Effect of Dietary Garden Cress Seeds on Growth Performance, Feed Utilization, Carcass Characteristics and some Physiological Responses of Growing Rabbits

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ABSTRACT

A total number of 72 growing rabbits (V-Line) with an average initial weight of 605 ± 8.79 g live body. Rabbits at the age of 6 weeks were used to investigate the effect of increasing levels of garden cress, *Lepidium sativum*, seeds (0, 3, 4.5, 6%) on growth performance, feed utilization, digestibility, carcass characters and physiological performance. The growing rabbits were fed the experimental diets for 7 weeks. The results revealed that garden cress seeds contain considerable levels of crude proteins and crude lipids levels. The dietary garden cress significantly improved final weight, weight gain, and total relative growth rate compared to the control. The maximum growth response was recorded between 3- 4.5% garden cress seeds levels according to the high significant quadratic regression. The feed conversion ratio significantly improved with 3 and 4.5% dietary garden cress seeds levels. The digestibility of crude protein 70.37, 72.46, 73.30 and 79.04%, lipids 77.76, 81.36, 85.20 and 76.94% and nitrogen balance 1.64, 2.22, 2.02 and 2.18 for 0,3,4.5 and 6% garden cress seeds improved with increasing dietary garden cress seeds. The carcass treats did not affect with different treatments, except a significant reduction in the Kidney fat with dietary garden cress seeds. The serum lipid profile did not affect by garden cress seeds supplementation. Finally, the dietary garden cress seeds at levels of 3-4.5% could be recommend as dietary supplementation to the ration of growing rabbits to improve growth, feed utilization, digestibility, and immune response.

Keywords: growing rabbits, garden cress seeds, supplementation, growth, immune status.

INTRODUCTION

Garden cress scientifically known as *L. sativum*. is an annual fast-growing herb, located in the west region of Asia, Egypt and cultivated all over the world (Doke and Guha, 2014). Garden cress can grow in any type of soil and climate conditions and primarily harvested for its seeds (Ramadan and Oraby, 2020), its seeds are small seeds with an oval shape, a smooth texture, and a reddish-brown color. Garden cress seeds are classified as oilseeds and are rich in macro- and micronutrients (Singh & Paswan, 2017; Vaishnavi & Choudhary, 2020), in lipids (14-27%), protein (22-25%), crude fiber (8%) and carbohydrates (33-54%) of the total weight and contain many calories (454 Kcal /100 g) (Gokavi *et al.,* 2004).

The main necessary fatty acids are presented in garden cress seeds; α-linolenic acid (34%), linoleic acid (8.5-11.5%) and arachidic acid (2-3.5%) (Diwakar *et al*., 2010; Jagdale *et al*., 2021).

In garden cress seeds, potassium forms the highest percentage of minerals followed by, phosphorous, calcium, and magnesium. While, both zinc and manganese represents the lowest ratio (Shail *et al*., 2016; El-Salam *et al*., 2019). Garden cress seeds contains vitamins mainly including Tocopherol (327.42 µmol/100 g oil) and Carotenoid (1.0 µmol/100 g oil) (Diwakar *et al*., 2010) as well as riboflavin (0.61 mg/100 g), thiamin (0.59 mg/ 100 g) and niacin (14.3 mg/100 g) are abundant in garden cress seeds (Chaudhary & Gupta, 2017; Singh & Paswan, 2017)**.**

Garden cress seeds are rich in phenolic compound (1572.4 µg/100g) including gallic acid (3001.75 µg/ 100g), ellagic (1460.80 µg/100g) and protocatechuic (582.23 µg/100g) (El-Salam *et al.,* 2019), which due to their high antioxidant activity are regarded as a possible source of functional food components (Sethiya *et al.,* 2014; Nasef & Khateib, 2021). Hesperidin, the main flavonoid (4934.99 µg/100g), was quantitatively identified in garden cress seeds together with rutin (1216.72 µg/100g), naringin (963.79 µg/100g), and other flavonoid components such quercetin, which is a strong antioxidant (El-Salam *et al.,* 2019).

Several studies have documented that the extract of Garden cress seeds possesses antioxidant, anti-diarrheal, anti-pasmodic, antimicrobial, anti-flammatory, and hepatoprotective effect against oxidative damage (Doke and Guha, 2014)**.** Garden cress seeds supplementation at concentration of 1% significantly increased feed intake, body weight, and weight gain of broiler (Hassan and El Shoukary, 2019).

Al-Taee (2013) evaluated the effect of *L. sativum* seeds on biochemical parameters of male rabbits. The results showed that significant decrease in both serum malondialdehyde (MDA) and total cholesterol

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concentration compared to control groups. Also, results showed significant increase in serum total protein concentration compared to control groups. The present study was carried out to investigate the effect of using three levels of garden cress seeds as a natural antioxidant activity on growing rabbit's responses regarding to growth performance, digestibility, immune responses, hematological parameter, and serum biochemistry.

MATERIALS AND METHODS

Experimental design

The present study was carried out at the rabbit Research Laboratory, Department of Animal and Fish Production, Faculty of Agriculture (Saba Basha), Alexandria University. A total number of 72 male and female of V-Line growing rabbits with an average initial live body weight of 605 ± 8.79 g at 6 weeks of age were used. This experiment was lasted for 7 weeks from March to May (2020) including two weeks as an adaptive period. According to Randomized Complete Block Design (RCBD), the growing rabbits were randomly divided into four experimental treatments (n=18). Each treatment was divided into 6 replicates (3 rabbits each). The first group was fed the basal diet without any feed additives. The rabbits of the second, third and fourth groups were fed on the basal diet included 3, 4.5 and 6 % of L. sativum, respectively (Table 1).

All experimental diets were formulated to cover the daily nutritional requirements of rabbits according to NRC (1977). Feed and water were presented ad libitum during whole period of experiment. Rabbits were placed individually in galvanized batteries (50L×50W×40H cm) provided with feeders and automatic drinkers in a windowed rabbit. The incidence of dangerous diseases was largely prevented, and rabbits were not treated with any kind of systematic vaccination or medication. Urine and faces dropped from cages on the floor were removing every day in the morning. In the morning before feeding, the initial live body weight was individually recorded at the beginning as well as the final body weight (FBW) was record at the end of the experiment. Total weight gain, Total feed intake, the relative growth rate, and feed conversion ratio were measured.

Digestibility and nitrogen balance trial

At 12 weeks of age and after the termination of fattening trial, twelve rabbits (four rabbits /treatment) were randomly taken to evaluate the nutrients digestion coefficients of the experimental diets.

Table 1. Ingredients of the experimental diets

Ingredients (%)	Garden cress seeds (%)			
	0	**3**	**4.5**	**6**
Maize grain	16.00	14.00	13.50	12.50
Barley	7.00	7.00	7.00	7.00
Wheat bran	19.00	19.00	19.00	19.00
Soya bean meal 44	20.00	19.00	18.00	17.50
Clover hay	24.00	24.00	24.00	24.00
Wheat straw	10.00	10.00	10.00	10.00
Beet molasses	2.00	2.00	2.00	2.00
Premix[1]	0.30	0.30	0.30	0.30
Calcium Carbonate	0.20	0.20	0.20	0.20
Di-Calcium Phosphate	0.80	0.80	0.80	0.80
Salt (NaCl)	0.50	0.50	0.50	0.50
L-Lysine HCL - 98%	0.15	0.15	0.15	0.15
Methionine - DL - 99%	0.05	0.05	0.05	0.05
Garden cress seeds	0.00	3.00	4.50	6.00

[1]It made up of (unit/ kg diet); vitamin A (12,000 IU), vitamin D3(2000 IU), vitamin E (11 IU), vitamin K (2 mg), pantothenic acid (d-Ca pantothenate) (10 mg), folic acid (1 mg), choline (choline chloride) (250 mg),manganous oxide (60 mg) ferrous sulfate (30 mg), zinc oxide (50), copper sulfate (10 mg), iodine (ethylenediamine di-hydroiodide) (1 mg), cobalt sulphate heptahydrate (0.1 mg) and sodium selenite (0.1 mg).

Rabbits for each treatment were individually placed in metabolic cages that allowed assembling of feces and urine. A period of two weeks was followed as a prime adaptation phase followed by five days for measurement the actual consumed feed, and assembling of feces and urine. The rabbits were fed twice daily at 8 am and 4 pm. Water was available all time. Before presenting the morning meal (8 am) and weighing, feces and urine of each rabbit were quantitatively collected once a day. A (10 %) of the total quantities of feces form each rabbit as representative samples were oven-dried at 70° C for 48 h and then determine the total dry matter (DM) of the feces and calculate the quantities of feces on a DM basis. After that, the samples were ground through (a 1-mm screen) on a Wiley mill grinder and stored frozen at -20 °C for the next chemical analysis.

Representative samples of the offered feed and the feces of each rabbit were chemically analysed according to the methods of (AOAC, 2006) for crude protein (CP, Method 968.06), ether extract (EE, Method 920.39) crude fibber (CF, Method 932.09) and ash (Method 967.05). Organic matter (OM) was calculated as the difference between 100 % DM and ash. Nitrogen free extract (NFE) was calculated following the equation as follow

NFE (%) = 100- (CP %+ EE %+ CF %+ Ash %) .

The urine of each rabbit was collected in a glass recipient, including 10 mL of a 1:1 H_2SO_4: H_2O solution, to prevent bacterial proliferation and losses by volatilization. Nitrogen in urine was determined following micro-Kjeldahl method (AOAC, 2006). According to the common formula of Cheeke (1987), nutritive in terms of total digestible nutrients (TDN %) and the digestible crude protein (DCP %) were calculated.

Carcass traits

At the end of the trial of growing rabbits, six rabbits were randomly selected from each treatment for carcass evaluations. The rabbits were fasted except for free water supply for 12 h before slaughter. The rabbits were weighed pre-slaughter, and according to (Blasco and Ouhayoun, 1993) slaughtered by cutting the carotid artery and the jugular vein for complete depletion, and every attempt was made to keep the animals from suffering unnecessarily (Lopez *et al.*, 2008). Just after bleeding, carcasses were weighed, skinned and eviscerated. The dressed carcass free from any internal organs was weighed (hot carcass weight without the head). The hot eviscerated carcass included the liver, heart, and kidney. After chilling of the carcass for 2 hours in a refrigerator at 5ºC the carcass was weighed to obtain cooled carcass weight without the head.

The yields of carcass were calculated as a percent of the pre-slaughter live BWs of the rabbits. Additionally, the ratios of giblets were calculated. Lengths of small intestine, large intestine, cecum and colon were measured.

Serum biochemical parameters

At the end of the feeding trail, four growing rabbits were selected from each treatment group, starved of feed but not water for 12 hrs. Briefly, 3 mL of the blood sample was put within a sterile vacuum tube for serum biochemical analysis with a sterile syringe. The remaining from blood sample 3 mL of blood sample was centrifuged for (700 × g, 15 min.) and the serum was decanted into serum vials and stored at -20 °C until biochemical analysis. Serum total lipids level was estimated using method described by Zollner and Kirsch (1962). Triglycerides concentration was calorimetrically measured by Fossati and Prencipe (1982). Cholesterol level was determined following analysis methods described by Allain *et al*. (1974). While, the High-density lipoprotein (HDL) concentration was determined according to the methods of Lopes-Virella *et al. (*1977). The Low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL) were calculated according to Warnick *et al.* (1983).

Sheep Red Blood Cells titers

The prime and secondary immune responses were measuring using antibody titer against to sheep red blood cells (SRBC). Eight rabbits of each treatment were injected with 0.1 mL of sheep red blood cells (2.5 %) (dilution in phosphate buffer saline) via the marginal ear vein at 3rd week after starting the growing experiment. Blood was collected from injected rabbits with SRBC three times at 7th, 14th and 21st days after injection. One mL of blood was refrigerated allowing red blood cells to be settled. Samples were centrifuged for 1 to 2 min at 3000 rpm when sedimentation was not complete to separate both serum and erythrocytes, and then supernatant was collected.

Briefly, 96-well plates were first filled with 50 µL of physiological saline solution in each well. At that time 50 µL of antiserum was pipetted into the first well in duplicates after which 50 µL from the first well was pipetted into the second well, and so forth using an automatic pipette.

Finally, an amount of 0.75 % of (SRBC) solution was added to each well. And then plates were incubated for 3 hours at 37º C, and then examined visually for agglutination (Wegmann and Smithies, 1966). The obtained complete agglutination as the log of the reciprocal of the highest serum dilution considered the agglutinion titer (Nelson *et al.*, 1995).

Phytohemagglutinin elicited skin reaction

After 30 days of starting study, 3 rabbits from each group were randomly selected to determine cell mediated immunity (CMI).

15 µg of PHA (Phytohemagglutinin-P; Difco, Detroit, MI) and 0.1 ml of saline or sterile pyrogen-free physiologic saline were injected intradermal (ID) in both right and left ears, correspondingly. Central ear width of each rabbit was recorded with a constant-tension dial micrometer before and after every 3 hours of injection (from 0-12 h). The response was detailed in millimeters as the variance between PHA response (right ear) and the saline response (left ear) after injection (El-Lethey *et al.,* 2003).

Statistical analysis

The obtained data was statistically analysis using the SPSS 11.0 software (SPSS, Inc., Chicago, Il, 2007). All data were considered with a one-way ANOVA using Duncan's New Multiple Range Test, at significant $p < 0.05$.

RESULTS AND DISCUSSION

Proximate analysis:

The chemical analysis (%) of the experimental diets and garden cress seeds on DM basis are shown in Table (2). Results showed that garden cress seeds contain 22.33, 22.68 and 12.10 for CP, EE and CF respectively, while DE was 254.95 kcal/kg. These results are in agreement with El-Salam *et al.* (2019) who reported that garden cress seeds powder contained 7.05 % moisture, 19-23% crude protein, 14-18%- crude Fat, 18.79% crude fiber and 4.8% ash. The few differences between our results and these results may be due to the kind of plant and the difference in cultivation regions and growing conditions. Gokavi *et al.* (2004) reported that the percent nutrient composition of *L. sativum* contains 24.2 % protein, 30.7% carbohydrates, 11.9% fiber, 7.1% ash, and 2.9% moisture. Aqafarini *et al.* (2019) found that the content of garden cress seeds of crude fiber, crude protein and ether extract were 10.5, 22.4 and 25.7,respectively. Higher protein and lipid contents in the garden cress seeds indicated that the seeds could be served as a high energy feedstuff. In addition, the proximate chemical composition of the experimental diets revealed homogeneous diets with isonitrogenous and isocaloric experimental diets (Table 2).

Performance of growing rabbits:

Data in Table (3). showed that the final weight, total weight gain, and average daily gain were significantly higher for rabbits fed garden cress seeds at dose of 3, 4.5 and 6% compared to the control. Meanwhile, the total relative growth rate (%) increased significantly with group fed diet supplemented with 3% garden cress seeds. The regression analysis of rabbit growth in response to increasing levels of garden cress seeds revealed the best fit of quadratic regression models with maximum response between 3-4.5% supplementation levels. The improvement of rabbit growth performance associated with dietary garden may be attributed to its antioxidant properties that could improve the physiological performance, health status and finally growth performance(El-Salam et al., 2019). Garden cress seeds are rich in phytochemical, such as gallic acid, ellagic, protocatechuic, flavonoid, rutin, naringin, quercetin, and hesperidin which is a strong antioxidant (Sethiya *et al*., 2014; El-Salam *et al.,* 2019). There is also an evidence that garden cress seed extract has performed as antimicrobial, antihypertensive, antiasthmatic, antioxidant, hypoglycemic, antispasmodic, antidiarrheal, , and hypolipidemic properties (Behrouzian *et al.,* 2014; Abo El-Maati *et al.,* 2016). In addition, Mellor (2000) reported that *L. sativum* improved nutrient digestibility.

Table 2. Chemical analysis (%) of experimental diets and garden cress seeds on DM basis

Ingredients (%)	Garden cress seeds	Garden cress seeds (%)			
		0	3	4.5	6
Dry matter	95.30	88.71	88.91	89.00	89.10
Organic matter	94.89	91.55	91.52	91.45	91.12
Ash	5.87	8.45	8.48	8.55	8.88
crude protein	22.33	17.21	17.29	17.15	17.18
ether extract	22.68	2.47	3.06	3.37	3.66
crude fiber	12.10	14.81	15.06	15.16	15.28
Neutral detergent fiber	36.87	38.66	38.82	38.88	38.96
acid detergent fiber	20.47	22.94	23.17	23.26	23.37
Hemicellulose	16.41	15.71	15.65	15.63	15.60
nitrogen-free extract	33.30	45.77	56.11	44.77	44.1
digestible energy. (kcal/ kg)	254.95	246.19	245.39	245.09	244.69

Neutral detergent fiber (%)=28.924+0.657(%CF)., Acid detergent fiber (%)=9.432+0.912 (%CF).
Digestible energy. (kcal/g) =4.36-0.0491 (%NDF).

Table 3. Effect of the increasing dietary levels of garden cress seeds on growth performance and feed utilization of growing rabbits

Items	Garden cress seeds (%)				SEM	*p* value		
	0	3	4.5	6		Treatment	Linear	Quadratic
Initial weight (g)	594.44	615.28	605.56	604.72	8.79	0.878	0.793	0.547
Final weight (g)	1919.44^{b}	2155.56^{a}	2116.94^{a}	2054.72^{a}	22.81	0.001	0.051	0001
Total weight gain (g)	1325.00^{b}	1540.28^{a}	1511.39^{a}	1450.00^{a}	20.18	0.000	0.035	0.000
Average daily gain (g)	27.04^{b}	31.43^{a}	30.85^{a}	29.59^{a}	0.41	0.000	0.035	0.000
Total relative growth rate (%)	105.28^{b}	111.34^{a}	111.04^{ab}	109.25^{b}	0.95	0.087	0.164	0.037
Average daily feed intake (g)	127.40^{b}	128.53^{b}	128.69^{b}	131.46^{a}	0.53	0.031	0.007	0.379
Total feed intake (g)	6242.33^{b}	6298.11^{b}	6305.61^{b}	6441.35^{a}	25.76	0.031	0.006	0.380
Average feed conversion ratio	4.69^{a}	4.09^{b}	4.20^{b}	4.45^{ab}	0.07	0.011	0.288	0.002

Means in rows with various superscript letters have significant differences at $p \leq 0.05$.
Relative Growth Rate (RGR) = (ln W2 - ln W1)/(t2 - t1), where W1 and W2 are plant dry weights at times t1 and t2

Meanwhile, average daily feed intake and total feed intake were increased significantly with the higher levels of garden cress seeds as compared to the control and the lower supplementation levels. This could indicate that garden cress seed could improve the palatability of the experimental diets. In contrast, average FCR was significantly improved with 3 and 4.5% as compared to the control and the highest supplementation levels with quadratic regression fit models. These beneficial properties of garden cress seeds are suggested to occur if used as a feed additive in broiler ration and could improve growth and feed adaptation ratio. Also, Shawle *et al.* (2016) reported that the daily intake DM, final body weight and average of the daily body weight gain during the starter stage were not differ among birds fed portion containing changable levels of garden cress. However, Hassan and El Shoukary (2019) revealed the best ($p < 0.000$) FCR were gained from birds were fed with 0.75% garden cress followed by the control portion. Garden cress seeds supplementation at concentration of 1% significantly increased feed intake, body weight, and weight gain of broiler .

Digestibility coefficients:

Results in Table 4 showed that there is no significant effect among treatments in digestibility coefficients of all nutrients except of CP and either extract (EE). The digestibility of CP was increase as garden cress seeds increased in the diet. Meanwhile, the digestibility of EE was improved significantly with 4.5% of garden cress seed supplementation compared to the control and the highest supplementation levels. These results were agreed with Mellor (2000) who reported that *L. sativum* can improve nutrient digestibility. On the other hand, the results showed that the fecal and urine nitrogen were significantly decreased with increasing garden cress levels in the experiential diets. At the same time, nitrogen balance tended to improve with increasing garden cress levels.

The percent of nitrogen balance intake and nitrogen balance absorption revealed a significant improvement with all dietary supplementation levels of garden cress seeds. Lahiri and Rani (2020) reported that garden cress seeds contain 6.26 gm lysine and methionine per kg, where methionine is beneficial in the digestion process and has an important role in burning fat and lysine as well as playing as an important factor in improving the nitrogen balance.

Carcass traits

Results in Table 5 showed that there is no significant effect on different parameters of carcass traits. It was observed that the weights of slaughter and skinning tended to increase as the garden cress seeds increased.

In contrast, the kidney fat (%) was significantly decreased as adding garden cress seeds. The large intestine and colon lengths were significantly affected with dietary garden cress levels, whereas the highest values were recorded with 3% garden cress levels. These results were agreed with Mellor (2000) who illustrated that dietary garden cress improve quality of broiler carcass.

Table 4. Effect of the increasing dietary levels of garden cress seeds on digestibility and nitrogen balance of growing rabbits

Items	Garden cress seeds (%)				SEM	*p* value		
	0	3	4.5	6		Treatment	Linear	Quadratic
Digestibility (%)								
Dry matter	60.43	65.38	66.89	63.91	1.29	0.363	0.317	0.152
Organic matter	63.51	68.37	70.27	67.83	2.47	0.295	0.261	0.126
Crude protein	70.37^{b}	72.46^{b}	73.30^{ab}	79.04^{a}	1.24	0.049	0.011	0.347
Ether extract	77.76^{b}	81.36^{ab}	85.20^{a}	76.94^{b}	1.15	0.010	0.830	0.003
Neutral detergent fiber	56.48	61.56	62.79	62.43	1.39	0.385	0.157	349
acid detergent fiber	51.19	56.50	57.36	60.50	1.64	0.261	0.067	0.731
nitrogen-free extract	65.69	71.23	73.31	65.16	1.41	0.073	0.963	0.014
Hemicellulose	64.19	69.06	70.86	65.33	1.27	0.213	0.622	0.053
Nitrogen balance (NB)								
Intake N (g)	3.67	3.94	3.81	3.80	0.05	0.262	0.544	0.146
Fecal N (g)	1.09^{a}	1.08^{a}	1.01^{a}	0.39^{b}	0.05	0.039	0.011	0.141
Absorbed N (g)	2.59	2.86	2.80	3.00	0.07	0.159	0.050	0.790
Urine N (g)	0.95^{a}	0.643^{c}	0.777^{bc}	0.827^{ab}	0.04	0.013	0.303	0.006
N balance	1.64	2.22	2.02	2.18	0.09	0.083	0.063	0.189
Nitrogen balance % intake (%)	44.46^{b}	56.19^{a}	52.88^{ab}	57.13^{a}	1.94	0.050	0.027	0.229
Nitrogen balance % absorption (%)	63.21^{b}	77.51^{a}	71.97^{a}	72.17^{a}	1.87	0.021	0.088	0.021

Means in rows with different superscript letters have significant differences at p ≤0.05.

Table 5. Effect of the increasing dietary levels of garden cress seeds on carcass traits of growing rabbits

Items	Garden cress seeds (%)				SEM	*p* value		
	0	3	4.5	6		Treatment	Linear	Quadratic
Live body weight (g)	2040.83	2058.33	2062.50	2105	14.99	0.506	0.163	0.85
Slaughter weight (g)	1990	2002.50	2006.67	2030	15.14	0.842	0.393	0.867
Skinning weight (%)	72.89	73.31	73.24	74.23	0.46	0.788	0.371	0.773
Hot carcass (%)	52.60	53.08	52.38	52.59	0.35	0.92	0.827	0.851
Cold carcass (%)	51.81	52.20	51.41	51.72	0.37	0.910	0.757	0.957
Kidney fat (%)	0.388^{a}	0.173^{b}	0.205^{b}	0.187^{b}	0.02	0.001	0.001	0.006
Dressing percentage (%)	56.55	56.94	56.44	56.33	0.40	0.960	0.766	0.768
Giblets (%)	3.95	3.87	4.06	3.75	0.09	0.701	0.626	0.557
Carcass traits length (cm)								
Small intestine length	2.87	3.13	3.04	2.94	0.08	0.672	0.858	0.268
Large intestine length	69.83^{bc}	83.86^{a}	64.50^{c}	73.83^{b}	2.01	0.001	0.581	0.432
Cecum length	41.67	42.47	42.50	41.83	0.70	0.698	0.938	0.626
Colon length	37.00^{ab}	41.08^{a}	33.17^{b}	37.33^{ab}	0.93	0.016	0.330	0.979

Means in rows with different superscript letters have significant differences at p ≤0.05.

Lipid profile parameters:

Data of serum lipid profile parameters (mg/dL) of growing rabbits were shown in Table 6. Results showed that there no significant effects of dietary garden cress seeds among treatments, while there is a decreasing trend with increasing garden cress levels in whole lipid, cholesterol, LDL-c. Meanwhile, the HDL-c, HDL-c/LDL-c, triglyceride, and VLDL-c values were increased with 3% garden cress seeds supplementation levels.

Approximately similar results were obtained by Chauhan *et al.* (2012) who recorded a significant decline in lipid profile, total cholesterol, triglycerides, and lipoprotein fractions (LDL and VLDL) with a significant increase in HDL levels with dietary cress seed. Al Hamedan (2010) reported that rat groups with oral administration of garden cress seeds extract, and powder showed significant lower values for serum cholesterol and total lipids. Similarly, Amawi and Aljamal (2012), Chauhan *et al.* (2012) also reported similar results, where decreases ($p \leq 0.05$) in lipid profile, total cholesterol, triglycerides, and lipoprotein fractions (LDL-c and VLDL-c) with a significant increase in HDL-c levels after treatment with *L. sativum* extract (30 mg/kg body weight) for a period of four weeks.

Garden cress seeds is steady oil, since its component natural antioxidants (tocopherol, phytosterol, and carotenoids) guard the oil from rancidity (Diwakar *et al.*, 2010). Supplementation of garden cress seeds in nhuman diet is efficient in decreasing cholesterol, triglycerides, α-linolenic acid and arachidonic acid levels in both liver tissues and serum, and for transforming linoleic acid into the long-chain fatty acids, eicosapentaenoic acid and docosahexaenoic acid in liver, heart, serum, and brain tissue (Diwakar *et al.*, 2008).

Immune responses:

The effect of the increasing dietary levels of garden cress seeds on immune status of growing rabbits were shown in Table 7. The SRBC levels increased in a time dependent manner and highest significant levels were observed after 14 days of treatments.

Table 6. Effect of the increasing dietary levels of garden cress seeds on serum lipid profile parameters (mg/ dL) of growing rabbits

Items	Garden cress seeds (%)				SEM	*p* value		
	0	3	4.5	6		Treatment	Linear	Quadratic
Total Lipid (mg/dL)	392.15	368.97	300.45	338.30	30.37	0.760	0.429	0.632
Cholesterol (mg/dL)	57.97	51.04	50.52	50.27	4.76	0.939	0.607	0.744
HDL-c (mg/dL)	22.91	21.87	22.50	20.48	1.94	0.977	0.723	1.440
LDL-c (mg/dL)	18.36	11.41	11.26	14.11	1.29	0.173	0.253	0.059
HDL-c/LDL-c	1.10	1.89	1.78	1.35	0.14	0.159	0.603	0.033
Triglyceride (mg/dL)	86.76	90.35	85.92	82.69	7.64	0.990	0.822	0.837
VLDL-c (mg/dL)	17.35	18.07	17.18	16.54	1.53	0.990	0.822	0.837

Means in rows with different superscript letters have significant differences at $p \leq 0.05$.
HDL-c: high density lipoprotein-cholesterol, LDL-c: low density lipoprotein-cholesterol, VLDL-c: very low density lipoprotein-cholesterol.

Table 7. Effect of the increasing dietary levels of garden cress seeds on body immune response of growing rabbits

Items	Garden cress seeds (%)				SEM	*p* value		
	0	3	4.5	6		Treatment	Linear	Quadratic
Sheep RBCs titer								
SRBC (7^{th} day)	0.498^{b}	0.540^{ab}	0.469^{b}	0.630^{a}	0.020	0.011	0.034	0.076
SRBC (14^{th} day)	0.737^{b}	0.844^{a}	0.874^{a}	0.855^{a}	0.137	0.001	0.001	0.001
SRBC (21^{st} day)	0.902^{b}	0.929^{ab}	0.937^{ab}	0.961^{a}	0.007	0.032	0.004	0.910
Phytohemagglutinin								
PHA (3 hours)	0.100	0.104	0.100	0.100	0.009	0.998	0.967	0.917
PHA (6 hours)	0.067	0.050	0.100	0.400	0.075	0.313	0.126	0.078
PHA (9 hours)	0.075	0.107	0.075	0.090	0.015	0.866	0.953	0.796
PHA (12 hours)	0.063	0.079	0.096	0.090	0.009	0.674	0.284	0.596

Means in rows with different superscript letters have significant differences at $p \leq 0.05$.
SRBC: sheep red blood cell, PHA: phytohemagglutinin

Whereas all garden cress seeds level revealed a significant increase in SRBC compared to the control group, meanwhile after 7- or 21-days significant difference were recorded with the highest levels of garden cress seeds compared to the control. The phytohemagglutinin test did not affected by dietary treatment of garden cress seeds.

Qusti *et al.* (2016) observed that immunoglobulins increased significantly with dietary garden cress seeds in comparison with control group.

CONCLUSION

The current findings revealed a significant improvement growth performance in growing rabbits feed garden cress seeds. The response of growing rabbit to increasing dietary levels of garden cress seeds showed the best fit of quadratic regression models with maximum response between 3-4.5% supplementation levels. In addition, the digestibility of crude protein and ether extract, and nitrogen balance were improved with increasing dietary garden cress seeds level. The carcass was not affected by treatment. The immune response (SRBC) of growing rabbit to dietary garden cress seeds showed immune stimulating activities.

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الملخص العربي

تأثير حب الرشاد على كفاءة وصفات الذبيحة وبعض الاستجابات الفسيولوجية فى الارانب النامية

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- تم استخدام عدد 72 من الأرانب النامية ع من V-Line بمتوسط وزن حى أولى يبلغ 6.5 ± 8.79 جم عند عمر 6 أسابيع لاختبار تأثير زيادة مستويات بذور حب الرشاد (Lepidium sativum)، (0 ، 3، 4.5، 6 ٪) على أداء النمو ، والهضم ، وصفات الذبيحه والأداء الفسيولوجى. تم تغذية الأرانب النامية على العلائق التجريبية لمدة 7 أسابيع. أظهرت النتائج ما يلي:-
- بذور حب الرشاد تحتوى على مستويات جيدة من البروتين والدهون الخام .
- تحسن في وزن الجسم النهائي ومعدلات النمو مقارنة بالكنترول.
- اعلى معدل نمو سجل عند مستوى (4.5% , 3) من بذور حبوب الرشاد.
- تحسن معدل التحويل الغذائي معنويا عند مستوى (3.00 , 4.5%) من حبوب حب الرشاد.
- تحسن معامل هضم البروتين و الدهون ولاتزان الازوتي بزيادة بذور حب الرشاد.
- صفات الذبيحة لم تتاثر مع المعاملات المختلفة ما عدا انخفاض دهون الكلى باضافة بذور حب الرشاد.
- لم يتاثر مصل الدهون باضافة بذور حب الرشاد.
- جميع المعاملات المحتوية على حب الرشاد ادة الى زيادة معنوية في خلايا الدم الحمراء للاغنام مقارنة بالكنترول.
- ينصح باضافة بذور حب الرشاد عند مستويات (3.00 , 4.5%) في علائق الارانب النامية حيث انها حسنت من النمو والاستفادة من الغذاء او معاملات الهضم والاستجابة المناعية.

الكلمات المفتاحية: زراعة الأرانب ، بذور حب رشاد ، المكملات ، النمو ، الحالة المناعية.