels of peanut hulls and peanut skins.

Items	Dietary groups				
	D_1(Control)	D_2	D_3	D_4	D_5
Blood serum constituents:					
Total protein (g/dl)	7.94 ± 0.19^{bc}	8.91 ± 0.19^{a}	8.0 ± 0.12^{b}	$6.37 \pm 0.16d$	7.93 ± 0.18^{c}
Albumin (g/dl)	3.98 ± 0.17^{b}	4.81 ± 0.12^{a}	3.86 ± 0.17^{b}	2.35 ± 0.15^{c}	3.95 ± 0.14^{b}
Globulin (g/dl)	3.96 ± 0.42	4.10 ± 0.27	4.14 ± 0.35	4.05 ± 0.37	4.11 ± 0.35
Total lipids (mg/dl)	396.5 ± 23.11	405.89 ± 33.4	399.09 ± 27.35	411.76 ± 22.11	408.59 ± 24.13
GOT (IU/L)	22.55 ± 1.45	19.90 ± 2.24	20.56 ± 1.69	19.55 ± 1.85	21.68 ± 1.75
GPT (IU/L)	9.95 ± 0.76	10.72 ± 0.85	10.30 ± 0.63	10.45 ± 0.88	9.87 ± 0.84
Urea-N (mg/dl)	22.25 ± 1.09^{b}	21.85 ± 3.07^{b}	23.40 ± 2.87^{b}	31.00 ± 2.20^{a}	33.25 ± 2.75^{a}
Creatinine (mg/dl)	1.23 ± 0.20	1.12 ± 0.16	1.27 ± 0.24	1.18 ± 0.18	1.25 ± 0.15
Carcass traits:					
Live body weight (g)	2408 ± 131.3	2520 ± 165.8	2290 ± 224.7	2220 ± 90.83	2420 ± 135.0
Carcass weight (g)	1233 ± 112.6^{a}	1316 ± 74.4^{a}	1139 ± 117.5^{b}	1032 ± 27.7^{b}	1246 ± 70.9^{a}
(%)	51.13 ± 0.76^{a}	51.63 ± 0.56^{a}	49.72 ± 0.66^{b}	$46.76 \pm 1.11c$	51.5 ± 0.51^{a}
Giblets (g)	102.4 ± 4.39	93.0 ± 18.2	107.6 ± 7.77	110.6 ± 4.28	91.0 ± 6.89
(%)	4.3 ± 0.04	3.7 ± 0.03	4.7 ± 0.06	5.0 ± 0.08	3.8 ± 0.06
Visceral fat (g)	54.7 ± 1.2^{d}	62.8 ± 1.92^{c}	66.8 ± 2.02^{b}	78.2 ± 1.92^{a}	80.2 ± 1.35^{a}
(%)	2.3 ± 0.01^{d}	2.5 ± 0.03^{c}	2.9 ± 0.04^{b}	3.5 ± 0.02^{a}	3.3 ± 0.01^{a}

Means in the same row bearing different letters differ significantly ($P < 0.05$).

On the light of the obtained results it can be concluded that :

1) source of fibre is a main factor in the diet of rabbits and should be taken into account during formulation of the ration to ensure high nutrients utilization .
2) Low-cost rouphages such as peanut hulls may have useful application as an inexpensive source of fibre in the diet of rabbits, However its level should not be higher than 12%. Additional studies are required to determine the optimum level of peanut skins in the diet of growing rabbits.

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