

## **GROWTH PERFORMANCE, NUTRIENTS DIGESTIBILITY AND CARCASS MEASUREMENTS OF GROWING RABBITS FED DIETS INCORPORATED WITH LENTIL OR CHICKPEA SCREENING BY-PRODUCTS.**

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### **SUMMARY**

This work aimed to study the influence of replacement 15 or 30% of soybean meal protein by either lentil screening by-products protein (LSBP) or chickpea screening by-products protein (CSBP) on performance, nutrients digestibility, plasma parameters, carcass measurements and economic profitability of growing rabbits. Sixty New Zealand White (NZW) growing rabbits, six weeks of age, were divided to five experimental groups. Each group included four replicates (three rabbits each) as follow: control group fed basal diet without LSBP or CSBP; the 2<sup>nd</sup>, 3<sup>th</sup>, 4<sup>th</sup> and 5<sup>th</sup> groups of rabbits fed 15% LSBP, 30% LSBP, 15% CSBP and 30% CSBP diets, respectively. Results showed that LSBP has lower DM, OM and EE contents than CSBP. Meanwhile, LSBP has higher CP, CF, ash% and GE (kcal/kg) contents compared to CSBP. LSBP was higher in arginine, threonine, isoleucine, and lysine. Meantime, CSBP had higher contents in leucine, methionine and phenylalanine as predominant essential amino acids. Inclusion of LSBP and CSBP insignificantly improved FBW, BWG and FCR. However, average daily feed intake of rabbits fed 15% CSBP was higher ( $P<0.05$ ) than those fed 30% CSBP. No significant differences were observed in all nutrients digestibility (DM, OM, CP, EE and NFE) and nutritive values expressed as DCP%, TDN% and DE Kcal/kg between groups of rabbits fed LSBP and CSBP diets and those fed the control diet. Meanwhile, group of rabbits fed 30% LSBP had higher ( $P<0.05$ ) CP digestibility. Conversely, group of rabbits fed 30% CSBP recorded the lowest ( $P<0.05$ ) CP digestibility. Significant higher ( $P<0.05$ ) values of plasma total protein and albumin concentrations were recorded for rabbits fed diets contained 30% LSBP, 15 or 30% CSBP than the control group. Moreover, there were insignificant differences in globulin and uric acid among all the experimental groups. Regarding liver functions (AST and ALT), there was a significant decrease ( $P<0.05$ ) in AST levels with rabbits fed 30% LSBP and 15 or 30% CSBP compared to the control group. No significant differences in most carcass measurements were found between rabbits fed different levels of LSBP and CSBP diets and those fed the control diet except heart, kidneys weights and total edible parts %. The inclusion of LSBP at a level of 15% significantly decreased ( $P<0.05$ ) total edible parts % compared with the inclusion of 30% CSBP and the control group. The net revenue improved by 4.16, 7.75, 3.43 and 9.52% for 15% LSBP, 30% LSBP, 15% CSBP and 30% CSBP, respectively. The best net revenue and economical efficiency were recorded by 30% CSBP diet followed by 30%LSBP, 15%LSBP, 15% CSBP diets and the lowest one was the control group. In conclusion, lentil or chickpea screening by-products protein could be used up to 30% substitution level for soybean meal protein without any detrimental effects on performance, nutrient digestibility, plasma parameters and carcass measurements of growing rabbits.

**Keywords:** *growing rabbits, chickpea screenings, lentil screenings, performance and digestibility, profitability.*

### **INTRODUCTION**

The use of lentil and chickpea screening by-products might reduce the costs of feed production and reduce the environmental impact. The rising prices of feed ingredients frequently used in animal feeding has led to the evaluation of alternative and less costly ingredients, as feeds which can be accounted for up to 70% of the total costs of rabbit production (Gidenne *et al.*, 2017). Therefore, it could be argued that feed costs could be minimized by using cheaper, non-traditional feed ingredients (de Blas *et al.*, 2018 and Uhlřřov *et al.*, 2018). The chickpea (*Cicer arietinum* L.) and lentil (*Lens culinaris* L.) are cultivated for their edible seeds, they are the major legumes in the Mediterranean Basin. Among the 17 pulses identified as food sources by FAO, the four most widely produced are common bean, chickpea, dry pea, and lentil. Pulses are concentrated sources of protein and dietary fiber and have very low-fat content (FAO, 2017).

The majority of chickpea wastes are culled chickpea (cracked, broken, fine, deformed and impurities) and chickpea processing wastes including chickpea hulls, broken and ground peas and foreign materials

(Mousavi and Miraza Aghazadeh, 2007). Lentil screenings are the by-products of cleaning lentil seeds. They may consist of whole and broken lentils, cereal grains, weed seeds, chaff and dust. If lentils suffered from quality problems, these by-products become occasionally available to the animal feed industry (Stanford *et al.*, 1999 and Çabuk *et al.* 2014). Lentil seeds are a good source of protein and energy, but low in sulphur amino acids. Amino acid supplementation is recommended when lentil seeds are used in poultry diets, therefore lentil screenings can be included up to 20% in broiler diets (Sherasia *et al.*, 2017).

Lentil and chickpea seeds have relatively high crude protein content (24.6-30 % and 18.2-26.5%), respectively (Feedipedia, 2016) and low digestive inhibitors (Görgülü, 2010). Mustafa *et al.* (2000) reported that chickpea and other pulse crops can be used as protein and energy source in animal diets. However, the major anti-nutritional factor in lentils is protease inhibitor, it has excessive content of polyphenols, especially tannins, but this is not present in sufficient quantities to depress animal performance (Mavromichalis, 2013).

The current study aims to investigate the effect of lentil (LSBP) and chickpea (CSBP) screening by-products proteins substitution for soybean meal protein on growth performance, nutrients digestibility, carcass measurements and plasma parameters of growing rabbits besides, economical efficiency of experimental diets.

## MATERIALS AND METHODS

The experiment was conducted at Borg El-Arab experimental station, Animal Production Research Institute (APRI), Agricultural Research Center, Egypt. The laboratories works were carried out at Laboratories of Utilization of By-Products Research Department, APRI, Giza, Egypt. The LSBP and CSBP were obtained from Egyptian holding company for silos & storage, El Nobarria, El-Bahera governorate. Feed mixing and pelleting processes were carried out at El Nobarria manufactory, El Nobarria Station, APRI, Agricultural Research Center, Egypt.

### *Experimental animals, diets and design*

Sixty New Zealand White (NZW) growing rabbits, 6 weeks age with live body weight ranging from 579.44 to 580.56g were divided into five experimental groups, 12 rabbits in each. Five experimental diets were formulated as follow; the control diet without LSBP and CSBP, the other experimental diets were formulated by replacing two levels (15 and 30%) of soybean meal protein by protein of LSBP and CSBP. The diets and fresh water were supplied *ad libitum*. The experimental period lasted for 7 weeks from 6 to 13 weeks of age. All experimental diets (Table 1) were formulated to be isonitrogenous and isocaloric, to meet all the essential nutrient requirements of growing rabbits in accordance with De Blas and Mateos (1998).

### *Management and growth performance*

All rabbits were kept under the same management, hygienic conditions and housed in metal battery cages supplied with separated feeders. All rabbits were vaccinated against diseases and kept under veterinary control. Feed intake (FI, g/rabbit/day) and body weight gain (BWG, g/rabbit/day) were recorded weekly, accordingly, feed conversion ratio (FCR) was calculated as g feed / g gain over an experimental period.

### *Digestion trial and chemical analyses*

Digestion trial was conducted according to Perez *et al.* (1995). Fifteen rabbits were used individually to digestion trial and divided to 5 groups of three per treatment. Rabbits were housed in individual metabolism cages diets for a period of 7 days (preliminary period) for adaptation then faeces were collected every 24 hours for 5 consecutive days (collection period). Samples of LSBP and CSBP, diets and feces were prepared to determine moisture, ash, crude protein, ether extract and crude fiber according to A.O.A.C. (2000). Amino acids were determined using Beckman Amino Acid Analyzer (model 6300; Beckman Coulter Inc., Fullerton, Calif., USA). Acid hydrolysis was carried out according to the method of A.O.A.C. (2012). Data of feed intake and dried feces as well as chemical analysis of feed and dried feces were used to calculate the nutrient digestion coefficients and nutritive values for each dietary treatment, as described by Fekete (1985). Digestible energy (DE, Kcal/Kg diet) was calculated as follow:  $DE = TDN \times 44.3$  according to Schneider and Flatt (1975).

### *Slaughter traits*

At the end of the growing period (13 week of age), three rabbits were taken randomly from each treatment, fasted about 16 hours before slaughtering and individually weighed as pre-slaughtering weight. Animals were slaughtered according to the Islamic religion instructions with a sharp knife. The empty carcass was weighed without head and giblets. The giblets (liver, heart and kidneys) were separated and weighed. The edible giblets percentage, total edible parts and dressing percentage were calculated according to Blasco *et al.* (1993).

**Table (1). Ingredients and chemical composition of experimental diets.**

Ingredient	Control diet	Substitution level of legumes screenings by-products protein			
		15% LSBP	30% LSBP	15% CSBP	30% CSBP
Soybean meal (44% CP)	20.0	17.00	14.00	17.00	14.00
Legume screenings by-products	0.00	5.44	10.86	5.90	11.77
Yellow corn	12.80	12.80	12.80	12.80	12.60
Barley	15.00	15.00	15.00	15.00	15.00
Wheat bran	12.15	12.15	12.15	12.15	12.15
Clover hay	34.00	31.56	29.14	31.10	28.43
DL-methionine	0.20	0.20	0.20	0.20	0.20
Di calcium phosphate	2.00	2.00	2.00	2.00	2.00
Sodium chloride (NaCl)	0.35	0.35	0.35	0.35	0.35
Vitamin and mineral primix <sup>1</sup>	0.30	0.30	0.30	0.30	0.30
Anti coccidia and fungi	0.20	0.20	0.20	0.20	0.20
Molasses	3.00	3.00	3.00	3.00	3.00
Total	100	100	100	100	100
Chemical composition (DM basis)					
DM%	82.94	83.00	83.05	83.06	83.19
OM%	94.92	94.94	94.97	95.06	95.19
CP%	17.48	17.36	17.05	17.31	17.03
CF%	13.87	13.60	13.44	13.27	13.2
EE%	2.01	2.06	2.11	2.12	2.23
NFE%	61.56	61.92	62.37	62.36	62.73
Ash%	5.08	5.06	5.03	4.94	4.81
DE kcal/kg <sup>2</sup>	2680	2693	2701	2708	2712

<sup>1</sup>Each kg of vitamins and minerals mixture contains: Vit. A 2.000.000 IU, Vit.B<sub>1</sub> 0.33g, Vit.B<sub>2</sub> 1.0g, Vit.D<sub>3</sub> 150.000 IU, Vit E 8.33g, Vit. K 0.33 g, Pantothenic acid 3.33g; Nicotinic acid, 30.00g; Vit. B<sub>6</sub> 2.00g; Vit. B<sub>12</sub> 1.7 mg, Folic acid 0.83g, Biotin 33 mg, Cu 0.5g, choline chloride 200mg, Mn 5.0g, Fe 12.5g, Mg 66.7mg, Co 1.33 mg, Se 16.6 mg, Zn 11.7g, Iodine 16.6 mg and Anti-oxidant 10.0g.

LSBP= Lentil screening by-product; CSBP= Chickpea screening by-product.

<sup>2</sup>DE kcal/kg DM=3330 - 46.8 (%CF) according to Lebas and Gidme (2000).

### Blood sampling and analysis

Blood samples were collected during slaughter to determine blood biochemical components. Blood samples were collected at slaughtering time in heparinized glass tubes and centrifuged at 3,000 rpm for 20 minutes, then, samples were transferred and stored in deep freezer at -20°C till being assayed. Plasma total protein, albumin, creatinine, uric acid, aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were measured by colorimetric methods using commercial kits supplied by Bio-diagnostic, Egypt. All measurements were performed according to the manufacturer's instructions. Total protein was determined according to Gornall *et al.*, (1949), albumin was estimated according to Doumas and Waston, (1971), Plasma globulin concentration was calculated by the difference between total protein and albumin. Creatinine and uric acid was assayed according to Young (2001), aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were determined according to Henry, (1964).

### Economical efficiency

Economical efficiency was calculated as a ratio between the return of weight gain and the cost of consumed feed. The economical efficiency was calculated according to the following equation:

Economical efficiency = (Net revenue/ total feed cost). Whereas, Net revenue = Selling price/rabbit- total feed cost/rabbit. The price of ingredients and selling of one kg live weight of rabbits was calculated according to the price in the local market at the time of experiment during January, 2019. The price of one kg live body weight was 50.00 LE.

### Statistical analysis

The data obtained herein were analyzed by using the GLM (General Linear Model) procedure of SAS (2004) using the following model:  $Y_{ij} = \mu + T_i + e_{ij}$ , Where,  $Y_{ij}$  = An observation;  $\mu$  = Overall mean;  $T_i$  = Effect of treatment groups;  $e_{ij}$  = experimental random error. Duncan's multiple range test (Duncan, 1955) was performed to detect significant differences between treatment means. Significance is acceptable at ( $p \leq 0.05$ ).

## RESULTS AND DISCUSSION

### *Chemical composition of LSBP and CSBP*

Chemical composition of LSBP and CSBP is shown in Table (2). The results indicated that LSBP had lower DM, OM and EE contents than CSBP. While, LSBP has higher CP, CF, ash% and GE (kcal/kg) contents compared to CSBP. The chemical composition of CSBP exhibited 22.43% CP content, which is close to the content of CP (22.50%) in Kabuli chickpea type reported by Mustafa *et al.* (2000). Higher CP content (23.56 %) and higher fat content (5.18%) of chickpea have been reported by Silva-Cristobal *et al.* (2010). Furthermore, Ladjal Ettoumi and Chibane (2015) reported that chickpea contained (24.41%) CP and (5.57%) crude fat. On the other hand, Maheri-Sis *et al.* (2007) analyzed the chemical composition of culled chickpea and chickpea dehulling by-products and found that DM, OM, CP and EE% were 89.78, 96.90, 19.70 and 7.80% for culled chickpea and 90.17, 92.20, 21.80 and 3.10%, respectively for chickpea dehulling by-products. Moreover, Brenes *et al.* (2008) observed that chickpea contained 20% CP, 6.4% CF, 13.5% EE and 6.4% ash. Algam *et al.* (2012) found that the chickpea seeds contained 24.31% CP, 13.37%CF and 3.78% EE.

Concerning to the chemical composition of LSBP, Woyengo *et al.* (2014) found that lentil contained lower contents of DM (88.70%), EE (1.63%), and CF (4.10%), and higher content of CP (27.40%). In addition, Hefnawy (2011) stated that lentil contained 26.6%CP, 3.40 % Ash, 1.0% fat, 6.30% CF and 8.51% moisture. Likewise, Ladjal Ettoumi and Chibane (2015) stated that lentil had higher CP content (26.34 g/100 g dry basis) and lower fat content (1.25 g/100 g dry basis). The present values of LSBP nutrients are within the range of protein (20.6-31.4%), fat (0.7-4.3%), carbohydrates (43.4-69.9%) reported by Urbano *et al.*, (2007). As demonstrated by Brummer *et al.* (2015), lentil is richer in total soluble fiber than peas and chickpeas. Also, like most legumes, lentil is a rich source of protein.

**Table (2). Chemical composition of lentil and chickpea screenings by-products (DM basis)**

Item	DM%	OM%	CP%	CF%	EE%	Ash%	NFE%	GE Kcal/kg*
LSBP	89.20	93.80	24.30	12.40	2.20	6.20	54.90	4400
CSBP	90.19	95.69	22.43	3.04	3.18	4.31	67.04	4120

\*GE (kcal/kg) = Gross Energy

LSBP= Lentil screening by-product; CSBP= Chickpea screening by-product.

The amino acids profile of chickpea and lentil screenings by-products protein is summarized in Table (3). The present study shows that the limiting amino acids were methionine and cysteine for LSBP and CSBP. Similar results were reported by Chavan *et al.*, (1989) who found that methionine and cysteine are the limiting amino acids in chickpeas. Pulses were very low sources of essential sulfur amino acids (Cysteine and Methionine) as mentioned by Margier *et al.*, (2018). Besides, Lentil contains low percentages of sulphur-amino acids (Jarpa-Parra 2018). It is clear to note that LSBP had higher in contents of arginine, threonine, isoleucine and lysine while, CSBP had higher contents of leucine, methionine and phenylealanine as predominant essential amino acids.

Regarding the non-essential amino acids, LSBP had higher concentrations of alanine, aspartic acid, glutamic, glycine, proline and tyrosine. On the other hand, CSBP had higher concentration of cystine content than LSBP. The amino acids contents of LSBP and CSBP are mostly in agreement with values reported by Nestares *et al.* (1996); Hawthorne (2006); Lizarazo *et al.*, (2014) and Margier *et al.*, (2018). Therefore, lentil can be added to the range of feeds (Lizarazo *et al.*, 2014). In general, the present results of the amino acids composition confirm that LSBP and CSBP could supply enough essential amino acids to cover the growing rabbit's nutritional requirements. High quantities of these proteins and essential amino acids in LSBP and CSBP offer an important dietary protein sources for growing rabbits.

### *Growth performance*

Data of Table (4) revealed insignificant differences between the dietary treatments of LSBP and CSBP compared with the rabbits fed the control diet. Average daily feed intake of rabbits fed 15% CSBP was higher ( $P<0.05$ ) than those fed 30% CSBP. Rabbits fed the control diet recorded higher ( $P<0.05$ ) average daily feed intake than rabbits fed 30% LSBP and those fed 30% CSBP. It is clearly to note that feed intake was linearly reduced with the increase of dietary inclusion of either LSBP or CSBP. These results were similar with the findings reported by Ciurescu *et al.* (2017) who demonstrated that broiler groups

fed 20 and 40% lentil seeds replacement levels of soybean meal had an insignificant difference in DWG, FI and FCR. On the contrary, Soğüt *et al.* (2018) reported that there were insignificant differences in feed intake of turkey groups fed lentil by-products up to 30% and found also that body weight gain did not affect when turkey group fed lentil by-products up to 15%. While, the best of FCR was recorded by turkey group fed 25% lentil by-products. Additionally, Hassan *et al.* (2016) stated that rabbits fed 25% and 50% chickpea screenings by-products achieved significantly ( $P < 0.05$ ) better average daily gain by 10.56% and 12.52%, respectively and better FCR (3.65 and 3.74 vs. 4.16 g feed/g gain) than the control group.

**Table (3). Amino acids profile of LSBP and CSBP (gkg<sup>-1</sup> dry matter).**

Item	Essential amino acids		Non-essential amino acids		
	LSBP	CSBP	LSBP	CSBP	
Arginine	21.3	18.5	Alanine	10.98	9.30
Threonine	9.90	8.01	Aspartic acid	29.0	22.3
Histidine	9.2	9.20	Glutamic acid	40.2	40.10
Isoleucine	10.60	9.80	Glycine	10.2	9.50
Leucine	19.01	21.03	Proline	10.5	9.90
Lysine	17.6	14.3	Serine	13.0	10.01
Methionine	2.2	3.40	Cystine	2.10	4.01
Phenylelalanine	12.98	13.87	Tyrosine	7.80	7.20
Tryptophan*	-	-			
Valine	10.98	14.50			
Total	115.97	114.19	Total	123.78	112.32

\*Not determined

LSBP= Lentil screening by-product; CSBP= Chickpea screening by-product.

**Table (4). Growth performance of growing rabbits fed on experimental diets**

Item	Substitution level of legume screenings by-products protein					P-value
	Control	15% LSBP	30% LSBP	15% CSBP	30% CSBP	
Initial live body weight, (IBW)(g)	580.56 ±26.88	580.56 ±24.43	579.44 ±26.23	580.56 ±24.88	580.56 ±23.46	1.00
Final live body weight, (FBW)(g)	2011.67 ±70.98	2013.89 ±50.91	2016.67 ±47.28	2013.33 ±45.13	2015.56 ±34.93	1.00
Daily weight gain (DWG) (g/rabbit/day)	29.21 ±1.48	29.25 ±1.09	29.33 ±1.25	29.24 ±1.12	29.28 ±0.65	1.00
Average daily feed intake (ADFI) (g/rabbit/day)	113.20 <sup>a</sup> ±1.83	108.07 <sup>abc</sup> ±2.42	106.46 <sup>bc</sup> ±1.88	109.44 <sup>ab</sup> ±0.96	102.94 <sup>c</sup> ±1.02	0.003
FCR (g feed/g gain)	3.87 ±0.22	3.69 ±0.13	3.63 ±0.19	3.74 ±0.14	3.52 ±0.08	0.44

a, b and c means within the same row with common letter are not significantly different ( $p > 0.05$ ).

In the present study, although rabbits did not have a significant improvement in growth performance, no deterioration in growth performance was observed during the growth experimental period. This may be due to that lentil and chickpeas screening by-products are rich sources of energy and protein and also could supply enough essential amino acids as presented in Tables (2 and 3) to cover the growing rabbit's nutritional requirements. Additionally, chickpeas and lentils are low in anti-nutritional factors. However, trypsin inhibitor limits the inclusion of chickpeas at high levels and excessive amounts may cause

digestive problems (Hawthorne, 2006). In this respect, Hassan *et al.* (2016) mentioned that the chickpea screenings by-products seem to be satisfactory an energy source for the weaned rabbit and it could be used at 25 and 50% in replacement of barley as a non-conventional feedstuff without any detrimental effects on the growth performance. In the same concern, lentil screenings had tannin concentrations of 1.4% (expressed as catechin equivalents) (Stanford *et al.* 1999), but this is not present in sufficient quantities to depress animal performance (Mavromichalis, 2013). Furthermore, Chickpea screenings by-products contained 4.57 g/100g DM phytic acid; 0.90 g/kg saponins and 1.44g/kg tannins (Hassan *et al.*, 2016), so there are some constraints to the inclusion levels of chickpea and lentil screenings by-products in rabbit diets. It is worth to note that bioactive compounds like polyphenol and high nutritional compositions of chickpea and lentil screening by-products are highly associated with improving the rabbit's health. Therefore, chickpeas and lentils screenings by-products are useful as protein and energy sources for rabbits diets.

#### *Nutrients digestibility and nutritive values*

Nutrients digestibility and nutritive values of rabbits fed experimental diets are summarized in Table (5). The results indicated that no significant changes were noticed in all nutrients digestibility of DM, OM, CP, CF, EE and NFE between groups of rabbits fed LSBP and CSBP diets and those fed the control diet. Meanwhile, a group of rabbits fed 30% LSBP had the highest ( $P<0.05$ ) of CP digestibility. Conversely, a group of rabbits fed 30% CSBP recorded the lowest ( $P<0.05$ ) CP digestibility. In regard to

**Table (5). Nutrients digestibility and nutritive values of growing rabbits fed on different levels of LSBP and CSBP.**

Item	Substitution level of legume screenings by-products protein					P-value
	Control diet	15% LSBP	30% LSBP	15% CSBP	30% CSBP	
Nutrient digestibility (%)						
Dry matter (DM)	84.86 ±3.57	78.63 ±3.53	81.34 ±2.85	77.07 ±1.52	81.76 ±3.59	0.48
Organic matter (OM)	86.27 ±3.12	80.49 ±3.09	82.85 ±2.82	78.98 ±1.34	83.64 ±3.08	0.43
Crude protein (CP)	86.08 <sup>abc</sup> ±0.54	86.53 <sup>ab</sup> ±1.16	88.22 <sup>a</sup> ±0.94	84.52 <sup>bc</sup> ±0.09	83.67 <sup>c</sup> ±0.91	0.02
Crude fiber (CF)	45.71 ±4.23	42.18 ±3.84	38.40 ±5.82	26.81 ±2.03	33.11 ±5.83	0.09
Ether extract (EE)	77.61 ±1.17	73.29 ±2.08	72.05 ±6.28	70.44 ±5.66	81.78 ±1.09	0.31
Nitrogen free extract (NFE)	88.95 ±2.60	82.63 ±3.62	85.75 ±1.73	83.80 ±0.98	87.15 ±2.39	0.41
Nutritive value						
Digestible crude protein (DCP%)	15.42 <sup>ab</sup> ±0.10	15.41 <sup>ab</sup> ±0.22	15.64 <sup>a</sup> ±0.18	15.00 <sup>b</sup> ±0.02	14.95 <sup>b</sup> ±0.17	0.04
Total digestible of nutrients (TDN%)	77.88 ±2.58	73.16 ±2.88	74.07 ±2.30	71.02 ±1.18	74.17 ±2.52	0.41
Digestible energy (DE Kcal/kg)	3450.10 ±114.58	3240.80 ±127.83	3281.20 ±102.08	3146.30 ±52.45	3285.90 ±111.45	0.41

*a, b and c means within the same row with common letter are not significantly different ( $p>0.05$ ).*

nutritive values expressed as DCP%, TDN% and DE Kcal/kg. Data showed significant ( $P<0.05$ ) differences in DCP% between the group of rabbits fed 30% LSBP and groups of rabbits fed 15 or 30% CSBP. However, it is clearly noticed insignificant differences in DCP%, TDN% and DE Kcal/kg among the control group and the other tested groups. On the contrary, Hassan *et al.*, (2016) demonstrated that rabbits group fed 25 or 50% chickpea screenings by-products recorded significantly ( $P<0.05$ ) higher digestibilities of DM, OM, CP, CF, EE and NFE compared with the other tested levels of 0, 75 and 100% chickpea screenings by-products. As well the digestibility and biological value of chickpea nutrients are high for poultry (Brenes *et al.*, 2008 and Nalle, 2009). However, due to the presence of anti-nutritional factors, it could have contributed to decrease nutrients digestibility of DM, OM, CF, EE and NFE. Besides, Stanford *et al.* (1999) found that lentil screenings have poor OM digestibility. Furthermore,

chickpea contains a number of secondary compounds that can impair nutrient absorption from the gastrointestinal tract such as variable amounts of trypsin and chymotrypsin inhibitors that may decrease the feeding value for poultry (Bampidis and Christodoulou, 2011). At the same time, Johnson *et al.*, (2013) stated that lentils are known to be a good source of prebiotics and have nutritionally important quantities of prebiotic carbohydrates (12.3–14.1 g/100 g of dry lentils) that help to keep up the gut microbial environment and prevent gut-associated diseases. So, those prebiotic carbohydrates promote the growth of beneficial bacteria in the gut. Lentil and chickpea are rich in prebiotic carbohydrates (Siva *et al.*, 2019). This could explain the significant increase in CP digestibility for a group of rabbits fed 30% LSBP compared to those fed 15 or 30% CSBP because LSBP promotes gut motility and increasing retention in the gut of rabbits.

**Blood plasma parameters**

Results of Table (6) illustrated significant higher ( $P<0.05$ ) values of plasma total protein and albumin concentrations for rabbits fed diets contained 30% LSBP and 15 or 30% CSBP than the control group. While, no significant differences in plasma total protein and albumin values were observed between the rabbits fed 15% LSBP and those fed the control diet. Moreover, the inclusion of LSBP and CSBP did not significantly affect globulin and uric acid among all the experimental groups. Regarding liver functions (AST and ALT), there were significant decreases ( $P<0.05$ ) in AST levels with rabbits fed 30% LSBP and 15 or 30% CSBP compared with a those fed 15% LSBP and the control group. On the other hand, the inclusion of LSBP and CSBP at tested levels of 15 and 30% decreased ( $P<0.05$ ) the blood plasma ALT levels. Rabbits fed the control diet recorded the highest ( $P<0.05$ ) ALT level compared with the other groups. In regard to kidneys function, rabbits fed diets included 30% LSBP and 15 or 30% CSBP had a significant decrease ( $P<0.05$ ) in creatinine levels compared with 15% LSBP and the control group.

**Table (6). Plasma parameters of growing rabbits fed on different levels of LSBP and CSBP.**

Item	Substitution level of legume screenings protein					by-products <i>P</i> -value
	Control diet	15%LSBP	30%LSBP	15%CSBP	30%CSBP	
Plasma proteins						
Total Protein (mg/dl)	6.79 <sup>b</sup> ±0.49	7.05 <sup>ab</sup> ±0.13	7.92 <sup>a</sup> ±0.06	7.81 <sup>a</sup> ±0.23	7.88 <sup>a</sup> ±0.15	0.03
Albumin (mg/dl)	3.87 <sup>c</sup> ±0.03	4.06 <sup>c</sup> ±0.13	4.63 <sup>b</sup> ±0.13	4.88 <sup>ab</sup> ±0.09	4.98 <sup>a</sup> ±0.08	<.0001
Globulin (mg/dl)	2.92 ±0.49	2.99 ±0.17	3.29 ±0.07	2.93 ±0.14	2.90 ±0.12	0.79
Liver functions						
AST (U/ml)	45.27 <sup>a</sup> ±1.03	43.04 <sup>a</sup> ±0.89	38.62 <sup>b</sup> ±1.14	37.33 <sup>b</sup> ±0.77	32.05 <sup>c</sup> ±1.21	<.0001
ALT(U/ml)	40.28 <sup>a</sup> ±0.92	36.61 <sup>b</sup> ±0.42	35.39 <sup>b</sup> ±1.16	31.17 <sup>c</sup> ±1.01	24.58 <sup>d</sup> ±1.64	<.0001
Kidneys functions						
Creatinine (mg/dl)	1.18 <sup>a</sup> ±0.02	1.12 <sup>a</sup> ±0.02	1.02 <sup>b</sup> ±0.03	0.96 <sup>b</sup> ±0.02	0.96 <sup>b</sup> ±0.02	0.0002
Uric acid (mg/dl)	3.36 ±0.14	4.80 ±0.73	6.00 ±0.96	5.84 ±0.35	6.00 ±0.55	0.0531

*a, b, c and d means within the same row with common letter are not significantly different (p>0.05).*

Similar results were observed by Hassan *et al.* (2016) who reported insignificant differences in globulin between rabbits fed diets contained chickpea screenings by-products at levels of 25, 50, 75 and 100% of barley compared to the control group, while rabbits fed 50% chickpea screenings by-product had higher ( $P<0.05$ ) plasma total protein concentration than the control group. The present results disagreed with findings reported by Algam *et al.* (2012) who demonstrated that 10% chickpea had no significant effect on plasma total protein of broiler chicks. Also, Algam *et al.*, (2011) found that plasma total protein did not affect in broiler fed 10% chickpea seed replaced by either groundnuts meal or sesame meal. The significant higher contents of plasma total protein and albumin for rabbits may be attributed to that LSBP and CSBP have high quality amino acids profile (Table 3). Furthermore,

lentil protein contains all the essential amino acids however, like other legumes, it is limiting in sulphur amino acids, tryptophan and threonine (Joshi *et al.*, 2017). Moreover, the predominant proteins in lentils are globulin (47% of the total seed proteins) and an adequate quantity of albumin (Lombardi-Boccia *et al.* 2013). In the present study, all values of plasma constituents were within the physiological ranges according to Harcourt-Brown (2002).

### Carcass measurements

The results of Table (7) revealed that insignificant differences in most carcass measurements were found between groups of rabbits fed different levels of LSBP and CSBP diets and those control diet except heart, kidneys weights and total edible parts %. At the same time, rabbits fed 30% CSBP were lower ( $P<0.05$ ) in heart weight than the rabbits fed LSBP at levels of 15 or 30% and the control group. However, the rabbits fed 15% CSBP had lower ( $P<0.05$ ) kidneys weight than those fed the control diet. The inclusion of LSBP at a level of 15% significantly decreased ( $P<0.05$ ) total edible parts % compared with the inclusion of 30% CSBP and the control group. Similarly, Ciurescu *et al.* (2017) did not observe any effect on both carcass weight and dressing percentage of broiler fed two cultivars of lentil seeds up to 40% replacement of soybean meal. In contrast, Hassan *et al.*, (2016) demonstrated significant increase ( $P<0.05$ ) in hot carcass weight of rabbits group fed 50% chickpea screening by-products compared to the control group. They found also that 100% CSB recorded the lowest ( $P<0.05$ ) hot carcass weight, dressing %, Heart% and total edible parts. The present results are in disagreement with those reported by Ndalwise (2013) who reported that hot carcass weight was decreased ( $P>0.05$ ) with increased levels (32 and 47%) of chickpea seed wastes in rabbit diets compared with the control group. The differences of carcass measurements might be due to the slaughter age, breeding, weaning age and feeding conditions (Fernandez and Fraga, 1996 and Yalçın *et al.*, 2006).

**Table (7). Carcass measurements of growing rabbits fed on the experimental diets.**

Item	Substitution level of legume screenings by-products protein					P-value
	Control diet	15% LSBP	30% LSBP	15% CSBP	30% CSBP	
Pre-slaughter weight (g)	2110.00 ±0.0	2046.67 ±77.53	2123.33 ±57.83	2055.00 ±42.52	2108.33 ±102.48	0.88
Carcass weight (g)	1189.61 ± 31.92	1094.96 ±46.67	1187.57 ±33.46	1128.81 ±29.63	1188.25 ±59.32	0.41
Dressing (%)	56.38 ±1.37	53.50 ±0.12	55.93 ±1.08	54.93 ±0.56	56.36 ±0.34	0.15
Head (g)	111.667 ±1.66	108.333 ±4.41	108.333 ±4.40	111.667 ±1.67	110.00 ±5.00	0.93
Liver (g)	80.58 ±3.71	73.86 ±6.60	80.10 ±6.35	85.80 ±7.71	73.67 ±5.52	0.61
Heart (g)	7.33 <sup>ab</sup> ±0.61	7.50 <sup>ab</sup> ±0.50	8.27 <sup>a</sup> ±0.07	6.40 <sup>bc</sup> ±0.80	5.37 <sup>c</sup> ±0.35	0.02
Spleen (g)	1.42 ±0.27	1.62 ±0.32	1.22 ±0.40	1.08 ±0.25	1.23 ±0.12	0.72
Kidneys (g)	20.17 <sup>a</sup> ±1.43	17.13 <sup>ab</sup> ±0.27	16.00 <sup>ab</sup> ±1.51	15.40 <sup>b</sup> ±0.62	16.07 <sup>ab</sup> ±1.97	0.01
Edible giblets (%) <sup>1</sup>	5.12 ±0.24	4.83 ±0.44	4.90 ±0.24	5.23 ±0.33	4.53 ±0.23	0.56
Total edible parts (%) <sup>2</sup>	56.38 <sup>a</sup> ±1.37	53.50 <sup>b</sup> ±0.12	55.93 <sup>ab</sup> ±1.08	54.93 <sup>ab</sup> ±0.56	56.35 <sup>a</sup> ±0.34	0.01
Cecun length (cm)	29.33 ±0.88	31.00 ±1.15	30.66 ±0.66	30.67 ±1.45	30.33 ±0.66	0.80
Intestine length (cm)	165.00 ±2.00	184.00 ±13.07	187.66 ±10.71	199.66 ±14.72	187.67 ±16.04	0.43

*a, b and c means within the same row with common letter are not significantly different ( $p>0.05$ ).*

1) *Edible Giblets %= (liver+ kidney + heart) / Pre-slaughter weight (g)\*100*

2) *Total edible parts (%)= (carcass wt+ Edible Giblets)/ Pre-slaughter weight (g)\*100*



**Economical efficiency**

The present results of Table (8) show that the best economical efficiency and net revenue were recorded by 30% CSBP diet followed by 30%LSBP, 15%LSBP, 15% CSBP diets and the lowest values were found for the control group. This may be related to the decreasing of total feed cost per rabbit with groups fed diets contained LSBP and CSBP because of the low prices of chickpea and lentil screenings by-products. Moreover, no impairment of growth performance was observed with groups of rabbits fed diets contained LSBP and CSBP. This is in accordance to the other results reported by Hassan *et al.*, (2016) who stated that the inclusion of chickpea screening by-products at 25, 50, 75 and 100% in rabbit diets had an improvement in economic efficiency and net revenue compared with the control group. Therefore, lentil and chickpeas screenings by-products are useful protein sources with good quality and energy-rich feed because of their competitive price (Lardy and Anderson, 2009 and Hassan *et al.* 2016). It is well known that feed costs could be minimized by using cheaper and non-traditional feed ingredients. Furthermore, possible effects on animal growth performance must also be evaluated (De Blas *et al.*, 2018 and Uhlířová *et al.*, 2018). Effective utilization of available feed resources is the key to economical livestock rearing (Beigh *et al.*, 2017 and Mudgal *et al.*, 2018). So the present study confirms that LSBP and CSBP could be used as alternative protein sources with competitive prices compared with the traditional protein sources in growing rabbits.

**Table (8). Economical efficiency of experimental diets included LSBP and CSBP**

Item	Substitution level of legume screenings protein				
	Control diet	15%LSBP	30%LSBP	15%CSBP	30%CSBP
Total body weight gain (kg)	1.431	1.433	1.437	1.432	1.435
Price of 1 kg body weight (L.E.)	50	50	50	50	50
Selling price/rabbit (L.E.) (A)	71.56	71.67	71.86	71.64	71.75
Total feed intake (kg)	5.55	5.30	5.22	5.36	5.04
Price of 1 kg feed (LE)	4.97	4.88	4.69	4.88	4.68
Total feed cost/rabbit (LE) (B)	27.58	25.86	24.48	26.16	23.59
Net revenue (LE) <sup>1</sup>	43.97	45.80	47.38	45.48	48.16
Economic efficiency <sup>2</sup>	1.59	1.77	1.94	1.74	2.04

<sup>1</sup>Net revenue =A - B

<sup>2</sup>Economical efficiency = Net revenue / B

**CONCLUSION**

According to the previous results, it may be concluded that the substitution of LSBP and CSBP protein for soybean meal protein up to 30% level did not cause any adverse effects on growth performance, nutrients digestibility, plasma parameters and carcass measurements. Additionally, LSBP and CSBP diets had the best profitability. The LSBP and CSBP could be used as unconventional protein sources in growing rabbit diets.

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**أداء النمو وهضم العناصر الغذائية وقياسات الذبيحة للأرانب النامية المغذاه علي علائق تحتوي علي مخلفات غربلة العدس أو الحمص.**

**مروه عبد المنعم و فوزية عامر حسان و هدي الجابري و لمياء فتحي عبد المولي**  
**معهد بحوث الانتاج الحيواني- مركز البحوث الزراعية- الدقي- الجيزة- مصر.**

هذا البحث يهدف إلي دراسة تأثير إحتلال 15 او 30 % من بروتين كسب فول الصويا بكلا من بروتين مخلفات غربلة العدس والحمص علي أداء النمو وهضم العناصر الغذائية وقياسات البلازما وقياسات الذبيحة والعائد الإقتصادي للأرانب النامية.

قسمت 60 أرنب نيوزلندي أبيض عمر 6 اسابيع إلي 5 مجموعات تجريبية كل مجموعة مقسمة إلي 4 مكررات كل مكرر يحتوي علي 3 أرانب كالتالي: مجموعة الكنترول المغذاه علي العليقة الأساسية بدون بروتين مخلفات غربلة العدس والحمص والمجموعة الثانية والثالثة والرابعة والخامسة المغذاه علي 15 و30% بروتين مخلفات غربلة العدس، 15 و30% بروتين مخلفات غربلة الحمص. علي الترتيب. اظهرت النتائج أن بروتين مخلفات غربلة العدس يحتوي علي أقل محتوى من المادة الجافة والمادة العضوية ومستخلص الايثير والطاقة المهضومة من بروتين مخلفات غربلة الحمص. وكذلك يحتوي علي محتوى عالي من البروتين الخام والألياف الخام والرماد مقارنة ببروتين مخلفات الحمص. كان بروتين مخلفات غربلة العدس عالي في الاحماض الامينية الارجينية والثريونين والايزوليوسين والليسين. ويحتوي بروتين مخلفات غربلة الحمص علي محتوى عالي من الليوسين والمثيونين والفينيل الانين كأحماض أمينية اساسية. حسن إحتلال بروتين مخلفات غربلة العدس والحمص من وزن الجسم النهائي والزيادة الوزنية ومعامل التحويل الغذائي. كان متوسط المأكول من العلف اليومي عالي معنويا للأرانب المغذاه علي 15% من بروتين مخلفات غربلة الحمص عن تلك المغذاه علي 30% بروتين مخلفات غربلة الحمص. ولم تلاحظ فروق معنوية في كل معاملات هضم العناصر الغذائية (المادة الجافة والمادة العضوية و البروتين الخام

ومستخلص الإبيثير والمستخلص الخالي من النيتروجين) والقيم الغذائية كالبروتين الخام المهضوم ومجموع المركبات الغذائية المهضومة والطاقة المهضومة بين مجموعة الأرانب المغذاه علي علائق بروتين مخلفات غربلة العدس والحمص وتلك المغذاه علي عليقة الكنترول. وكانت مجموعة الأرانب المغذاه علي 30% بروتين مخلفات غربلة العدس أعلي معنويا في معامل هضم البروتين الخام. علي العكس سجلت مجموعة الأرانب المغذاه علي 30% بروتين مخلفات غربلة الحمص أقل معامل هضم بروتين خام معنويا. سجلت مجموعة الأرانب المغذاه علي 30% بروتين مخلفات غربلة العدس و 15, 30% بروتين مخلفات غربلة الحمص أعلي التركيزات من بلازما الدم للبروتين الكلي والاليومين من مجموعة الكنترول. بالإضافة انه لا توجد فروق معنوية في الجلوبيولين وجامض اليوريك بين كل المجموعات التجريبية، يوجد انخفاض معنوي في مستويات انزيم AST مع الارانب المغذاه علي 30% من بروتين مخلفات غربلة العدس و 15 و 30% من بروتين مخلفات غربلة الحمص مقارنة بمجموعة الكنترول. لا توجد فروق معنوية في معظم قياسات الذبيحة بين الارانب المغذاه علي مستويات مختلفة من بروتين غربلة مخلفات العدس والحمص وتلك المغذاه علي العليقة الكنترول ما عدا وزن القلب والكليتين ونسبة الاجزاء الكلية المأكولة مقارنة مع الاحلال 30% بروتين مخلفات غربلة الحمص ومجموعة الكنترول. تحسن العائد الصافي بنسبة 4,16 , 7,75 , 3,43 , 52, 9% للمجموعة 15% بروتين مخلفات العدس, 30% بروتين مخلفات غربلة العدس , 15% بروتين مخلفات غربلة الحمص, 30% بروتين مخلفات غربلة الحمص علي الترتيب. سجلت 30% بروتين مخلفات غربلة الحمص افضل عائد وكفاءة اقتصادية متبوعة بمجموعة 30% بروتين مخلفات غربلة العدس ثم 15% بروتين مخلفات غربلة العدس ثم 15% بروتين مخلفات غربلة الحمص ثم 15% بروتين مخلفات غربلة الحمص والاقل كانت مجموعة الكنترول.

يمكن استخدام بروتين مخلفات غربلة العدس أو الحمص حتي مستوي احلال 30% من بروتين كسب فول الصويا بدون اي تأثيرات سلبية علي اداء النمو ومعاملات الهضم وقياسات بلازما الدم وقياسات الذبيحة للأرانب النامية.