Growth Performance of New Zealand White Rabbits Fed Diets Containing Different Levels of Pea Straw

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Abstract: An experiment was conducted to determine the effects of partial replacing berseem hay (BH) with pea straw (PS) on performance of growing New Zealand White rabbits (NZW). Forty five growing NZW rabbits aged 5-6 weeks with an average weight 741±4.27g were randomly divided into 5 equal groups, 9 for each in 3 replicates and assigned for control diet and 4 experimental diets contained the (PS) which was replaced from (BH) in commercial diet at 0, 25, 50, 75 and 100% (complete replacement). Feeding trial lasted 56 days and animals were fed according to NRC allowances. The tested rations were almost iso caloric and iso nitrogenous. The results showed that, inclusion of PS in the diets lead to significant ($P<0.05$) decreased DM and CP digestibilities compared to control diet, however, OM, CF, EE and NFE digestibilities were significantly ($P<0.05$) improved with replacement BH in control diet (R_1) by PS in tested rations at different levels of replacement (R_2 to R_5). The best digestion coefficients for nutrient were observed when diet contained 20% BH and 20% PS (R_3). Replacement of BH with PS in tested diets at different levels lead to significantly ($P<0.05$) increasing in TDN values, however it significantly ($P<0.05$) decreasing DCP. Nitrogen retention was positive for all experimental groups. Dietary treatments had no significant effect ($P>0.05$) on DM and CP intakes, however it had significant effect ($P<0.05$) on TDN, DE and DCP intakes. Rabbits that received (R_3) revealed the highest values of DM, TDN, CP and DCP intakes (g/day) and DE intake (kcal/d). Feeding rabbits on 20% BH and 20% PS containing diet caused the highest values of final live body weight, total gain and ADG compared to the other groups. Feed conversion that expressed as (g feed intake of DM, TDN, CP and DCP/ g gain) were improved when BH replaced with PS at different levels. Dietary treatment in significantly ($P>0.05$) increased blood plasma of alkaline phosphatase compared to the control diet; meanwhile, (AST) and (ALT) were in the same trend. However, total cholesterol significantly ($P<0.05$) decreased. On the other hand, total protein and albumin were increased in tested rations compared to the control diets. There were no significant differences among groups on all carcass measurements. Net revenue was improved by 15.3, 36.7, 19.7 and 28.7% for R_2, R_3, R_4 and R_5, respectively compared to the control diet (R_1). Generally, replacement of BH with PS in growing rabbits improved ADG, feed conversion and decreased feeding cost, consequently improved relative economical efficiency. The results also indicated that, Pea straw could be used up to 50% in growing rabbit diets in place of the most conventional ingredients (berseem hay) without any adverse effect on productive performance.

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1. Introduction

In Egypt, shortage in animal feeds has been found to have a negative effect on the development of animal and poultry production. More attention was given to agricultural by-products (El-Ashry, *et al.,* 2002). Clover hay considered the main ingredient forage in rabbit diets (Radwan and Khalil, 2002).

Rabbits have high ability to consume forage and agricultural by-products containing high levels of fiber (Cheeke, 1986). There are about 35 million tons of plants by-products annually produced that can be used in animal, rabbits and poultry diets (El-Manylawi *et al.,* 2005).

Dietary fibers are the main constituent of a rabbit feed and, depending of the analytical technique also, sufficient dietary fiber supply is essential to prevent digestive troubles in growing rabbits (Chao and Li, 2008).

The agricultural policy in Egypt aimed to increase the area cultivated by strategically crops on behalf of that cultivated by berseem. At the same time, several crops such as pea are cultivated in the newly reclaimed lands. So, significant amount of the straw of this crop is produced annually as residues (about 13 thousand tons from pea straw, AIEG, 2005). On the other hand, several researches have shown that this straw had considerable amounts of nutrients that of suitable digestibilities (Abdel-Magid, 2005).

Therefore, this work was carried out to investigate the effect of partial or complete replacement of berseem hay in commercial diet with pea straw on growth performance, nutrient digestibilities, nutritive values, some blood constituents and carcass quality of growing New Zealand White (NZW) rabbits. In addition to the economical efficiency of the experimental diets.

2. Materials and Methods

Forty five growing New Zealand White (NZW) rabbits aged 5-6 weeks with an average weight 741±4.27g were kept under the same managerial and hygienic conditions. Rabbits were randomly divided into 5 equal groups, 9 for each in 3 replicates and assigned for control diet and 4 experimental diets contained the pea straw (PS) which were replaced from berseem hay (BH) in commercial diet at 0, 25, 50, 75 and 100% (complete replacement). All rabbits were housed individually in galvanized wire hutches of rabbit batteries.

Diets (on pellets form) and fresh water were available all times *ad lib.* during the experimental period that lasted 8 weeks. Live body weight of rabbits and feed consumption were weekly recorded. Feed conversion ratio was calculated as (g feed intake/ g gain).

At the last week of experimental period, a digestibility trial was carried out over a period of 7 days. Six rabbits from each group were housed individually in metabolism cages. Feces and urine were daily collected quantitatively during the collection period before feeding at 8:30 a.m. Feed intake of experimental rations and weight of feces and urine volume were daily recorded. Representative samples of 10% of total fresh weight of feces was sprayed with solution of 10% sulfuric acid and 10% formaldehyde and oven dried at 60°C for 48 hrs and composite samples of dried feces were ground and stored for later chemical analysis.

At the end of the experimental period, four representative rabbits from each treatment were randomly chosen and fasted for 12 hours before slaughtering according to Blasco *et al.* (1993) to determine the carcass traits.

Blood samples were also taken from the slaughtered rabbits and centrifuged at 4000 r.p.m. for 20 min., for preparation of blood plasma. Plasma was kept frozen at –18 °C for subsequent analysis. Plasma total protein was determined according to Armstrong and Carr, 1964; albumin according to Doumas *et al.* (1971); total cholesterol according to Pisani *et al.* (1995); alkaline phosphates activity was measured according to the method of Beliefield and Goldberg (1971); AST and ALT according to Harold (1975) using commercial kits. Globulin and albumin: globulin ratio (A: G ratio) were calculated.

Chemical analysis of ingredients, experimental rations, feces and urine were analyzed according to A.O.A.C (2000) methods. Cell wall constituents {Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL)} were also determined in the ingredients and experimental rations according to Goering and Van Soest (1970). Hemicellulose was calculated as the difference between NDF and ADF, while cellulose was calculated as the difference between ADF and ADL.

Gross energy (kcal/kg DM) was calculated according to Blaxter (1986), where each g CP = 5.65 kcal, g EE = 9.40 kcal and g (CF & NFE) = 4.15 kcal. On the other hand, Digestible energy (DE), M cal was calculated according to NRC (1977), where DE (Mcal/kg DM) = TDN, kg x 44.3.

Economical efficiency (%0 of experimental diets was calculated according to the local market price of ingredients and rabbit live body weight as following:
Net revenue= Total revenue – Total feed cost.
Economical efficiency (%) = Net revenue / Total feed cost %.

Chemical analysis and cell wall constituents of feed ingredients are presented in Table (1), while composition, chemical analysis and cell wall constituents of the experimental rations have been done according to the Nutrient Requirements Council of growing rabbits NRC (1977) as shown in Table (2).

Collected data of digestibility, nutritive values, nitrogen balance, feed intake, daily gain, feed conversion, blood constituents and carcass were subjected to statistical analysis as one way analysis of variance using the general linear model procedure of SPSS (1998). Duncan's Multiple Range Test (1955) was used to separate means when the dietary treatment effect was significant according to the following model: $Y_{ij} = \mu + T_i + e_{ij}$
Where: Y_{ij} = observation
μ = the overall mean,
T_i = the effect of treatment levels for i =1 to 5, 1= control ration contained 40% BH and 0 % PS, 2= 30% BH and 10 % PS, 3 = 20% BH and 20 % PS, 4= 10% BH and 30% PS and 5 = 0% BH and 40 % PS.
e_{ij} = the experimental error.

3. Results and Discussion

Composition, chemical analysis and cell wall constituents

Chemical analysis and cell wall constituents of feed ingredients are shown in Table (1). The results revealed that (PS) contained 12.70% CP, 29.51% CF, 2.44% EE, 44.03% NFE, 11.32% Ash, 53.82% NDF, 42.64% ADF, 13.11 % ADL, 11.18%, hemicellulose 29.53% cellulose and 20.72% NFC. These values are generally within the published range of many authors (Awadalla and Mohamed, 1997; El Sayed *et al*., 1999 and Abdel-Magid, 2005). In general, the chemical analysis of any feedstuff still the preliminary indicator on the possibility of using such material in feeding livestocks, but the final evaluation can't obtained without more information through digestibility trials and determining the feeding values of this feedstuff.

Composition, chemical analysis and cell wall constituents of the experimental rations are presented in Tables (2). The results showed that PS replaced 0, 25, 50, 75 and 100% of BH. Experimental rations were formulated to be almost iso caloric and iso nitrogenous to meet the rabbit's nutrient requirements for growth (NRC, 1977).

The rations were contained 16.43, 16.39, 16.35, 16.31 and 16.00% CP for R_1, R_2, R_3, R_4 and R_5, respectively. The corresponding ether extract contents were 3.33, 3.18, 3.03, 2.88 and 2.73% for the same three experimental rations. Replacement BH by PS in the rations decreased hemicellulose content while, increased cellulose content of experimental rations.

Table (1): Chemical analysis and cell wall constituents of feed ingredients

Item	Ingredients					
	Yellow corn	Barley	Soybean meal	Wheat bran	Berseem hay	Pea straw
DM	89.12	89.60	90.63	89.53	91.26	94.40
Chemical analysis on DM basis						
Organic matter	98.54	97.19	93.69	89.68	85.74	88.68
Crude protein	9.15	11.83	44.00	14.25	13.11	12.70
Crude fiber	2.32	8.35	6.54	8.42	26.30	29.51
Ether extract	4.03	2.05	2.56	4.05	3.95	2.44
Nitrogen free extract	83.04	74.96	40.59	62.96	42.38	44.03
Ash	1.46	2.81	6.31	10.32	14.26	11.32
NFC*	52.80	39.16	11.40	29.76	19.52	20.72
Cell wall constituents						
NDF	32.56	44.15	35.73	41.62	49.16	53.82
ADF	22.83	7.16	26.82	10.33	22.23	42.64
ADL	2.30	1.83	7.63	6.95	10.43	13.11
Hemicellulose**	9.73	36.99	8.91	31.29	26.93	11.18
Cellulose***	20.53	5.33	19.19	3.38	11.80	29.53

* NFC: Non fibrous carbohydrates, calculated according to Calsamiglia *et al.* (1995) using the following equation:
NFC= 100 – {CP + EE + Ash + NDF}. NDF: neutral detergent fiber. DF: acid detergent fiber. ADL: acid detergent lignin.
** Hemicellulose = NDF – ADF. *** Cellulose = ADF- ADL.

Table (2): Composition, chemical analysis and cell wall constituents of the experimental rations

Item	Experimental rations				
	R_1	R_2	R_3	R_4	R_5
Composition of the experimental rations					
Yellow corn	15	15	15	15	15
Barley grain	16	16	16	16	16
Soybean meal	13	13	13	13	13
Wheat bran	12	12	12	12	12
Berseem hay (BH)	40	30	20	10	-
Pea straw (PS)	-	10	20	30	40
Sodium chloride	0.5	0.5	0.5	0.5	0.5
Limestone	1.0	1.0	1.0	1.0	1.0
Di-Ca-Phosphate	1.8	1.8	1.8	1.8	1.8
DL-Methionine	0.2	0.2	0.2	0.2	0.2
Premix*	0.5	0.5	0.5	0.5	0.5
Price, L.E/Ton	2108	2038	1968	1898	1828
Chemical analysis on DM basis					
Dry matter	90.61	90.93	91.24	91.56	91.87
Organic matter	87.87	88.16	88.46	88.74	89.04
Crude protein	16.43	16.39	16.35	16.31	16.00
Crude fiber	14.07	14.39	14.71	15.03	15.35
Ether extract	3.33	3.18	3.03	2.88	2.73
Nitrogen free extract	54.04	54.20	54.37	54.52	54.96
Ash	12.13	11.84	11.54	11.26	10.96
GE (kcal/kg DM)**	4068	4078	4075	4080	4079
DE (Mcal/kg DM)***	2.693	2.714	2.893	2.825	2.772
Cell wall constituents					
NDF	41.23	41.70	42.16	42.64	43.10
ADF	18.19	20.23	22.28	24.31	26.36
ADL	6.63	6.90	7.17	7.43	7.70
Hemicellulose	23.04	21.47	19.88	18.33	16.74
Cellulose	11.56	13.33	15.11	16.88	18.66

* Premix: Each kilogram of premix contains: 2000.000 IU Vit. A, 150.000 IU Vita. D, 8.33 g Vit. E, 0.33 g Vit. K, 0.33 g Vit. B_1, 1.0 g Vit. B_2, 0.33g Vit. B_6, 8.33 g Vit.B_5, 1.7 mg Vit. B_{12}, 3.33 g Pantothenic acid, 33 mg Biotin, 0.83g Folic acid, 200 g Choline chloride, 11.7 g Zn, 12.5 g Fe, 16.6 mg Se, 16.6 mg Co, 66.7 g Mg and 5 g Mn.
** GE: Gross energy (kcal/kg DM) was calculated according to Blaxter (1986). Each g CP = 5.65 kcal, g EE = 9.40 kcal and g (CF & NFE) = 4.15 kcal.
*** Digestible energy: DE (M cal) was calculated according to NRC (1977). Where DE (Mcal/kg DM) = TDN, kg x 44.3

Nutrient digestibility and nutritive values of the experimental diets

Digestion coefficients of OM, CP, CF, EE and NFE for different experimental diets are presented in Table (3). The data showed that inclusion of PS in the diets lead to significant (P<0.05) decreased DM and CP digestibilities compared to control diet that not contained PS. However, OM, CF and NFE digestibilities were significantly (P<0.05) improved with replacement BH in control diet (R_1) by PS in tested rations at different levels of replacement (R_2 to R_5). The best digestion coefficients for nutrient were observed when diet contained 20% BH and 20% PS (R_3). These results are in agreement with those found by El Sayaad *et al.* (1996); Abdel-Magid (1997); Abdel-Magid (2005) and El-Medany *et al.* (2008) they found that, digestibility coefficients were in the same trend approximately. Sandford (1957) noted that CF is the most important factor, which affects the digestibility of any feeding stuff for rabbits because it tends to protect the more digestible constituents from the digestive juices.

Table (3): Nutrient digestibilities and nutritive values of the experimental rations

Item	Experimental rations					SEM
	R_1	R_2	R_3	R_4	R_5	
Nutrient digestibilities coefficient						
DM	90.62^a	87.77^d	89.81^b	88.71^c	87.62^d	0.23
OM	66.15^d	66.55^d	71.05^a	69.45^b	67.58^c	0.35
CP	63.88^a	56.77^e	62.07^b	60.52^c	58.04^d	0.50
CF	38.50^d	42.17^c	56.50^a	54.61^{ab}	53.57^b	1.39
EE	62.30^{ab}	61.30^b	64.70^a	59.83^b	54.21^c	0.75
NFE	74.39^c	76.35^b	78.05^a	76.72^b	74.93^c	0.26
Nutritive values						
TDN%	60.78^d	61.27^d	65.31^a	63.78^b	62.58^c	0.32
DCP%	10.50^a	9.30^d	10.15^b	9.87^c	9.29^d	0.09
DE (Mcal/kg DM)*	2.693^d	2.714^d	2.893^a	2.825^b	2.772^c	0.014

a, b, c, d and e: Means in the same raw having different superscripts differ significantly at level (P<0.05).
SEM, standard error of the mean
*Digestible energy: DE (M cal) was calculated according to NRC (1977). Where DE (Mcal/kg DM) = TDN, kg x 44.3

Nutritive values of the different experimental diets are shown in Table (3). The data revealed that replacement of BH in control diet (R_1) with PS in tested diets at different levels (R_2 to R_5) caused significantly (P<0.05) increasing in TDN of the tested diets, however it caused significantly (P<0.05) decreasing in DCP for the same experimental diets. This decreasing in DCP value may be related to decrease CP digestibility. The TDN values were ranged from 60.78 to 65.31%, while DCP values were ranged from 9.29 to 10.50%. Also, the highest TDN value (65.31%) was observed when PS replaced 50% of BH (R_3). On the other hand the lowest DCP value (9.29%) was noticed in the diet that complete replacement of BH wit PS (R_5). Values of calculated DE were in parallel to the determined TDN values. The highest value of DE (2.893 Mcal) was obtained by the animals that fed diet replaced 50% of BH with PS (R_3). These results of nutritive value as TDN, DCP and DE are in agreement with those noted by Tag El-Din *et al.* (2002); Abdel-Magid (2005) and El-Medany *et al.* (2008).

Nitrogen utilization by the experimental groups

Results given in Table (4) showed that, dietary treatment had significant effect on nitrogen utilization by the experimental groups. Nitrogen retention was positive for all experimental groups indicating the adequacy of protein content of different experimental diets. Nitrogen retained (g/day) ranged from 0.67 to 0.79. Rabbits that received diet contained 20% BH and 20% PS ($R_{3)}$ realized the highest value of nitrogen retention (0.79 g) and the highest value of nitrogen retention as percentage of nitrogen intake (26.78%) compared to the other diets. These results may be related to increase nitrogen intake by the rabbits that fed on the third experimental ration (R_3). These results are in agreement with that noticed by El-Adawy and Borhami (2001); Abdel-Magid (2005) and Abou Sekken *et al.* (2008).

Growth performance of the experimental groups

Growth performance of the experimental groups is presented in Table (5). The results cleared that, dietary treatments had significant effect (P<0.05) on final live body weight (FLBW), total gain (TG) and average daily gain (ADG) among the different experimental groups. FLBW, TG and ADG ranged from 1860 to 2028 g; from 1115 to 1293g and from 19.91to 23.09 g, respectively. Feeding rabbits on 20% BH and 20% PS containing diet (R_3) realized the highest values of FLBW, TG and ADG compared to the other groups. These results are in the same trend with those obtained by Gad Alla (1997); Mohamed (1999); El-Adawy and Borhami (2001); Tag El-Din *et al*. (2002), Abdel-Magid (2005) and Omer *et al.* (2011). They noted that, replacing berseem hay by carrot-tops, strawberry by-products, peanut hay, kidney beans or pea straws significantly improved the growth performance of growing rabbits than those fed the control diet. Dietary treatments had no significant effect (P>0.05) on DM and CP intakes, however it had significant effect (P<0.05) on TDN, DE and DCP intakes.

Table (4): Nitrogen utilization by the experimental groups

Item	Experimental rations					SEM
	R_1	R_2	R_3	R_4	R_5	
Nitrogen intake, g (NI)	2.73^{bc}	2.56^{c}	2.95^{a}	2.79^{ab}	2.58^{c}	0.039
Fecal nitrogen, g (FN)	0.99^{b}	1.11^{a}	1.12^{a}	1.10^{a}	1.08^{a}	0.015
Urinary nitrogen, g (UN)	1.04^{a}	0.78^{c}	1.04^{a}	0.94^{b}	0.81^{c}	0.022
Total nitrogen excretion, g	2.03^{a}	1.89^{b}	2.16^{a}	2.04^{a}	1.89^{b}	0.028
Digestible nitrogen, g (DN)	1.74^{ab}	1.45^{c}	1.83^{a}	1.69^{b}	1.50^{c}	0.031
Nitrogen retention, g (NR)	0.70^{bc}	0.67^{c}	0.79^{a}	0.75^{ab}	0.69^{c}	0.011
NR, % of NI	25.64^{c}	26.17^{b}	26.78^{a}	26.76^{a}	26.77^{a}	0.093
NR, % of DN	40.23^{d}	46.21^{a}	43.17^{c}	44.38^{b}	46.00^{a}	0.416

a, b, c and d: Means in the same raw having different superscripts differ significantly at level (P<0.05).
SEM: standard error of the mean.

Table (5): Growth performance of the experimental groups

Item	Experimental rations					SEM
	R_1	R_2	R_3	R_4	R_5	
No. of rabbits	9	9	9	9	9	-
Initial weight, g	745	740	735	743	742	4.27
Final weight, g	1860^{d}	1927^{bc}	2028^{a}	1910^{cd}	1944^{bc}	11.31
Gain, g	1115^{c}	1187^{b}	1293^{a}	1167^{b}	1202^{b}	10.85
Experimental duration, days	56	56	56	56	56	-
Average daily gain (g/day)	19.91^{c}	21.20^{b}	23.09^{a}	20.84^{bc}	21.46^{b}	0.20
Feed intake as:						
Dry matter (DM), g/d	81.6	82.6	84.4	81.9	82.9	1.13
Total digestible nutrient (TDN), g/d	49.6^{b}	50.6^{ab}	55.1^{a}	52.2^{ab}	51.9^{ab}	0.77
Digestible energy (DE) , kcal/d	220^{b}	224^{ab}	244^{a}	231^{ab}	230^{ab}	3.34
Crude protein (CP), g/d	13.4	13.5	13.8	13.6	13.3	0.18
Digestible crude protein (DCP), g/d	8.57^{a}	7.68^{b}	8.57^{a}	8.08^{ab}	7.70^{b}	0.12
Feed conversion (g intake /g gain) of						
DM	4.10^{b}	3.90^{ab}	3.66^{a}	3.93^{ab}	3.86^{ab}	0.063
TDN	2.49	2.39	2.39	2.50	2.42	0.039
CP	0.67^{b}	0.64^{ab}	0.60^{a}	0.65^{ab}	0.62^{ab}	0.010
DCP	0.43^{b}	0.36^{a}	0.37^{a}	0.39^{ab}	0.36^{a}	0.007

a, b, c and d: Means in the same raw having different superscripts differ significantly at level (P<0.05).
SEM: standard error of the mean.

Rabbits that received (R_3) recorded the highest values of DM, TDN, CP and DCP intakes (g/day) and DE intake (kcal/d). These results are in agreement with those noted by El-Adawy and Borhami (2001); Tag El-Din *et al.* (2002) and Abdel-Magid (2005). They observed that, rabbits fed diet containing peanut hay, kidney beans or pea straws instead of berseem hay had the higher daily feed consumption. In contrast El-Kerdawy *et al.* (1992); Abd El-Hamid (1998) and El- Gendy *et al.* (2002) noticed that, DM intake decreased with increasing the level of carrot tops, sorghum grass, kidney beans straw and sweet lupin forage.

Also, the data of feed conversion expressed as (g feed intake of DM, TDN, CP and DCP/ g gain) are shown in Table (5) showed that, feed conversion was improved by replacement BH in control diet (R1) with PS at different levels of replacement (R_2 to R_5). Feed conversion of (R_3) was improved by 10.73% approximately compared to control ration (R_1). These results are in the same trend with those obtained by Gad Alla (1997) who stated that feed conversion was improved by incorporation of sun dried crops and vegetable residues up to 50 or 75%. Also, these results are in agreement with those found by Abdel-Magid (2005) and El-Medany *et al.* (2008) and Omer *et al.* (2011). They replaced berseem hay with pea, chick pea or kidney beans straws; dried carrot processing waste or strawberry by-products, in growing rabbit diets.

Blood plasma constituents of the experimental groups

The results of blood plasma constituents as affected by replacement of BH in control ration (R_1) with different levels of PS in tested diets (R_2 to R_5) in growing New Zealand White rabbit diets (Table 6) indicated that, alkaline phosphatase in significantly (P>0.05) increased compared to control diet. But asparrtate amino transferase (AST) and alanine amino transferase (ALT) were in the same trend with the control diet. However, total cholesterol significantly (P<0.05) decreased. On the other hand, blood plasma total protein and albumin were increased in tested rations compared to the control diets. The values ranged from 6.62 to 6.92 g/dl for total protein; 3.65 to 3.79 g/dl for albumin; from 3.00 to 3.15 g/dl for globulin; from 77.0 to 97 mg/dl for total cholesterol; from 37.7 to 41.1 U/L for alkaline phosphatase; from 24 to 26 U/L for AST and from 14 to 16 U/L for ALT, respectively. These results in the same trend approximately with those noted by Abdel-Magid (1997); Gad Alla (1997); Mohamed (1999); El-Sayed *et al.* (1999); Tag El-Din *et al.* (2002); Abdel-Magid (2005); Abou Sekken *et al.* (2008) and El-Medany *et al.* (2008).

Table (6): Blood plasma constituents of the experimental groups

Item	Experimental rations					SEM
	R1	R2	R3	R4	R5	
Total protein, g/dl	6.63b	6.75b	6.92a	6.68b	6.62b	0.031
Albumin, g/dl	3.67bc	3.72b	3.79a	3.71bc	3.65c	0.014
Globulin, g/dl	3.08b	3.11ab	3.15a	2.98c	3.00c	0.016
Albumin / globulin ratio	1.19d	1.20bcd	1.20bcd	1.24a	1.22abc	0.005
Total cholesterol, mg/dl	97a	93a	85b	80bc	77c	1.910
Alkaline phosphatase, U/L	37.7	39.4	39.7	40.5	41.1	0.574
AST, U/L*	26	25	24	26	25	0.610
ALT, U/L**	14	14	15	16	15	0.451

a, b, c and d: Means in the same raw having different superscripts differ significantly at level (P<0.05).
SEM: standard error of the mean. *AST: Aspartate amino transferase. **ALT: Alanine amino transferase.

Carcass characteristics of the experimental groups

Carcass traits and dressing percentage results are shown in Table (5). The results indicate that, there were no significant differences between the levels of PS that used in this experiment and control group in all measurement of carcass characteristics. These results indicated that PS could be incorporated in rabbit diets without any adverse effects on carcass characteristics measurements. These results were in harmony with those obtained by El-Adawy and Borhami (2001); El-Gendy *et al.* (2002); Abdel-Magid (2005); El-Medany *et al.* (2008) and Omer *et al.* (2011), they noted that feeding growing rabbits diets replaced clover hay with pea, chick pea or kidney beans straws, peanut hay; dried carrot processing waste or strawberry by-products had no significant differences in dressing percentages.

Table (7): Carcass characteristics of the experimental groups

Item	Experimental rations					SEM
	R_1	R_2	R_3	R_4	R_5	
Animal No.	4	4	4	4	4	-
Slaughter weight (SW), g	1800	1810	1830	1835	1840	13.22
Inedible offal's, g[1]	450	453	458	459	460	3.34
Giblets (edible offal's),g [2]	70.2	70.6	71.4	71.6	71.8	0.51
Hot carcass weight, g (HCW)	1010	1014	1026	1029	1032	7.42
Hot carcass weight + edible offal's	1080	1085	1097	1101	1104	7.92
Digestive tract weight, g						
Full	270	272	275	275	276	1.98
Empty	115	116	117	118	118	0.83
Digestive tract contents weight, g	155	156	158	157	158	1.16
Empty body weight, g (EBW)[3]	1645	1654	1672	1678	1682	12.09
Dressing percentages						
HCW/SW	56.11	56.02	56.07	56.08	56.09	0.011
HCW/EBW	61.40	61.31	61.36	61.32	61.36	0.024
HCW + edible offal's/EBW	65.65	65.60	65.61	65.61	65.64	0.009

[1] Inedible offal's include fur, head, ears, legs and tail weight.
[2] Giblets (edible offal's) include liver, heart and kidneys weights.
[3] Empty body weight (EBW) = Slaughter weight – digestive tract contents.

Economical evaluation of the experimental groups

The economical efficiency of dietary treatments are presented in Table (8) The profitability of using PS depends on upon the price of BH and the growth performance of rabbits fed these dietary waste. The total feed cost was reduced by 2.44%, 4.14%, 10.53% and 13.06%, respectively for tested rations (R_2 to R_5) that replaced PS at levels of (25, 50, 75 and 100%) from BH in control diet (R_1).

Inclusion PS in the rabbit diets improved net revenue by 15.3, 36.7, 19.7 and 28.7% for R_2, R_3, R_4 and R_5, respectively, compared with the control diet (R_1). Also, relative economic efficiency was improved by 15.8, 39.5, 23.7 and 34.2%, respectively, for the same tested diets compared to the control diet. The highest net revenue was realized by replacement BH in control diet with 50% PS (R_3). The relative low price of PS as compared with that BH made using this by-product in rabbit diets a feasible and a promising feed. These results in agreement with those reported by Abdel-Magid (2005); Abou Sekken *et al.* (2008); El-Medany *et al.* (2008) and Omer *et al.* (2011). They observed that inclusion pea, chick pea or kidney beans straws; peanut hay; fennel and marjoram waste; dried carrot processing waste or strawberry by-products to partially or completely replacement of berseem hay contributed in lowering the feeding cost and hence increasing the economic efficiency.

Table (8): Economical evaluation of the experimental groups

Item	Experimental rations				
	R_1	R_2	R_3	R_4	R_5
Live body weight (LBW), kg	1.860	1.927	2.028	1.910	1.944
Feed consumed for each rabbit, kg	5.043	5.087	5.180	5.009	5.053
Costing of one kg feed, (LE)[1]	2.11	2.04	1.97	1.90	1.83
Total feed cost, (LE)	10.64	10.38	10.20	9.52	9.25
Management / Rabbit, (LE)[2]	4	4	4	4	4
Total cost, (LE)[3]	29.64	29.38	29.20	28.52	28.25
Total revenue, (LE)[4]	40.92	42.39	44.62	42.02	42.77
Net revenue	11.28	13.01	15.42	13.50	14.52
Economical efficiency[5]	0.38	0.44	0.53	0.47	0.51
Relative economic efficiency[6]	100	115.8	139.5	123.7	134.2
Feed cost / kg LBW (LE)[7]	5.72	5.39	5.03	4.98	4.76

[1] Based on prices of year 2013.
[2] Include medication, vaccines, sanitation and workers.
[3] include the feed cost of experimental rabbit which was LE 15/ rabbit + management.
[4] Body weight x price of one kg at selling which was LE 22. [5] net revenue per unit of total cost (Khial, 1997).
[6] Assuming that the relative economic efficiency of control diet equal 100.
[7] Feed cost/kg LBW = feed intake * price of kg / Live weight.
LE = Egyptian pound equals 0.15 USS approximately.

4. Conclusion

Under the conditions of this experiment, the results indicated that, pea straw could be used up to 50% in growing rabbit diets in place of the most conventional ingredients (berseem hay), or incorporated pea straw at 20 % of growing rabbit diets, achieved a better results of growth, carcass, digestibility and economic efficiency without any adverse effect on productive performance of growing rabbits.

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