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EFFECT OF CHICKPEA SCREENINGS BY-PRODUCTS AS UNTRADITIONAL ENERGY SOURCE ON GROWTH PERFORMANCE AND DIGESTIBILITY OF GROWING RABBITS

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SUMMARY

This work aimed to study the effects of partial and complete substitution of barley by chickpea screenings by-products (CSB) at levels 25, 50, 75 and 100% in rabbit diets on growth performance and nutrients digestibility of New Zealand White rabbits. Seventy five rabbits, five weeks old with an average body weight 786.73 g±32.02 were randomly divided into five groups. Each group included five replicates (three rabbits each). Results of growth trail revealed that rabbits fed 25% and 50% CSB achieved significantly ($P<0.05$) better ADG by 10.56%; 12.52% compared with the control group. Besides, FCR values were significantly ($P<0.05$) better with rabbits group fed 25 and 50% CSB than the control group (3.65 and 3.74 vs. 4.16 g feed/g gain). Nutrients digestibility increased ($P<0.05$) with the rabbit groups fed 25 or 50% CSB diets in comparison to the control group. The recorded values were 69.20 and 69.44% vs. 63.88% for DM; 71.51 and 71.56% vs.66.12% for OM.; 70.55 and 72.30% vs. 63.77% for CP.; 52.40 and 51.80% vs. 42.75% for CF.; 75.61 and 75.31% vs.71.60% for NFE, respectively. Accordingly, rabbit groups fed 25 or 50% CSB recorded higher ($P<0.05$) values of DCP, TDN and DE in comparison with the other experimental groups. Total VFA values were higher ($P<0.05$) with rabbit groups fed CSB at 25 and 50% CSB diets (5.98 and 5.79 meq/100ml). Higher increases ($P<0.05$) in hot carcass weight were observed in rabbits group fed 50% CSB diets than the control group. On the other hand, 100% CSB diets recorded the lowest ($P<0.05$) hot carcass weight, dressing %, Heart% and total edible parts. Significant ($P<0.05$) higher values of plasma total protein and urea-N were detected in rabbits fed diets contained 50% CSB than the control group. While, both groups fed 75 and 100% CSB had nearly comparable values of total protein and lower ($P<0.05$) concentrations of plasma total cholesterol compared with the control group. Inclusion of 25, 50, 75 and 100% CSB improved economical efficiency and net revenue compared to the control group. It could be concluded that substitution of chickpea screenings by-products as non-traditional energy source in rabbit diets at 25, 50, 75 and 100% instead of barley has no negative effect on growth performance and digestibility of most nutrients and nutritive values of tested diets indicating that it could be considered as promising source of energy for incorporation into rabbit's diets.

Keywords: *chickpea screenings by-products, growth performance, rabbit, digestibility, carcass, blood, economical efficiency*

INTRODUCTION

Rabbit is not only herbivorous but also a monogastric animal. Thus, it is able to valorize raw forages and concentrates. A great attention must be given to the quality of the proteins distributed to rabbits especially the composition in amino acids of these proteins. (Lebas, 2013). Chickpea *(Cicer arietinum* L.) is a legume seed, which is mostly used for human food. There are 2200 Ha cultivated with chick peas in Egypt (FAOSTAT, 2013). Approximately 4700 tons of chickpea are produced annually in Egypt. The wastes of chick peas were ranged from 15- 20% of the total production,. Chickpeas by-products include light, cracked or broken seeds and hulls (Pourhesabi *et al*. 2007)**.** Chickpea seed contains 29% protein, 59% carbohydrate, 3% fiber, 5% oil and 4% ash. Chickpea is also a good source of absorbable Ca, P, Mg, Fe and K (Chavan *et al*. 1989 and Christodoulou *et al*., 2005). The chemical composition of grades of screenings may nearly resemble chickpea in feeding value. It is known that the proteins of legumes are higher in essential amino acids especially lysine and arginine which are more digestible than those of cereals but, are deficient in sulphur-containing amino acids being methionine and cystine (Fraga, 1998, Iqbal *et al*. 2006 and Lebas, 2013). Due to their low level of fibre, chickpeas have a digestible energy that exceeds rabbit energy requirements, making them a suitable source of energy for rabbit feeding (Lebas, 1988 and Nizza *et al*. 1993). However, the value of these seeds when they are used unprocessed, is limited by the presence of various anti-nutritive factors such as trypsin inhibitors, saponins, lectins or tannins, These metabolites, in some concentrations reduced nutrient digestibility (Fraga, 1998 and Jezierny *et al*. 2010). The main objective of this work was to study the possibility of replacing chickpea by-products for barley in rabbit diets at 0, 25, 50, 75 and 100% levels and their effects on growth performance, digestibility, carcass characteristics and blood constituents of New Zealand White rabbits.

MATERIALS AND METHODS

Animals, diets and experimental design

The experimental work of this study was carried out at Borg-El Arab, Alexandria Governorate, Experimental Research Station, Animal Production Research Institute, Egypt. Samples of Chickpea (*Cicer arietinum* L.) by-products (broken seeds and hulls) were obtained from chickpea sorting factories located in El-Bahera Governorate. The moisture content in these samples is 10%, they are ground by hammer mill and kept for mixing and pelleting.

Table (1): Feed ingredients and chemical composition of experimental diets (%DM basis).

Feed Ingredients (%)	Substitution level of barley by chickpea screenings by-products				
	Control (0%CSB)	25%CSB	50%CSB	75%CSB	100%CSB
Soybean meal (44%CP)	16	16	15	14	14
chickpea by-products	--	5	10	15	20
Barley	20	15	10	5	--
Clover hay	34	34	34	36	35
Wheat bran	24	24	25	24	25
Molasses	3.0	3.0	3.0	3.0	3.0
Di- Ca- phosphate	2.0	2.0	2.0	2.0	2.0
Dl-Methionine	0.4	0.4	0.4	0.4	0.4
Salt	0.3	0.3	0.3	0.3	0.3
Vit.-Min. premix[1]	0.3	0.3	0.3	0.3	0.3
Chemical composition(%DM basis)					
DM	88.38	88.30	88.49	88.87	88.24
OM	90.55	91.46	92.07	91.69	91.40
CP	17.37	17.50	17.03	17.73	17.43
CF	13.16	13.09	12.90	12.71	12.51
EE	2.08	2.44	2.77	2.16	2.77
NFE	58.04	58.43	59.29	59.47	58.88
Ash	9.35	8.54	8.01	7.93	8.41
NDF	29.93	30.33	30.42	30.49	30.57
ADF	16.67	16.94	17.11	17.27	17.44
ADL	3.64	3.71	3.74	3.78	3.82
Methionine[2]	0.64	0.64	0.64	0.64	0.64
Lysine[3]	0.80	0.80	0.80	0.80	0.80
Calcium[4]	1.01	1.01	1.01	1.01	1.01
Phosphorus[5]	0.66	0.66	0.65	0.65	0.65
Digestible energy(Kcal/Kg DM)[6]	2599.60	2630.80	2639.21	2645.51	2617.67

(1) Each kg vitamins and minerals premix contains:Vit. A. 2.00000IU,10.000mg, $B_1$400mg, $B_2$1200mg, B_6,400mg, B_{12}.2mg, K_3 400 mg, D_3 200000IU, Choline chloride 240mg pantothenic acid 400mg, Niacin 1000mg, Folic acid 1000 mg, Biotin 40 mg, Manganese 1700 mg, Zinc 14000 mg, Iron 1500mg, copper 500 mg, selenium 20 mg, Iodine 40 mg and Magnesium 8000 mg.
(2,3,4,5) Calculated on the basis of the ingredients composition.
(6) Digestible energy (DE) was calculated according to Lebas (2013) using the following equation: $DE = 15.627 + 0.000982\ CP^2 + 0.0040\ EE^2 - 0.0114\ MM^2 - 0.169\ ADF \pm 1.250$ MJ/kg DM. DE in M Joules /kg DM ; DM = Dry matter ; CP = %crude protein in DM; EE = % ether extract (lipids) in DM; MM =% minerals (ash) in DM; ADF = % acid detergent fibre in DM ; CF = % crude fibre in DM.

Seventy five weaning male New Zealand White rabbits, at 5 weeks of age and nearly equal average initial live body weight (786.73 g) were randomly assigned to five experimental treatment groups (n=15 in each) in a completely simple randomized design. Each group has five replicates of which three rabbits per replicate are housed in galvanized batteries (60×40×24 cm) and provided with feeders and automatic drinkers. Feed and water were offered *ad libtium*. Five experimental diets were formulated; the first used as control diet (0% chickpea screenings by-products) while, other four diets were formulated to replace chickpea screenings by-products for barley at levels of 25, 50, 75, 100%. All the experimental diets were formulated to be iso-nitrogenous, iso-caloric, and to meet all the essential nutrient requirements of growing rabbits according to Lebas 2013 as shown in Table 1.

The experimental period lasted for 8 weeks. Live Body weight was determined weekly throughout the experimental period, and weight gain was calculated. Feed consumption was determined precisely and calculated as grams per rabbit per day (during the all experimental period). Feed conversion ratio was also calculated (g feed / g gain).

A digestibility trial was conducted to determine the nutrient digestibility coefficients and the nutritive value of the experimental diets according to (Perez *et al.* 1995). Fifteen male New Zealand White rabbits were used in a digestibility trial and allotted randomly to five groups of three rabbits each. Rabbits were housed in individual metabolism cages and fed the experimental 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 daily feces of each rabbit were taken and oven dried at 70º C for 48h, then was ground and stored for proximate chemical analysis. Samples of feed and dried feces were analyzed for dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF), and ash according to the classical (AOAC, 2000) methods. The nutritive value of the experimental diets as DCP and TDN value were calculated according to Cheeke *et al*. (1982). Digestible energy (DE, Kcal/Kg diet) was calculated as follow: TDN × 44.3 according to (Schneider and Flatt, 1975).

Chemical analysis

Chemical analysis was performed as recommended by A.O.A.C (2007) for determining moisture, crude protein (CP), crude fiber (CF), ether extract (EE), nitrogen free extract (NFE), ash and minerals for the raw materials, diets and dried feces, Calcium was determined by atomic absorption spectrophotometer and phosphorous was determined clorimetrically using spectrophotometer. Neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) were determined sequentially according to Van Soest *et al*. (1991). Gross energy was determined by Isoperibol bomb calorimeter (Parr 1261). Chickpea by-products was ground by hammer mill and kept for mixing and pelleting. Tannins were determined using vanillin hydrochloric acid method as described by Burn (1971) and saponins were determined by using the method of Shany *et al.* (1970) and phytic acid was determined clorimetrically using DU 7400 spectrophotometer according to A.O.A.C (2000).

Slaughter traits

At the end of the experimental period (14weeks old), 5 rabbits from each treatment were randomly kept off feed for 12h, weighed and slaughtered for carcass characteristics and meat analysis. Slaughter procedure and carcass analysis were carried out as described by Blasco and Ouhayoun (1996). After complete bleeding, the skin, viscera and tail were removed and the hot carcasses and its components were weighed as edible parts (liver, kidneys and heart), besides, caecum weight and caecum length was determined. Dressing percentage was calculated by dividing the hot dressed carcass weight by pre-slaughter weight and expressed as a percentage according to Steven *et al.* (1981). Blood samples (5 ml from each rabbit) were collected during slaughter to determine blood biochemical components. Plasma was separated from blood by centrifugation at 3,000 rpm for 15 min and stored at -20^{o}C till assayed. Plasma total protein, albumin, total cholesterol, urea-N, AST, ALT and creatinine 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 Orsonneau *et al*. (1989). Plasma globulin concentration was calculated by the difference between total protein and albumin so the Albumin/Globulin ratio was easily calculated. Cholesterol was estimated according to Richmond (1973). Cretatinin was assayed according to Hauot (1985), Urea-N was determined according Fawcett and Scott (1960) and AST, ALT were measured according Reitman and Frankel, (1957).

Caecum Parameters

Gastrointestinal tracts were individually removed from three slaughtered rabbits from each group, the cecum was weighed and the pH of the caecal content was measured using digital pH meter (Orion Research Digital pH meter, model 201). Then, the caecal content was collected and divided into two samples, one of them was taken to estimate the cecum microflora (Total anaerobic bacterial count and Anaearobic cellulytic bacterial count) determined by standard method according to British Standards Institution (1991). Using nutrient agar medium (Difco Manual, 1984), another sample was filtered through four folds of gauze for determination of total volatile fatty acids by steam distillation (UDK 139-Semi-Automatic Distillation Unit) according to Warner (1964).

Economical Evaluation

The relative economical efficiency (REE) of the experimental diets for the cost of feed required for producing one kg of body weight gain were calculated. The cost of the experimental diets was calculated according to the price of different ingredients prevailing in local market as well as the price of testing materials at the time of experimentation. Economical efficiency (EE) was calculated as a ratio between the return of weight gain and the cost of consumed feed.

Statistical Analysis

The results of experimentation were statistically analyzed using GLM (general linear model) procedure of SAS (2000) by one-way ANOVA. Differences among means were separated using Duncan's multiple range test (Duncan, 1955). The model used was: $Yij = \mu + Ti + Eij$. Where: Yij= the observation of ij; μ= the overall mean; Ti= the effect of I (treatments); Eij= the experimental random error.

RESULTS AND DISCUSSION

Chemical evaluation of chickpea screenings by-products

Results of chemical composition in Table (2) indicated that, Chickpea screenings by-products had higher CP, EE contents and lower CF, neutral detergent fiber (NDF) and acid detergent fiber (ADF), ADL contents, compared with barley. These results are in agreement with those obtained in the literature (Chavan *et al*. (1989), Brenes *et al*. (2008), Lardy and Anderson (2009) and Bampidis and Christodoulou (2011)). While, Ghezeljeh and Mesgaran (2010) reported that chickpea pre-screening by-products has high CP, EE, CF and low NDF, ADF (279, 78, 72, 351 and 96 g/kg DM, respectively) compared with the present study. Also Algam *et al*., (2012) found that the chickpeas seeds contained 24.31%CP, 13.37%CF and 3.78% EE .Concerning to minerals content, Ca and P content were higher in chickpea screenings by-products than in barley. Minerals level of Chickpea screenings by-products are comparable to those values reported by Lardy and Anderson (2009) who found that CSB contained 0.17% and 0.37% for Ca, P, respectively.

Table (2): Chemical composition of chickpea screenings by-products and Barley (on dry matter basis).

Item %	DM	OM	CP	CF	EE	NFE	Ash	NDF	ADF	ADL	Ca	P	GE*
Barley	92.00	97.30	9.62	6.30	2.00	79.38	2.70	19.01	8.02	2.04	0.06	0.35	3770
CSB**	90.19	95.69	22.43	3.04	3.18	67.04	4.31	13.60	5.64	1.43	0.18	0.36	4120

**GE(Kcal/Kg DM): Gross Energy. **CSB: Chickpea screenings by-products.*

Data in Table (3) indicated that chickpea by-products contained 4.57g/100g DM phytic acid. While, El-Adawy (2002) found that chickpea grains contained 12.1 g/kg. Phytic acid form complex with proteins and consequently reduce their availability besides, it reduces the activity of pepsin, trypsin and αamylase (Sebastian *et al*., 1998). Chickpea screenings by-products also contain 0.90 g/kg saponins and 1.44 g/kg tannins which impair nutrient absorption from the gastrointestinal tract and can result in detrimental effects on animal health and growth (Chavan *et al*. 1989 and Perez-Maldonado *et al*. 1999). Moreover, Algam *et al*. (2012) stated that chickpeas seeds contained 0.056% tannins and 0.641% phytic acid. On the other hand, the content of GE in Chickpea screenings by-products was higher than that of barley, Thacker *et al*. (2002) found that GE of chickpea is 4400 kcal/kg DM (Table 2).

Table (3): Anti-nutritional factors of chickpea screenings by-products (on dry matter basis).

Item	Phytic acid (g/100g DM)	Saponins g/kg	Tannins g/kg
CSB	4.57	0.90	1.44

CSB: chickpea screenings by-products

Growth performance

Performance evaluation of the rabbits fed varied levels of CSB substituted for barley during the whole experimental period are presented in Table 4 indicated that LBW of rabbits fed 25%CSB, 50%CSB and 75%CSB diets recorded significantly ($P<0.05$) better final live body weight (LBW) and average daily gain (ADG) when compared with the control group but insignificant differences were observed between 25%CSB and 50%CSB during the whole experimental period. It is noting that when barley was partially replaced with CSB at 75 and 100% levels, final LBW and average daily gain significantly decreased during the experimental period. Average daily feed intake in 50%CSB group was higher ($p<0.05$) than those in (25%CSB, 75%CSB and 100%CSB) groups during entire experimental period. It is observed that when CSB level increased, the amounts of feed intake significantly decreased ($p<0.05$), but insignificant differences were observed between (CSB0) and (75%CSB) during the whole experimental period. Feed conversion ratio were clearly better ($P<0.05$) with rabbit groups fed CSB diets at different tested levels in comparison with the control group.

In this connection, Lebas (1988) found that the inclusion of chickpeas up to 20% replacing partially soybean meal had no negative effects on growth rates. Alicata *et al*. (1991) found that the inclusion rates of 10 and 20% chickpeas are more common in rabbit diets. However, Christodoulou *et al*. (2006) showed that broiler turkey diets containing higher inclusion levels of extruded chickpeas (400, 600, 800 g/kg of diet) did not affect daily feed at 84 days of age, but negatively influenced final BW and FCR. This improvement in growth performance with 25, 50 or 75% CSB could be attributed to both high nutritive value (Bampidis and Christodoulou, 2011). Moreover, chickpeas have a high digestible energy making them a suitable source of energy for rabbit feeding (Lebas, 1988; Nizza *et al*. 1993). Besides, chickpea seeds can be used safely as a protein source for growing and breeding rabbits (Alicata *et al*. 1992; Roy *et al*. 2002). Thus, chickpea protein quality was described by Friedman (1996) as being equivalent to that of soybean meal. Nevertheless, the values of daily feed intake (DFI) and average daily gain (ADG) were lower with the highest inclusion of CSB at 100%compared with the other tested inclusion levels (25, 50 and 100%). This adverse effect may be due to the presence of various anti-nutritional factors such as trypsin inhibitors, saponins, lectins or tannins at high level which led to reduce nutrient digestibility (Fraga, 1998 and Jezierny *et al*. 2010). Saponins have long been known to inhibit the absorption and utilization of minerals by animals. Saponins can decrease protein quality by reducing digestibility and palatability (Ogunbode *et al*. 2014).

Table (4): Performance of rabbits fed diets containing chickpea screenings by-products.

Item	Substitution level of barley by chickpea screenings by-products					
	Control (0% CSB)	25% CSB	50% CSB	75% CSB	100% CSB	±SEM
No. of rabbits	15	15	15	15	15	
Initial live body weight, g	789.66	787.88	780.83	784.16	791.11	32.02
Final live body weight, g	1961^{c}	2083^{a}	2099^{a}	2047^{b}	2004^{bc}	23.26
Average daily gain (ADG) / g	20.92^{c}	23.13^{a}	23.54^{a}	22.55^{b}	21.66^{bc}	0.46
Average daily feed intake (ADFI) g/h/d	87.06^{ab}	84.56^{b}	88.01^{a}	85.00^{ab}	81.34^{c}	1.05
FCR (g feed/g gain)	4.16^{a}	3.65^{b}	3.74^{b}	3.77^{b}	3.75^{b}	0.07

a,b,c Means values with the same letter within the same row did not differ significantly (P>0.05).

Digestibility and nutritive values of the experimental diets

Results in Table (5) showed that rabbits group fed 25 or 50% CSB recorded significantly ($P<0.05$) higher digestibility of DM, OM, CP, CF, EE and NFE compared with the other tested levels (0, 75 and 100% CSB). Besides, the digestibility of DM and CP were higher ($P<0.05$) with rabbit groups fed 25, 50 and 75% CSB than the control group. Meantime, insignificant differences were observed among 100% CSB and control group in DM, OM, CP, CF and NFE. These results agreed with those reported by Brenes *et al*. (2008); Nalle (2009) who reported that digestibility and biological value of chickpea nutrients for poultry are high. While, Viveros *et al*. (2001) noticed that the inclusion of 300 g/kg raw Kabuli chickpeas in diets of broiler chickens reduced ileal starch digestibility by 3%, ileal CP digestibility by 18% and apparent ME by 9% compared with those fed the control diet without chickpea. The improvement of digestibility percentages for most nutrients is associated with the increasing of BW and BWG results (Table 4) and the improvement of FCR (Table 4) for the rabbits fed on (25%CSB). Moreover, Data of nutritive values illustrated that rabbit group fed 25 or 50% CSB recorded the highest ($P<0.05$) values of DCP, TDN and DE in comparison with other experimental groups. Lebas (1988) stated that the inclusion of chickpea at 10 or 20% in growing rabbit diets resulted in a high digestible energy concentration for chickpea 3100-3200 kcal DE/kg and a moderate to high digestibility of protein 70 to 80%. Also Nizza *et al*. (1993) found that due to that chickpeas have a low level of fibre, digestible energy exceeds rabbit energy requirements, therefore makes them a suitable source of energy for rabbit feeding.

Table (5): Effect of inclusion of chickpea screenings by-products on digestibility and nutritive values of experimental rabbit diets.

Item	Substitution level of barley by chickpea screenings by-products					
	Control (0% CSB)	25% CSB	50% CSB	75% CSB	100% CSB	±SEM
Digestibility (%)						
DM	63.88^{c}	69.20^{a}	69.44^{a}	66.07^{b}	63.16^{c}	0.67
OM	66.12^{b}	71.51^{a}	71.56^{a}	67.43^{b}	65.57^{b}	0.63
CP	63.77^{c}	70.55^{a}	72.30^{a}	67.06^{b}	64.00^{c}	0.64
CF	42.75^{b}	52.40^{a}	51.80^{a}	44.11^{b}	42.33^{b}	1.28
EE	73.01^{b}	75.49^{a}	75.16^{a}	71.84^{bc}	70.40^{c}	0.65
NFE	71.60^{b}	75.61^{a}	75.31^{a}	71.94^{b}	70.49^{b}	0.71
Nutritive values						
DCP	10.66^{cd}	11.44^{b}	11.78^{a}	10.98^{c}	10.44^{d}	0.11
TDN	63.87^{b}	67.95^{a}	67.90^{a}	63.81^{b}	62.05^{b}	0.63
DE(kcal/kg)	2829^{b}	3010^{a}	3008^{a}	2827^{b}	2748^{b}	28.13

a,b,c--- Means in the same row with different superscripts are significantly different (P<0.05).

Caecum parameters

Results in Table (6) revealed insignificant differences in caecum weight of rabbits fed CSB and control diets. While, rabbit group fed 100% CSB recorded the lowest ($P<0.05$) cecum length. Besides, total VFA values were higher ($P<0.05$) with rabbit groups fed CSB at 25 and 50% CSB diets (5.98 and 5.79 meq/100ml). These values are in general agreement with those obtained by García *et al*. (2002). Moreover, there a significant difference ($P<0.05$) between rabbit fed 25% CSB and the control group in caecum pH. The caecal contents are slightly acid (pH 5.4–6.8) (García *et al*. 2002). Caecal pH varies to the increase in VFA concentration. The high total VFA concentration may be due to high digestible crude fibre content of CSB, which could be well utilized by rabbits since they have hind gut fermentation. Fermentation which is performed by micro flora enables rabbits to obtain protein and energy from feeds with quality cellulose materials. Results of the microbial counts of caecum indicated that rabbits fed 25 and 50% CSB recorded the highest ($P<0.05$) values of total anaerobic bacterial count and anaearobic cellulytic bacterial count. It is clear to notice that incorporating CSB as an energy sources in rabbit diets stimulating the maturation of cecal flora especially cellulolytic bacteria which secretes enzymes capable of hydrolyzing the cellulose as the main components of dietary fiber. These results are confirmed those of Gidenne *et al*. (1998) and Gidenne and LeBas (2002).

Table (6): Caecum activity and microflora count as affected by feeding different levels of chickpea screenings by-products for growing rabbits.

Item	Substitution level of barley by chickpea screenings by-products					
	Control (0% CSB)	25% CSB	50% CSB	75% CSB	100% CSB	±SEM
Caecum weight, g	168.27	188.73	199.43	184.20	183.80	19.89
Caecum length, cm	11.38^{a}	11.60^{a}	11.46^{a}	11.16^{ab}	10.70^{b}	0.18
TVFA meq./100ml cecal juice	5.08^{b}	5.98^{a}	5.79^{a}	5.09^{b}	4.70^{b}	0.15
Caecum pH	5.89^{b}	6.71^{a}	6.27^{ab}	6.13^{ab}	6.05^{ab}	0.22
Total anaerobic bacterial count (log^{-1} cfu/ml)	6.81^{b}	7.32^{a}	7.71^{a}	6.67^{b}	6.47^{b}	0.17
Anaearobic cellulytic bacterial count (log^{-1} cfu/ml)	6.26^{b}	6.72^{a}	6.57^{ab}	6.23^{b}	5.85^{c}	0.13

a,b,c Means in the same row with different superscripts are significantly different (P<0.05).

Carcass characteristics

The effect of CSB inclusion on the carcass characteristics of rabbits is shown in Table (7) the obtained results revealed significant increases (P<0.05) in hot carcass weight of rabbits group fed 50% CSB compared to the control group. On the other hand, 100% CSB recorded the lowest (P<0.05) hot carcass weight, dressing %, Heart% and total edible parts. These results are in disagreement with those reported by Ndalwise (2013) who reported that the mean values of hot carcass weight decreased (P>0.05) with increased levels (32 and 47%) of chickpea seed wastes in rabbit diets compared with control group. The author also noticed insignificant differences in dressing percentage among the different treatments (0,32 and 47%). Besides, Brenes *et al*. (2008) found that increasing amount of chickpea up to 300 g kg^{-1} increased relative liver weights by 3.6 for growing broiler chickens. Moreover, relative liver and kidneys weights and edible giblets% calculated herein showed insignificant differences among all tested groups. These results are in agreement with those reported by Christodoulou *et al*. (2006) who stated that carcass weight, liver weight and carcass yield traits were not affected by feeding diets with increasing levels of extruded chickpeas (400, 600 and 800 kg/t of diet) of broiler turkeys.

Table (7). Carcass characteristics of growing rabbits fed experimental diets.

Item	Substitution level of barley by chickpea screenings by-products					
	Control (0% CSB)	25% CSB	50% CSB	75% CSB	100% CSB	±SEM
Pre-slaughter weight (g)	2042.16^{b}	2100.00^{b}	2185.00^{a}	2056.16^{b}	2047.33^{b}	26.17
Hot carcass weight (g)	1226.67^{b}	1277.15^{ab}	1314.92^{a}	1254.40^{ab}	1142.58^{c}	21.68
Dressing %	60.06^{a}	60.81^{a}	60.18^{a}	61.00^{a}	55.81^{b}	0.73
Liver %	2.73	2.55	2.75	2.84	2.46	0.17
Heart %	0.39^{ab}	0.38^{ab}	0.40^{a}	0.35^{b}	0.29^{c}	0.02
Kidneys%	0.62	0.64	0.58	0.64	0.64	0.02
Edible Giblets[1] %	3.73	3.57	3.74	3.83	3.39	0.19
Total edible parts[2] %	63.80^{a}	64.38^{a}	63.90^{a}	64.83^{a}	59.21^{b}	0.74

a, b, Mean values with the same letter within the same row did not differ significantly (P>0.05).
*(1) Edible Giblets %= (liver+ kidney + heart) / Pre-slaughter weight (g)*100*
*(2) Total edible parts %= (carcass wt. + edible giblets wt.) / Pre-slaughter weight (g)*100.*

Blood constituents

The findings of blood plasma constituents in experimental tested rabbits as shown in (Table 8) illustrated significant ($P<0.05$) higher values of total protein and urea-N for rabbits fed diets contained 50% CSB than the control group. While, both groups fed 75 and 100% CSB diets had nearly comparable values of total protein and the lower ($P<0.05$) values of blood total cholesterol compared to the control group. This may due to chickpea screenings by-products content (0.90 Saponins g/kg), where saponins can inhibit intestinal cholesterol absorption in rabbits resulting in decreased plasma and hepatic cholesterol levels **(**Harwood *et al*. 1993 and Morehouse *et al*. 1999). These results disagree with findings reported by Algam *et al*. (2012) who found that broiler chicks fed 10% chickpea had no significant effect on serum cholesterol and total protein. Moreover, there were insignificant differences in albumin, globulin, A/G ratio, creatinine, AST and ALT values among all the experimental groups.

Table (8). Blood constituents of growing rabbit fed experimental diets.

Item	Substitution level of barley by chickpea screenings by-products					
	Control (0% CSB)	25% CSB	50% CSB	75% CSB	100% CSB	±SEM
Total protein,g/dl	6.50 [b]	6.74 [ab]	7.22 [a]	6.98 [ab]	6.97 [ab]	0.19
Albumin, g/dl	3.88	4.02	4.33	4.63	4.26	0.24
Globulin, g/dl	2.62	2.72	2.88	2.35	2.71	0.20
A/G ratio	1.48	1.48	1.50	1.97	1.57	0.21
Total cholesterol,mg/dl	91.07 [a]	85.70 [ab]	83.77 [ab]	84.64 [b]	82.29 [b]	2.28
Urea-N, mg/dl	21.14 [b]	22.39 [ab]	25.53 [a]	22.64 [ab]	23.49 [ab]	1.16
Creatinine, mg/dl	0.96	0.94	0.98	0.97	0.99	0.05
AST,u/l	32.50	32.34	33.06	32.70	30.73	1.52
ALT, u/l	24.32	24.18	24.68	22.67	22.41	1.31

a, b, Mean values with the same letter within the same row did not differ significantly ($P>0.05$).

Economical evaluation

The effects of the CSB inclusion on economical efficiency as presented in Table (9) showed an improvement in economical efficiency and net revenue compared to the control group with inclusion of

Table (9). Economic efficiency of experimental diets containing chickpea screenings by-products.

Item	Substitution level of barley by chickpea screenings by-products				
	Control (0% CSB)	25% CSB	50% CSB	75% CSB	100% CSB
Initial weight (Kg)	0.789	0.787	0.78	0.784	0.791
Final weight (Kg)	1.961	2.083	2.099	2.047	2.004
Average total weight gain/rabbit (kg)	1.172	1.296	1.319	1.263	1.213
Total revenue /rabbit (LE)[1]	29.30	32.40	32.975	31.575	30.325
Total feed intake/rabbit (Kg)[2]	4.875	4.735	4.928	4.76	4.555
Price of feeding/kg (LE)	2.85	2.7	2.45	2.27	2.21
Total feed cost /rabbit (LE)	13.893	12.784	12.0736	10.8052	10.066
Net revenue/rabbit (LE)[3]	15.406	19.615	20.9014	20.7698	20.258
Economic efficiency(EE)[4]	1.108	1.534	1.731	1.922	2.0124
Relative economic efficiency (REE)[5]	100	138.368	156.120	173.349	181.488

[1] *Assuming that the price of one kg LBW equal, 25 L.E.*
[2] *According to the price of ingredients available at the experimental time.*
[3] *Net revenue/rabbit = Total revenue /rabbit (LE) - Total feed cost /rabbit (LE)*
[4] *EE = Net revenue / Total feed cost / rabbit (LE).*
[5] *REE = EE of treatments other than the control/ EE of the control group.*

25, 50, 75 and 100% CSB. This beneficial effect could be attributed to the reduction of total feed cost because chickpea screenings by-product is so competitive in price as compared to other protein and energy feed sources used in rabbits feeding. Additionally, rabbits fed 50% CSB recorded the best net revenue. This is in agreement with the observation made by Ndalwise (2013) who stated that inclusion of chickpea seed waste at 18, 32 and 47% in growing rabbits diets reduced feed cost by 12.6 percent and increased gross margin per rabbit by 2.5 percent. This improvement may be due to the enhancement of rabbits performance fed 50% CSB. Chickpeas by-products will be available as an alternative source of protein and energy for rabbit nutrition especially when corn and barley are expensive or unavailable.

CONCLUSION

The chickpea screenings by-products seem to be satisfactory an energy source for the weaned rabbit. The reasonable growth performance obtained in this study could encourage us to recommend the use of chickpea screenings by-products at 25 and 50% in replacement of barley as a non-conventional cheap feedstuff in growing rabbit's diets without any detrimental effects on the growth performance.

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تأثير مخلفات غربلة الحمص كمصدر طاقة غير تقليدي علي اداء النمو والهضم في الارانب النامية.

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يهدف البحث إلي دراسة تأثير الإحلال الجزئي والكامل للشعير بمخلفات غربلة الحمص بمستويات 25و 50و 75و 100% في علائق الارانب علي اداء النمو والهضم للارانب النيوزلاندي الابيض. وتم التوزيع العشوائي لعدد 75 ارانب عمر 5 اسابيع ذكور بمتوسط وزن 786 جم إلي 5 مجموعات كل مجموعه تشمل 5 مكررات وكل مكرر يحتوي علي 3 ارانب. وتتلخص النتائج في الاتي:

- حققت الارانب المغذاه علي 25 و 50% مخلفات غربلة الحمص اعلي معدل زيادة يومية بحوالي 10،56 و 12،52% مقارنة بمجموعه الكنترول. بالاضافة إلي أن قيم معامل التحويل الغذائي كانت اعلي معنويا مع الارانب المغذاه علي 25 و50 % مخلفات غربلة الحمص عن مجموعة الكنترول (3،75 و 3،74 و4،16 جم علف/جم زيادة وزنية) علي الترتيب.

- معاملات الهضم زادت معنويا مع الارانب المغذاه علي 25 و 50% مخلفات غربلة الحمص مقارنة بالعليقة الكنترول. وكانت القيم علي الترتيب: 69،20 و 69،44 و 63،88% للمادة الجافة، 71،51 و71،61 و 66،12% للمادة العضوية، 70،55 و 72،30 و 63،77% للبروتين الخام 52،40 و 51،10 و 42،75% للالياف الخام، 75،61 و 75،31 و 71،60% للمستخلص الخالي من النتروجين.

- سجلت الارانب المغذاه علي 25 و 50% مخلفات غربلة الحمص اعلي قيم معنويا للبروتين الخام المهضوم والمركبات الغذائية المهضومة مقارنة بالمجموعات التجريبية الاخري.

- لاحظ ان قيم الاحماض الطيارة الكلية كانت اعلي معنويا مع الارانب المغذاه علي 25 و 50% مخلفات غربلة الحمص (5،98 و 5،79 ملي مكافئ/100 ملي).

- لاحظ ان زيادة معنوية في وزن الذبيحة مع الارانب المغذاه علي 50% مقارنة بمجموعه الكنترول وعلي العكس سجلت الارانب المغذاه علي 100% مخلفات غربلة الحمص اقل وزن للذبيحة ونسبة التصافي ووزن القلب والاجزاء الكلية المأكولة.

- سجلت الارانب المغذاه علي 50% مخلفات غربلة الحمص اعلي بروتين كلي ويوريا في بلازما الدم مقارنة بمجموعه و الكنترول. بينما كانت كل من 75 و 100% متقاربة في البروتين الكلي للبلازما واقل تركيزات للكوليسترول مقارنة بمجموعه الكنترول.

- الاحلال لكل من 25 و 50و 75و 100% حسن من الكفاءة الاقتصادية والعائد مقارنة بعليقة الكنترول.

ونستخلص من النتائج ان احلال مخلفات غربلة الحمص كمصدر طاقة غير تقليدي عند مستويات25 و 50و 75و 100% محل الشعير ليس له تاثير سلبي علي اداء النمو ومعاملات الهضم والقيم الغذائية للعلائق التجريبية ويعتبر مصدر واعد للطاقة في علائق الارانب.