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NUTRITIONAL AND BIOLOGICAL EVALUATION OF *PORTULACA OLERACEA* (PURSLANE) AS UNTRADITIONAL PROTEIN SOURCE IN FEEDING GROWING RABBITS.

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SUMMARY

Eighty males and females weanling New Zealand White rabbits at five week old were used to evaluate the effect of substitution of dried whole *Portulaca oleracea* (Purslane) at the levels 0, 10, 20 and 30% on the expense of soybean meal as source of protein in rabbits diet on growth performance, digestibility of nutrients, carcass traits, some blood constituents, liver and kidney functions and immunity. The results indicated that final body weight, daily weight gain and growth rate were significantly higher by 12.57, 19.34 and 5.14 %, respectively. Daily feed intake was significantly increased from 102.75 to 117.30 g/ day when *Portulaca oleracea* (P.O.) induced in the diets at the level of 20 %. The best feed conversion was recorded by rabbits fed diet substituted with 20% P.O. Growing rabbits could be fed 20 % P.O, on the expense of soybean meal without any adverse effects and realize the best values of growth performance, digestibility coefficients, carcass traits, globulin level and immune response. Economical efficiency and the relative economical efficiency were also improved with such level of P.O.

Key words: rabbits, Portulaca oleracea, growth performance.

INTRODUCTION

The increasing cost of imported feed ingredients has prompted animal nutritionists and feed processors to focus their attention on non-conventional feed sources. Soybean meal is frequently used as protein source in rabbit diets. However, Gutiérrez *et al.*, 2003 and García-Ruiz *et al.*, 2006 found that animals fed a diet based on soybean meal had a higher mortality than those fed sunflower meal-based diet and concluded that sunflower meal is preferred than soybean meal in the starter diet of rabbits in order to minimize digestive disorders. Earlier studies indicated that expensive and imported feedstuffs can be substituted with local feedstuffs containing suitable level of protein. *Portulaca oleracea* (P.O.), family Portulacaceae, commonly known as purslane in the U.S.A is an herbaceous weed. This plant is growing wild and/or cultivated in Egypt as well as several parts of the world. *Portulaca oleracea* contains many biologically active compounds and is a source of many nutrients. The plant is known infolk medicine in some parts of China as hypotensive and antidiabetic (Meng and Wu, 2008). *Portulaca oleracea* contains many compounds,

including free oxalic acids, alkaloids, omega-3 fatty acids, coumarins, flavonoids, polysaccharide, cardiac glycosides, and anthraquinone glycosides (Mohammad *et al.*, 2004). Polysaccharide from P.O has been studied for their physiological and pharmaceutical activities. It has high contents of Omega-3 fatty acids and protein compared to the other vegetables (Ezekwe, *et al.* 1999). They reported that the fatty acid and ß-carotene contents of the Australian varieties of P.O were ranged from 1.5 to 2.5 mg/g of fresh mass in leaves, 0.6 to 0.9 mg/g in stems and 80 to 170 mg/g in seeds. The ß-carotene content ranged from 22-to-30 mg/g fresh mass in leaves. Longer-chain omega-3 fatty acids were not detected (Liu *et al.*, 2000). The a-Linolenic acid (C18:3 ? 3) accounted for around 60% and 40% of the total fatty acid content in leaves and seeds, respectively. A water-soluble anionic, low molecular weight polysaccharide (gum) with surface, interfacial, and emulsification properties was extracted from leaves of P.O. and named *Portulaca oleracea* gum (POG). *Portulaca oleracea* gum is regarded as a good example of a new gum that can be considered as a food emulsifier (Garti *et al.*, 1999 a, b). The plant has been used as vegetable and for medicinal purpose from hundreds years ago. Purslane has been used as antibacterial, antidiabetic, antifungal, anti-inflammatory, diuretic and analgesic activity (Chan *et al.*, 2000). No data on the toxicity of P.O. has been found in the literature. Rabbit needs ration with high fiber content. The protein and fiber content of *Portulaca oleracea* are relatively high.

The aim of this study was to evaluate dried whole *Portulaca oleracea* (Purslane) as an alternative crude protein source of soybean meal in terms of growth performance, digestibility of nutrients, carcass traits, blood constituents, liver and kidney functions and immunity titer in growing rabbits.

MATERIALS AND METHODS

The present study was carried out at Sakha Animal Production Research Station, Animal Production Research Institute, Agriculture Research Center, Egypt from Augusts to October, 2009. This work was carried out through the project funded by the Council of Agricultural Research and Development.

Preparation of Portulaca Oleracea (P.O):

The whole *Portulaca oleracea* (Purslane) was daily collected in fresh form from a special farm (area of Kafr El Sheikh government), and immediately dehydrated at 50°C temperature for 72 hours in an electric oven then ground in hummer mill, well mixed and was stored in plastic bags.

Biological Evaluation of Portulaca Oleracea:

First experiment:

Twenty male rabbits at twelve weeks of age were used in this experiment to evaluate the digestibility and nutritive value of dried *Portulaca oleracea* (P.O.). The rabbits were reared in individual metabolic cages which allowed separation of faeces and urine. The rabbits were given water and dried P.O. only ad libitum for three days pre-experimental. Feed intake was recorded and excreta was collected over the following five days. The

excreta samples were dried and ground. Total digestible nutrients (TDN), digestible crude protein (DCP) and digestible energy (DE) were calculated as described by Perez et al. (1995).

Second experiment:

A total number of eighty males and females weanling New Zealand White (NZW) rabbits of five weeks of age were individually housed in open house and assigned at random to four groups of 20 rabbits each (10 males and 10 females). Rabbit were housed individually in cages with slatted floor of iron (45 × 45 × 38 cm) for length, width and high, respectively. Four pelleted diets were formulated to contain 0, 10, 20 and 30% dried P.O in the expense of soy been meal in diets. All diets were nearly iso- nitrogenous of about 17% CP, iso-caloric of about 2375 Kcal DE and contained nearly similar levels of micro-elements. All experimental diets were formulated to contain adequate levels of nutrients for growing NZW rabbits as recommended by NRC, (1994). The formulation and chemical composition of the experimental diets are given in Table (1). Feed and water were offered *ad libitum* throughout the experimental from 5 to 12 weeks of age. Live body weight (LBW) and daily feed intake (DFI) were recorded for rabbits biweekly and daily weight gain (BWG), relative growth rate (RGR), feed conversion (FC) values (feed, g/gain, g) and viability rate were calculated at the end of the feeding trial. Digestibility trial was carried out at the end of the growth experiment using five males per diet to determine the nutrient digestibility coefficients of experimental diets. Rabbits were housed individually in metabolic cages, which allowed separation of faeces and urine. Faeces were collected individually during five consecutive days according to the European reference method for rabbit's digestion trials (Perez *et al.*, 1995).

Analytical Methods:

Chemical analysis was carried out for dried P.O, soybean meal, diets and hard faeces according to methods of AOAC (1995). At 12 weeks of age, four male and four female rabbits each group were used to determine total protein, albumin, total lipids and total cholesterol which determined according to (Gornal *et al.* 1949), Doumas (1971), Trinder, (1969) and Zollner and Kirsch (1962), respectively. The total globulin values each treatment were randomly taken, fasted for 12 hours, weighed and slaughtered to estimate some of carcass traits. Blood samples were taken from four males and four females were calculated by subtracting the values of total albumin from the values of total protein for each sample. Aspartate aminotransferase (AST), alanine aminotransferase (ALT), creatinine and urea were determined by kits from Bio Merieux (France) according to the procedure outlined by the manufacturer. At the 3rd week of the experiment, each rabbit was injected i.m. with 0.5 ml of sheep RBCs suspension in phosphate-buffer saline containing 10 ^{9} cells/ml. A booster dose was given two weeks after the initial one. Blood was collected from the ear vein two weeks following the booster dose. Hemagglutination titer test (HA) was performed as a measure of humoral immunity according to Sanders *et al.* (1982). Serum was inactivated by heating and serial dilution was made in phosphate-buffer saline. An equal 0.5 ml suspension of RBCs was added to each dilution in a micro titer dish and the hemagglutination titer was determined. The purpose of performing this test is to examine the impact of feeding dried P.O. on the immune response.

Table (1): Formulation and chemical composition of experimental diets.

Items	Experimental diets			
	Control	10 %	20 %	30 %
Ingredients:	Diet 1	Diet 2	Diet 3	Diet 4
Barseem hey	30.00	29.60	28.70	28.20
Barley	18.60	24.00	28.20	33.30
Wheat bran	31.25	20.80	12.55	02.70
Soybean meal	14.65	10.00	04.90	00.00
Portulaca oleracea	00.00	10.00	20.00	30.00
Molasses	03.00	03.00	03.00	03.00
Dicalcuim Phosphate	00.45	01.00	01.20	01.50
Limestone	01.35	00.75	00.40	00.00
DL-Methionine	00.20	00.25	00.30	00.35
Lysine	00.00	00.10	00.25	00.45
Vit. and Min. premix [1]	00.30	00.30	00.30	00.30
Salt (NaCl)	00.20	00.20	00.20	00.20
Total	100.00	100.00	100.00	100.00
Calculated analysis [2] *(%)*				
Dry matter	86.50	86.36	86.25	86.51
Crud protein (C.P) %	17.31	17.31	17.30	17.30
Ether extract (E.E) %	02.87	02.89	02.97	03.00
Crude fiber (C.F) %	13.00	13.00	13.00	13.01
Ash%	07.54	08.44	09.31	10.20
Calcium %	01.06	01.06	01.07	01.09
Available Phosphorus %	00.12	00.20	00.22	00.26
Methionin	00.47	00.47	00.47	00.47
Lysin	00.89	00.79	00.72	00.69
Starch [3]	15.61	16.43	17.05	17.83
Digestible energy(kcal/kg) [3]	2374.82	2377.34	2376.91	2379.96
Cost (L.E) per 100 kg	150.3	144.4	136.4	129.9

1- Each 3 kg vitamin and mineral premix provides: vit. A 12000000 IU, vit. D3 750000 IU, vit. E 10000 mg, vit. K 2000 mg ,vit. B_1 1000 mg,vit B_2 4000 mg, vit. B_6 1500 mg, vit. B_{12} 10 mg, Pantothenic Acid 10000 mg,Niacin 20000 mg, Biotine 50 mg, Folic Acide 1000 mg,Choline choloride 500mg, selenium 100mg, Manganese 55 gm, Zinc 50 gm, Fe 60 gm, CU 2.5 gm, CO 6 mg and Iodine 1 gm.

2-According to Feed Composition Tables for animal and poultry feedstuffs used in Egypt (2001), except the values of *Portulaca oleracea*, which were determined (Table 2).

3-Calculated according to De Blas and Mateos, (1998).

Economical Efficiency (E.E):

Economical efficiency for all experimental diets was calculated from the input/output analysis according to the price of the experimental diets and live body weight. Values of economical efficiency were calculated as the net revenue per unit of total cost (Osman, 2003).

Statistical Analysis:

Data were subjected to two-way analysis of variance applying SAS program (SAS, 1996) using general linear model GLM. Significant differences among treatment means were separated using Duncan's multiple range procedure (Duncan, 1955).

RESULTS AND DISCUSSION

Approximate Analysis, Digestibility and Nutritive Values of (P.O):

The chemical composition of both whole P.O and soybean meal are presented in Table (2). The chemical analysis of whole P.O. plant is different than soybean meal in their content of crude protein and about two times higher CF content, ether extract and four times higher level of calcium but lower phosphorus. Generally, the chemical analysis of whole P.O. plant are in agreement with those reported by some authors (Mohamed and Hussein, 1994, El-Sayed, 2001 and Obied *et al.* 2003). The data presented in Table (3) revealed that values of digestibility coefficients of OM, CP, CF, EE and NFE were 80.55, 88.27, 27.41, 86.63 and 82.5 %, respectively. Moreover, DCP, TDN and DE were 26.84, 67.33 and 2409 K cal/kg, respectively. The chemical composition, nutrients digestibilities and feeding values of P.O. showed that it is a suitable ingredient in feeding livestocks. In this respect Abuo-Raya and Galal (1971) reported that any ingredient had 70 % digestible OM consider good feedstuff for livestocks.

Table (2): Chemical analysis of *Portulaca oleracea* and soybean meal used in the exeperiment

Items	OM %	CP %	CF %	EE %	Ash %	NFE %	Ca %	P %
Portulaca oleracea	73.36	30.41	12.81	4.44	16.98	35.36	1.35	0.36
Soybean meal	81.3	43.77	6.37	2.28	7.66	39.92	0.29	0.64

Table (3): Digestibility coefficients and nutritive values of *Portulaca oleracea*

Items	OM %	CP %	CF %	EE %	NFE %	Nutritive values		
						DCP	TDN	DE K cal/Kg
P. O	80.55	88.27	27.41	86.63	82. 05	26.84	67.33	2409.20

Growth Performance:

It is worthy to note that the initial BW at five weeks of age was statistically insignificant and had average of 766.83g. The percentage replacement levels of P.O. had a significant effect on the growth performance of growing NZW rabbits from five to 12

weeks of age (Table, 4). The LBW, BWG and RGR were significantly higher by 12.57, 19.34 and 5.14 %, respectively when growing rabbits were fed diet containing 20 % P.O., compared with those of the control group. While at the level of 30 % P.O the worst values of growth performance were obtained. These results revealed the real influence of the diet on weight gain, which may be related to differences in levels of diet digestibility (Dalia, 1997). These results are in agreement with those obtained by El-Sayed (2001) who noticed that rats fed diet contained 10% P.O significantly increased LBW and BWG compared to those fed diets contained 1% or 5% and the lowest values recorded by rats fed diet contained 15% P.O. The interaction between P.O level and sex indicated that the highest values of final LBW, daily BWG and RGR were recorded with males fed diet contained 20% P.O followed by the females fed the same diet compared to the other treatments. While the lowest values were recorded by males and females fed diet contained 30% P.O. These results in agreement with the data recorded by Divilin (1986) who reported that the reduction in body weight could be due to skeletal muscle degradation and lipolysis process. The major symptoms of diabetes are excessive thirst frequent urination, increased appetite, and loss of weight (Kirschman, 1996).

Daily feed intake was significantly ($P<0.05$) increased from 102.75 to 117.30 g/ day as P.O level increased from 0 to 20% in the diets, but rabbits fed diet contained 30% P.O significantly decreased DFI to 99.78 g/ day, this may be due unpalatable test of P.O as reported by Hassanin and Hassan (1996). These results are in agreement with those obtained by El-sayed (2001) who found that rats fed diet contained 10% P.O significantly increased feed intake compared to those fed diet contained 15% P.O. Feed conversion FC significantly ($P<0.05$) improved by increasing P.O and the best value of FC was recorded by rabbits fed substituted level of 20% P.O followed by those of 10% P.O diet, while the worst value was reported by rabbits fed 30% P.O diet. These improvements due to diet contained 10 or 20% P.O exhibit high digestibility values. It may be due to exhibit antibacterial, antifungal, anti-inflammatory and diuretic as reported by Chan *et al.* (2000). Moreover, results obtained in Table 4 pointed out that sex had significant effect on the growth performance from 5 to 12 weeks of age. Final LBW, daily BWG, RGR, DFI and FC had been improved for males compared to those for females. The interaction between P.O levels and sex indicated that the highest values of DFI and best FC were recorded with males fed diet contained 20% P.O followed by females fed the same diet. While the worst values were recorded by either males or females fed diet contained 30% P.O. Viability showed no differences among treatments and it ranged between 85 and 90 % (Table, 4).

Digestibility Coefficients:

The effect of dietary treatments on digestibility coefficients of nutrients are presented in Table (5). The rabbits fed on P.O diet at level of 20% recorded the significantly ($P<0.05$) better values of OM, CP, CF, EE and NFE digestibilities followed by those fed on 10% P.O diet. While the lowest ($P<0.05$) digestibilities of OM, CP, CF, EE and NFE were recorded for rabbits fed 30% P.O diet compared to the other treatments. No available literature regarding the effect of P.O on digestibility coefficients.

Table (4): Growth performance traits of rabbits from 5 to 12 weeks of age as affected by experimental treatments

Items	Initial BW (g)	Final BW (g)	DBG (g)	DFI (g)	FC (g FI/g BG)	RGR %	Viability %
Portulaca oleracea	NS	*	*	*	*	*	
0 %	766.45 ±1.07	1917.20^{c} ±13.88	23.48^{c} ±0.28	102.75^{c} ±0.83	4.38^{b} ±0.05	85.70^{c} ±0.59	90
10%	767.70 ±1.18	2046.60^{b} ±12.07	26.10^{b} ±0.24	112.85^{b} ±0.47	4.33^{b} ±0.03	90.84^{b} ±0.49	85
20%	766.55 ±1.09	2192.85^{a} ±15.16	29.11^{a} ±0.31	117.30^{a} ±0.31	4.03^{a} ±0.04	96.34^{a} ±0.52	85
30%	766.60 ±0.87	1848.85^{d} ±13.69	22.08^{d} ±0.27	99.78^{d} ±0.33	4.53^{c} ±0.04	82.69^{d} ±0.61	85
Sex effects	NS	*	*	*	*	*	
Meal (M)	767.37 ±0.88	2046.13^{a} ±22.66	26.09^{a} ±0.03	109.66^{a} ±1.17	4.22^{a} ±0.03	90.63^{a} ±0.85	87.5
Female (F)	766.27 ±0.55	1956.63^{b} ±21.28	24.29^{b} ±0.44	106.67^{b} ±1.18	4.45^{b} ±0.03	87.16^{b} ±0.88	87.5
Interaction effects	NS	*	*	*	*	*	
0% P.O level X M	766.50 ±2.11	1957.20^{e} ±05.92	24.30^{e} ±0.09	104.89^{e} ±1.35	4.32^{bcd} ±0.06	87.43^{e} ±0.20	90
F	766.40 ±0.64	1877.20^{f} ±20.56	22.67^{f} ±0.42	100.62^{f} ±0.24	4.45^{d} ±0.07	83.98^{f} ±0.89	90
10% P.O level X M	768.00 ±1.71	2087.70^{c} ±10.88	26.93^{c} ±0.23	114.67^{c} ±0.27	4.26^{bc} ±0.04	92.41^{c} ±0.47	90
F	767.40 ±1.71	2005.50^{d} ±11.02	25.27^{d} ±0.23	111.04^{d} ±0.33	4.40^{cd} ±0.05	89.28^{d} ±0.49	80
20% P.O level X M	768.20 ±1.69	2252.40^{a} ±8.19	30.29^{a} ±0.19	118.18^{a} ±0.38	3.90^{a} ±0.01	98.26^{a} ±0.39	80
F	764.90 ±1.22	2133.30^{b} ±10.72	27.92^{b} ±0.22	116.43^{b} ±0.29	4.17^{b} ±0.03	94.42^{d} ±0.43	90
30% P.O level X M	766.80 ±1.72	1887.20^{f} ±9.01	22.87^{f} ±0.18	100.92^{f} ±0.25	4.42^{cd} ±0.04	84.42^{f} ±0.39	90
F	766.40 ±0.49	1810.50^{g} ±19.59	21.31^{g} ±0.39	98.63^{g} ±0.31	4.64^{e} ±0.07	80.98^{g} ±0.87	80

Means having different letters at the same column are differ significantly.

* = (P<0.05), NS= Not significant.

BW= Body weight, DBG= Daily body weight gain, DFI= Daily feed intake, FC = Feed conversion, RGR= Relative growth rate

Table (5): Digestibility coefficients of rabbits fed the experimental diets

Items	Organic matter	Crude protein	Crude fiber	Ether extract	Nitrogen free extract
Portulaca oleracea	*	*	*	*	*
0%	$66.13^{d} \pm 0.16$	$70.62^{b} \pm 0.16$	$24.83^{b} \pm 0.11$	$78.71^{c} \pm 0.18$	$75.91^{c} \pm 0.17$
10%	$68.18^{b} \pm 0.52$	$74.48^{a} \pm 0.58$	$22.62^{d} \pm 0.12$	$80.05^{b} \pm 0.62$	$77.25^{b} \pm 0.17$
20%	$70.53^{a} \pm 0.23$	$73.96^{a} \pm 0.24$	$28.47^{a} \pm 0.12$	$83.07^{a} \pm 0.27$	$78.11^{a} \pm 0.17$
300%	$67.11^{c} \pm 0.19$	$69.28^{c} \pm 0.24$	$23.05^{c} \pm 0.11$	$76.41^{d} \pm 0.30$	$74.71^{d} \pm 0.17$

Means having different letters at the same column are differ significantly. * = ($P<0.05$).

Carcass Traits:

Results of slaughter traits are recorded in Tables (6). Rabbits fed substituted level of 20 % P.O had the higher percentage of carcass, dressing, bone, stomach and caecum. The highest giblets values were observed with rabbits fed on 30% P.O followed by rabbits fed on 20 and 10% P.O. diets, respectively. The lowest carcass, bone and caecum percentages were observed with rabbits fed on 30% P.O. diet. The lowest dressing and giblets were observed with rabbits fed on the control diet compared the other treatments. The sex had a significant effect on carcass, dressing, bone, stomach and caecum % of rabbits. Males had significantly higher percentages of carcass, dressing, bone, stomach and caecum than the females. The interactions between P.O. level and sex indicated similar results of carcass traits as those recorded with males fed diet contained 20% P.O. followed by females fed the same diet, while the worst values were recorded by males and females fed diet contained 30% P.O. There is no available literature regarding the effect of P.O. on carcass traits.

Blood Constituents:

Effect of dietary treatments on blood serum total protein, albumin, globulin, total lipids and cholesterol are presented in Table (7). Data revealed that rabbits fed P.O. diet at a level of 20% recorded the highest significant ($P<0.05$) values of total protein and total globulin. These results are in agreement with those obtained by Mohamed and Hussein, (1994) who found that P.O. has a high amount of total protein. Dalia, (1997) decleared that differences in digestibility, rate of amino acids absorption and the qualitative composition of fiber, may lead to differences in lipidemia. El-Sayed (2001) found that P.O. plays a very important role in lowering ($P<0.05$) total lipids and cholesterol. Fenglin *et al* (2009) mentioned that polysaccharide extracted from P.O. significantly decreased the concentration of blood total cholesterol, triglyceride and modulate the metabolism of blood lipid in diabetes mellitus mice.

Table (6): Carcass traits of rabbits as affected by experimental treatments

Items	Carcass %	Dressing[1] %	Bone less meat %	Giblet[2] %	Stomach %	Caecum %
Portulaca oleracea	*	*	*	*	*	*
0 %	56.65^{b} ±1.13	61.12^{c}±0.74	87.50^{b} ±0.40	4.26^{c} ±0.17	5.19^{b}±0.18	6.19^{b}±0.09
10%	58.56^{b} ±1.36	63.02^{b}±0.89	87.29^{bc}±0.28	4.79^{b} ±0.16	5.98^{a}±0.11	7.38^{a}±0.08
20%	63.35^{a} ±1.35	67.66^{a}±0.84	88.45^{a} ±0.29	4.96^{b} ±0.16	6.26^{a}±0.13	7.26^{a}±0.20
30%	56.22^{b} ±1.22	61.96^{bc}±0.60	86.65^{c} ±0.39	5.93^{a} ±0.07	6.15^{a}±0.16	6.10^{b}±0.09
Sex effects	NS	*	*	*	*	*
Meal (M)	59.85 ± 1.15	64.77^{a} ±0.81	86.86^{a} ±0.26	5.22^{a} ±0.17	6.13^{a} ±0.12	6.91^{a} ±0.18
Female (F)	57.54 ± 1.02	62.11^{b} ±0.71	88.08^{b} ±0.23	4.75^{b} ±0.17	5.66^{b} ±0.15	6.55^{b} ±0.16
Interaction effects	*	*	*	*	*	*
0% P.O levels X M	57.65^{bc} ±1.63	62.41^{cd}±0.86	86.66^{de} ±0.38	4.55 ^{c}±0.27	5.59 ^{b}±0.17	6.29^{c} ±0.13
F	55.66^{c} ±1.63	59.82^{d} ±0.83	88.34^{ab} ±0.38	3.98 ^{d}±0.12	4.78 ^{c}±0.17	6.08^{c} ±0.13
10% P.O levels X M	60.25^{abc}±1.86	64.84^{bc}±0.85	86.93^{cde}±0.38	5.00^{bc}±0.19	5.99^{ab}±0.17	7.39^{a} ±0.13
F	56.86^{bc} ±1.79	61.19^{d} ±0.86	87.65^{bcd}±0.38	4.57^{c} ±0.23	5.96^{ab} ±0.17	7.38^{a} ±0.13
20% P.O levels X M	64.89^{a} ±1.86	69.31^{a} ±0.86	88.01^{abc}±0.38	5.19^{b} ±0.26	6.47^{a} ±0.17	7.75^{a} ±0.12
F	61.80^{ab}±1.86	66.01^{b} ±0.86	88.88^{a} ±0.37	4.72^{bc}±0.16	6.05^{ab}±0.17	6.78^{b} ±0.13
30% P.O levels X M	56.61^{bc}±1.85	62.52^{cd}±0.86	85.85^{e} ±0.36	6.13^{a} ±0.02	6.46^{a} ±0.17	6.22^{c} ±0.13
F	55.83^{c} ±1.85	61.40^{d} ±0.86	87.45 ^{bcd}±0.38	5.74 ^{a}±0.01	5.83^{b} ±0.17	5.98^{c} ±0.13

Means having different letters at the same column are differ significantly.

1Dressing % = (carcass weight + Giblets / live body weight) × 100

2 Giblets = Heart + liver + kidneys. *= (P<0.05), NS= Not significant.

Table (7): Some blood constituents of rabbits as affected by experimental treatments

Items	Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	Total lipids (mg/dl)	Cholesterol (mg/dl)
Portulaca levels(P.O)	*	*	*	*	*
0 %	$6.53^{b} \pm 0.2$	$4.16^{c} \pm 0.3$	$2.37^{ab} \pm 0.4$	$676.55^{a} \pm 5.1$	$129.29^{a} \pm 0.5$
10%	$6.98^{b} \pm 0.2$	$4.95^{b} \pm 0.4$	$2.04^{b} \pm 0.3$	$661.83^{ab} \pm 5.2$	$118.16^{c} \pm 0.6$
20%	$8.22^{a} \pm 0.2$	$5.06^{b} \pm 0.2$	$3.16^{a} \pm 0.1$	$649.53^{b} \pm 5.5$	$116.32^{d} \pm 0.6$
30%	$7.88^{a} \pm 0.3$	$6.19^{a} \pm 0.2$	$1.69^{b} \pm 0.3$	$667.93^{a} \pm 5.4$	$124.50^{b} \pm 0.5$
Sex effects	*	*	NS	NS	*
Meal (M)	$7.79^{a} \pm 0.2$	$5.53^{a} \pm 0.2$	2.26 ± 0.2	660.19 ± 4.4	$121.42^{b} \pm 1.4$
Female (F)	$7.02^{b} \pm 0.2$	$4.65^{b} \pm 0.3$	2.37 ± 0.3	667.73 ± 4.2	$122.70^{a} \pm 1.4$
Interaction effects	*	*	*	*	*
0% P.O levels X M	$6.78^{cd} \pm 0.3$	$4.42^{b} \pm 0.5$	$2.35^{abc} \pm 0.5$	$673.96^{a} \pm 7.7$	$128.69^{a} \pm 0.7$
F	$6.28^{d} \pm 0.3$	$3.89^{b} \pm 0.5$	$2.39^{abc} \pm 0.7$	$679.15^{a} \pm 7.7$	$129.88^{a} \pm 0.6$
10% P.O levels X M	$7.37^{bc} \pm 0.6$	$5.67^{a} \pm 0.1$	$1.70^{bc} \pm 0.2$	$658.22^{ab} \pm 7.7$	$117.41^{cd} \pm 0.8$
F	$6.59^{cd} \pm 0.1$	$4.22^{b} \pm 0.5$	$2.37^{abc} \pm 0.5$	$665.45^{ab} \pm 7.5$	$118.91^{c} \pm 0.8$
20% P.O levels X M	$8.57^{a} \pm 0.2$	$5.56^{a} \pm 0.1$	$3.01^{ab} \pm 0.2$	$644.82^{b} \pm 7.7$	$115.74^{d} \pm 0.8$
F	$7.87^{ab} \pm 0.2$	$4.57^{b} \pm 0.1$	$3.31^{a} \pm 0.2$	$654.24^{ab} \pm 8.2$	$116.89^{cd} \pm 0.8$
30% P.O levels X M	$8.44^{a} \pm 0.2$	$6.47^{a} \pm 0.3$	$1.97^{bc} \pm 0.4$	$663.78^{ab} \pm 7.6$	$123.80^{b} \pm 0.6$
F	$7.33^{bc} \pm 0.3$	$5.90^{a} \pm 0.3$	$1.43^{c} \pm 0.3$	$672.09^{a} \pm 8.1$	$125.13^{b} \pm 0.7$

Means having different letters at the same column are differ significantly.
* = ($P<0.05$), NS= Not significant.

Rabbits fed 30 % P.O. diet recorded the highest ($P<0.05$) value of total albumin and the lowest ($P<0.05$) total globulin compared with the other treatments. The obtained values pointed out that sex had significant effect on total protein, albumin and total cholesterol. Males recorded significantly higher total protein, albumin but lower total cholesterol than the females. However, sex had insignificant effect on globulin and total lipids. The interaction between P.O. level and sex indicated that both males and females when fed P.O. diet at level of 20% recorded the highest ($P<0.05$) value of total protein and the least ($P<0.05$) total lipids and cholesterol.

Liver and Kidney Functions and Immunity Titer test (HA)

The effect of dietary treatments on some liver and kidney functions (AST, ALT, creatinine and urea) and HA of rabbits are reported in Table (8). No significant effect of experimental treatments on AST and ALT, while control group of rabbits had the lowest significant ($P<0.05$) values of urea and HA. While the highest significant ($P<0.05$) value in creatinine was recorded for rabbits fed 10% P.O. diet. Moreover, the highest significant ($P<0.05$) value in HA and the lowest one in creatinine were observed for rabbits group fed diet contained 20% P.O. Whereas, the greatest ($P<0.05$) urea value was recorded for rabbits fed diet contained 30% P.O. In general, feeding rabbits on diet contained 20% P.O improved ($P<0.05$) kidney function and HA. These results are in agreement with those obtained by El-Sayed (2001) who noticed that rats fed diet contained different levels of P.O., significantly decreased creatinine and uric acid. Sex had significant effect on AST, ALT, creatinine and urea and insignificant effect on HA. The values of

Table (8): Liver and kidney functions and immunity titer (HA) of rabbits as affected by experimental treatments

Items	AST (U/L)	ALT (U/L)	Creatinine (mg/dl)	Urea (mg/dl)	HA
Portulaca levels(P.O)	NS	NS	*	*	*
0 %	14.98 ±0.79	19.02±0.44	1.63^{c} ±0.08	46.42^{c} ±1.02	092.38^{d}±09.82
10%	15.34 ±1.03	19.80±1.05	1.83^{a} ±0.04	50.23^{b} ±0.37	208.32^{b}±10.22
20%	15.18 ±0.80	20.62±0.83	1.53^{d} ±0.05	47.98^{c} ±1.03	219.65^{a}±04.84
30%	15.28 ±0.25	20.35±1.55	1.72^{b} ±0.08	53.05^{a} ±0.92	194.10^{c}±05.19
Sex effects	*	*	*	*	NS
Meal (M)	14.71^{a} ±0.60	19.82^{a} ±0.86	1.82^{a} ±0.03	50.78^{a} ±0.70	178.60±09.39
Female (F)	11.13^{b} ±0.66	15.24^{b} ±0.60	1.53^{b} ±0.03	48.06^{b} ±0.90	178.62±17.66
Interaction effects	NS	NS	*	*	*
0% P.O levels X M	15.65 ±0.30	18.60±0.49	1.82^{ab}±0.04	48.69^{b} ±0.42	118.36^{e} ±0.34
F	14.20 ±0.27	17.85±0.49	1.43^{e} ±0.04	44.16^{c} ±1.10	066.40^{f} ±0.69
10% P.O levels X M	15.98 ±0.30	19.13±0.70	1.92^{a} ±0.03	49.58^{b} ±0.42	181.35^{d} ±0.66
F	14.75 ±0.30	18.21±0.81	1.74^{bc}±0.04	50.89^{b} ±0.42	235.30^{a} ±1.53
20% P.O levels X M	15.14 ±0.30	19.56±0.70	1.63^{cd}±0.04	49.99^{b} ±0.42	206.85^{c} ±0.33
F	14.05 ±0.33	18.68±0.49	1.42^{e} ±0.05	45.96^{c} ±1.44	232.44^{b} ±0.60
30% P.O levels X M	15.03 ±0.30	19.01±0.70	1.93^{a} ±0.03	54.85^{a} ±1.27	207.84^{c} ±0.33
F	14.23 ±0.30	18.08±0.49	1.51^{de}±0.04	51.25^{b} ±0.42	180.36^{d} ±0.27

Means having different letters at the same column are differ significantly.

* = (P<0.05), NS= Not significant.

AST= Aspartate aminotransferase, ALT= Alanine aminotransferase

AST, ALT, creatinine and urea were significantly higher for males than the females. The interaction results between P.O. levels and sex indicated that males and females fed P.O. at various levels had significant effects on urea, creatinine and HA, and insignificant effect on AST and ALT. Females fed P.O. recorded the lowest values of urea and creatinine than the males. The highest significant (P<0.05) value of HA recorded by females fed 10% P.O . diet followed by females and males fed diet contained of 20% P.O. In general, kidney functions and HA were significantly (P<0.05) improved for rabbits group fed 20 % P.O.

Economic Efficiency

The results of economic efficiency EEF and relative economic efficiency REEF estimated for experimental diets are shown in Table (9). According to the input-output analysis, the best REEF recorded by rabbits fed on diet contains 20% P.O followed by the groups fed diets containing 10 and 30% P.O. The REEF improved by increasing the level of (P.O) from 0 to 20%. Feeding P.O at level of 20% of rabbit diet was more economic than the other levels or the control group.

Table (9). Economical efficiency (E.E.F) and relative economical efficiency (R.E.E.F) of rabbits as affected by experimental treatments

Treatment	B.W.G (gm)	F.I (gm)	Price kg Feed p.t	Feed Cost L.E.	Net Reven. L.E	E.E.F	R.E.E.F%
Portulaca levels(P.O)							
0 %	1150.5	5034.8	1.503	7.57	13.14	1.74	100.00
10%	1278.9	5529.7	1.444	7.98	15.04	1.88	108.05
20%	1426.4	5747.7	1.364	7.84	17.84	2.27	130.46
30%	1081.9	4889.2	1.299	6.34	13.13	2.07	118.96

* Price of kg live body weight was 18.0 L.E, Price of kg Portulaca was 0.75 L.E at experimental time

* Net revenue = body revenue – feed cost. * E.E.F = (Net revenue / feed cost).

* R.E.E.F, assuming control treatment = 100%.

CONCLUSION

It could be concluded from the results of this study that growing rabbits could be fed 20 % P.O, on the expense of soybean meal without any adverse effects and realize the best values of growth performance, digestibility coefficients, carcass traits, globulin level and immune response. Economical efficiency and the relative economical efficiency were also improved with such level of P.O.

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التقييم الغذائى و البيولوجى لنبات الرجلة كمصدر غير تقليدى للبروتين فى أعلاف الأرانب النامية

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أجريت هذة التجربة بغرض دراسة تأثير احلال بروتين نبات الرجلة كمصدر غير تقليدى للبروتين محل بروتين كسب الصويا فى علائق الأرانب النامية و تأثيراتها على الأداء الإنتاجى و المعاملات الهضمية و مواصفات الذبيحة و صفات الدم و وظائف الكبد و الكلية و المناعة و الكفاءة الاقتصادية فى الأرانب النيوزيلاندى البيضاء. استخدم فى هذا البحث عدد (٨٠) أرنب نيوزيلاندى أبيض مفطوم عمر ٥ أسابيع (٤٠ ذكر و ٤٠ أنثى) و تم تقسيمهم عشوائيا الى ٤ مجاميع تجريبية احتوت كل مجموعة على (١٠ ذكر و ١٠ أنثى) فى أقفاص فردية. المجموعة الاولى غذيت على عليقة كونترول (بدون رجلة) بينما المجاميع الثلاثة الاخرى تم احلال الرجلة بمستويات ١٠، ٢٠ ، ٣٠% محل كسب الصويا.

و قد اظهرت النتائج أن استخدام الرجلة بمعدل ٢٠% فى العليقة أدى إلى زيادة معنوية فى وزن الجسم الحى و الزيادة فى وزن الجسم و معدل النمو بنسبة ١٢,٥٧ – ١٩,٣٤ – ٥,١٤% على التوالى و إلى زيادة معنوية فى استهلاك العلف اليومى مقارنة بمجموعة الكونترول. كما سجلت الأرانب التى تغذت على الرجلة بمعدل ٢٠% أفضل كفاءة تحويلية و تبعتها المجموعة التى غذيت على عليقة احتوت على ١٠% رجلة. وأيضا اظهرت الأرانب التى تغذت على الرجلة بمعدل ٢٠% أعلى القيم فى معاملات هضم البروتين و الألياف و الدهن و المستخلص الخالى من النيتروجين مقارنة بالمعاملات الأخرى. و بالنسبة للذبيحة فقد أظهرت الأرانب التى تغذت على الرجلة بمعدل ٢٠% أعلى القيم فى نسبة الذبيحة و العظم و المعدة و الاعور مقارنة بالمعاملات الاخرى. و فى قياسات الدم اظهرت الارانب التى تغذت على الرجلة بمعدل ٢٠% أعلى القيم فى بروتين الدم و الجلوبيولين و أقل القيم فى اللبيدات الكلية و الكوليسترول. كما حسن إستخدام الرجلة بمستوياتها المختلفة فى العلائق فى وظائف الكبد و الكلية و المناعة. أما إقتصاديا فقد سجلت العليقة المحتوية على ٢٠% رجلة أفضل كفاءة اقتصادية مقارنة بباقى المعاملات الأخرى و الكونترول.

من هذه النتائج تتضح إمكانية استبدال نبات الرجلة كمصدر غير تقليدى للبروتين بنسبة ٢٠% محل كسب الصويا فى أعلاف الأرانب النيوزيلاندى النامية.