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Effect of Crushed *Eruca sativa* Seeds Supplementation to Quail Ration on Lipid Profile Before and After Sexual Maturity

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ABSTRACT

The study aimed to evaluate the effect of crushed Rocket salad (*Eruca sativa*) seeds on serum lipid profile and risk index of males and females quail before and after sexual maturity. A total of two hundred forty unsexed quail (*Coturnix coturnix*) (7 days aged) were randomly distributed into 4 groups (60 birds/ group, 5 replicates, 12 birds / replicate), the feed and water were allowed *ad libitum*, and the treatment continued till 77 days age, as follows:-

1st group(control): birds were reared on standard ration (without *Eruca sativa* seeds).
2nd group: birds were reared on standard ration supplemented with 6 g / kg crushed *Eruca sativa* seeds from the age of 7 days till 42 days age.
3rd group: birds were reared on standard ration supplemented with 6 g / kg crushed *Eruca sativa* seeds from the age of 42 days till 77 days age.
4th group: birds were reared on standard ration supplemented with 6 g / kg crushed *Eruca sativa* seeds for the whole period of experiment (7 - 77 days).

The addition of crushed *Eruca sativa* seed don't change the level of blood glucose, but it improves serum lipid profile in males and females quail, especially when given in the early stage of growth before sexual maturity (*Eruca sativa* from 7days age), and there was a significant decrease ($P \leq 0.05$) in the level of cholesterol, triglycerides and VLDL-C compared with control.

Also the addition of *Eruca sativa* seeds in the ration enhanced and significantly increased ($P \leq 0.05$) the level of HDL-C in males and females quail before sexual maturity (2nd and 4th groups), and there is no significant changes in the level of LDL-C compared with control, which reflected in improvement of risk index (LDL/HDL) especially when *Eruca sativa* seeds were added from 7 days age.

On the other hand, the addition of *Eruca sativa* seeds reduced the stress effects in males and females quail as represented by a significant decrease ($P \leq 0.05$) in AST and ALT values as compared with the control group.

In conclusion, the addition of crushed *Eruca sativa* seeds improve the lipid profile and risk index, also reduce stress condition in males and females quail, especially when given in the growth stage and before sexual maturity.

Keyword: *Eruca sativa*, Rocket Salad, LDL, HDL, Quail.
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Introduction

Rocket salad "*Eruca sativa*" is one of the most commonly used plants in many countries of world, including the Mediterranean region, particularly in Iraq, the Levant and Egypt (Uğur *et al*., 2010 ; Al-Eneezy, 2004), as it is of great importance for human and animal health as well as its various medicinal therapeutic properties,

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according to the popular adage is used to increase sexual activity for both genders "Aphrodisiac", as it helps in increasing fertility and the production of sperm (Ansari and Ganaie, 2014).

Rocket salad or so-called "Arugula" it is used as leaves, seeds, extract or powder (Mossa *et al.,* 1987). Arugula seeds and its leaves possess antioxidant activity(Abdul-Jalil, 2016), anti-lipid peroxidation (Abdel-Rahman *et al.,* 2015), antioxidant vitamins and most of the vitamin B (Badee*et al.,* 2003 ; Carr *et al.,* 2004 ; Barillari *et al.,* 2005).

Eruca sativa seeds contain a wide range of nutritional elements and in different proportions depending on the environment in which the plant grows (Pignone and Ngu, 1995). The seeds are characterized by volatile oils (Flanders and Abdulkarim, 1985 ; El-Gengaihi *et al.,* 2004) and many nutrient elements, proteins, vitamins (A and C), carotenoids, mineral salts as well as containing glucosinolates (Bell and Wagstaff, 2014) and flavonoids vehicles (Barillari *et al.,* 2005).

While the seeds oil mainly consists of fatty acids (Palmitic, Oleic, Linoleic, Linolenic and Erucic acids). The *Eruca sativa* seeds oil decrease serum cholesterol, triglycerides, LDL-C, VLDL-C and elevate the HDL-C level (El-Gengaihi *et al.,* 2004; Mashi, 2017).

Materials and Methods

The study was conducted on a poultry farm of the Animal Production Department at the College of Agriculture and Forestry/University of Mosul. Two hundred forty unsexed males and females local quail (*Coturnix Coturnix*) were randomly distributed into four groups (60 birds/ group, 5 replicates,12 birds/ replicate), the birds were reared in cages with dimensions (50 x 50 x 50 cm), the feed and water were allowed *ad libitum* throughout the study, and with appropriate requirements of lighting, ventilation and temperature depending on age of birds. The treatment continued till the age 77 days as follows:

1st group (control): birds were reared on standard ration (without *Eruca sativa* seeds).

2nd group: birds were reared on standard ration supplemented with 6 g/kg crushed *Eruca sativa* seeds from the age of 7 days till 42 days age.

3rd group: birds were reared on standard ration supplemented with 6 g/kg crushed *Eruca sativa* seeds from the age of 42 days till 77 days age.

4th group: birds were reared on standard ration supplemented with 6 g/kg crushed *Eruca sativa* seeds for the whole period of experiment (7 - 77 days).

Eruca sativa seeds are bought from the local market, it crushed and mixed manually with ration before it was presented to the quail. The ration was formulated according to the standards of the National Research Council (Anonymous, 1994) which included: a starter ration of up to 35 days and a crude protein ratio of 22.4% and energy 2922.3 kcal/kg, and then replaced with a finisher ration until the age of 77 days, crude protein was 21.5% and energy 3013.3 kg/kg.

Five birds from each group were slaughtered at age 42 and 77 days, blood collected in tubes without anticoagulants and the serum isolated then preserved at (-20^{o}c) until the biochemical tests were carried out, which included: estimation of the concentration of serum glucose, cholesterol, triglycerides, HDL-C, LDL-C, VLDL-C, risk index (LDL/HDL), AST, and ALT using Biosystems kits.

The experiment was designed as C.R.D and the collected data were analyzed by one-way analysis of variance using statistical programs (S.A.S) (Anonymous, 2000). Then Duncan's Multiple Range test (Duncan, 1955) was used to determine the differences between means ($P \leq 0.05$), according to the Steel and Tories (1960).

Results and Discussion

Tables (1 and 2) showed that addition of crushed *Eruca sativa* to the ration had no effect on blood glucose. It may be due to that the level of blood glucose in birds is high, when compared with its level in mammals, and the preservation of blood glucose level is necessary as a source of energy for the brain and other body's cells (Al-Daraji *et al.,* 2008), as well as its role in sustaining muscle movements, heart activity, nerve impulse transmission, and ions (Al-Dalaly, 1994).

Tables (1 and 2) showed that the addition of crushed *Eruca sativa* led to an improvement in the lipid profile of males and females quail, especially when added from *Eruca sativa* seeds was given early in the growth stage and before sexual maturity 7 days old. The levels of cholesterol and triglycerides in the growth stage and whole period were relatively good and balanced, especially in males.

Table (1) reveals that the cholesterol level in males was decreased significantly at age 42 days in 4^{th} group (*Eruca sativa* seeds from 7-77 days) as compared with control. Also, triglycerides were decreased significantly at 42 days age in 2^{nd} and 4^{th} groups, and at the age of 77 days in the 4^{th} group compared to control.

Table (2) showed a significantly decreased in triglycerides of females in all treatment groups at age 77 days as compared with control.

The addition of *Eruca sativa* to the ration before sexual maturity improves serum HDL-C in males significantly ($P \leq 0.05$) in the 2^{nd} and 4^{th} groups at the age 42 and 77 days, as compared with control group (Table 1), and in females, at the age 77 days in both 2^{nd} and 4^{th} groups, as compared with the control group at level ($P \leq 0.05$)(Table 2).

There were no significant differences ($P \leq 0.05$) among the birds of all groups in LDL-C level in males and females quail at the age 42 and 77 days, as compared with control group (Tables 1 and 2).

Very low-density lipoproteins (VLDL-C) decreased significantly in the serum of males ($P \leq 0.05$) in the 2^{nd} and 4^{th} groups at the age of 42 and 77 days as compared with control group (Table 1). In females, the VLDL-C was significantly decreased in all treatments at the age 77 days as compared with the control group at level ($P \leq 0.05$) (Table 2).

Tables (1 and 2) showed that the risk index values was improved significantly by the addition of *Eruca sativa* before sexual maturity (7 days) in both of the 2^{nd} and 4^{th} groups in the males of the quail at the age 42, and at the age 77 days in females as compared with the control group at level ($P \leq 0.05$).

The results of the current study, research agreed with the findings of Razuki (2009) who used different levels of *Eruca sativa* (1, 2 and 3 g/kg feed) in the chickens ration in regard to cholesterol level.

Table (1): Effect of adding* crushed *Eruca sativa* seeds to the ration on blood glucose, serum total lipid profile and risk index in male quail at age 42 and 77 days.

Parameters / Treatments	Glucose mg/dl		Cholesterol mg/dl		Triglyceride mg/dl		HDL-C mg/dl		LDL-C mg/dl		VLDL-C mg/dl		Risk Index LDL / HDL	
	42 days	77 days	42 days	77 days	42 days	77 days	42 days	77 days	42 days	77 days	42 days	77 days	42 days	77 days
1st / Control (Without *Eruca sativa* seeds)	306.60 ±12.56 A	330.60 ± 8.76 A	308.20 ± 11.64 A	312.00 ±23.37 A	128.60 ± 10.41 A	128.00 ± 7.14 A	46.60 ± 1.50 B	46.40 ± 3.04 B	231.88 ± 8.69 A	240.00 ± 24.11 A	25.72 ± 2.08 A	25.60 ± 1.43 A	4.99 ± 0.18 A	5.37 ± 0.93 A
2nd / Growth stage (*Eruca sativa* seeds from 7-42 days)	308.20 ± 18.87 A	320.00 ± 12.39 A	276.00 ± 18.87 AB	331.00 ± 16.72 A	94.60 ± 12.70 B	108.60 ± 6.85 AB	52.80 ± 1.77 A	56.80 ± 1.36 A	204.28 ± 16.82 A	252.48 ± 17.30 A	18.92 ± 2.54 B	21.32 ± 1.32 B	3.86 ± 0.26 B	4.48 ± 0.41 A
3rd / Production stage (*Eruca sativa* seeds from 42-77 days)	313.60 ± 1.69 A	323.20 ± 7.13 A	278.00 ± 13.74 AB	326.60 ± 6.13 A	108.60 ± 9.91 AB	116.40 ± 5.73 AB	50.00 ± 2.12 AB	52.40 ± 2.91 AB	206.28 ± 14.98 A	250.92 ± 6.13 A	21.72 ± 1.98 AB	23.28 ± 1.15 AB	4.19 ± 0.41 AB	4.87 ± 0.37 A
4th / Total stage (*Eruca sativa* seeds from 7-77 days)	329.00 ± 7.89 A	302.80 ± 12.10 A	260.00 ± 13.18 B	319.80 ± 14.80 A	89.20 ± 6.51 B	96.60 ± 6.86 B	52.60 ± 1.69 A	57.60 ± 3.08 A	190.16 ± 12.35 A	242.88 ± 12.99 A	17.84 ± 1.30 B	19.32 ± 1.37 B	3.63 ± 0.24 B	4.23 ± 0.17 A

- Values are represent : Means ± Standard Error.
- Different letters in each column mean significant differences at ($P \leq 0.05$).
-*Adding 6 g/kg feed of crushed *Eruca sativa* seeds.

Table (2): Effect of adding* crushed *Eruca sativa* seeds to the ration on blood glucose, serum total lipid profile and risk index in female quail at age 42 and 77 days.

Parameters / Treatments	Glucose mg/dl		Cholesterol mg/dl		Triglyceride mg/dl		HDL-C mg/dl		LDL-C mg/dl		VLDL-C mg/dl		Risk Index LDL / HDL	
	42 days	77 days	42 days	77 days	42 days	77 days	42 days	77 days	42 days	77 days	42 days	77 days	42 days	77 days
1st / Control (Without *Eruca sativa* seeds)	222.80 ± 16.11 A	292.80 ± 10.46 A	289.20 ± 11.00 A	340.40 ± 19.27 A	714.60 ± 15.25 A	768.80 ± 79.58 A	20.00 ± 1.87 A	11.00 ± 0.71 B	126.20 ± 10.02 A	175.64 ± 33.54 A	143.00 ± 3.05 A	153.76 ± 15.92 A	6.50 ± 0.68 A	16.32 ± 3.47 A
2nd / Growth stage (*Eruca sativa* seeds from 7-42 days)	247.00 ± 5.19 A	300.60 ± 7.12 A	320.40 ± 31.05 A	294.80 ± 22.14 A	744.20 ± 17.86 A	579.80 ± 19.21 B	21.00 ± 1.48 A	18.60 ± 1.81 A	150.40 ± 32.68 A	160.24 ± 21.39 A	149.00 ± 3.63 A	115.96 ± 3.84 B	7.46 ± 1.62 A	8.95 ± 1.59 B
3rd / Production stage (*Eruca sativa* seeds from 42-77 days)	217.80 ±6.34 A	308.40 ± 9.64 A	284.20 ± 21.16 A	312.60 ±22.94 A	717.80 ± 17.65 A	575.60 ± 17.08 B	22.80 ± 0.97 A	14.60 ± 0.60 B	117.60 ± 23.25 A	182.88 ± 24.24 A	143.80 ± 3.40 A	115.12 ± 3.42 B	5.32 ± 1.28 A	12.65 ± 1.87 AB
4th / Total stage (*Eruca sativa* seeds from 7-77 days)	229.20 ± 10.85 A	314.40 ± 11.62 A	333.80 ± 26.11 A	305.20 ± 25.59 A	750.20 ± 16.30 A	564.20 ± 9.61 B	22.00 ± 1.87 A	20.80 ± 1.39 A	161.80 ± 27.66 A	171.56 ± 26.11 A	150.00 ± 3.21 A	112.84 ± 1.92 B	7.89 ± 1.84 A	8.50 ± 1.55 B

- Values are represent : Means ± Standard Error.
- Different letters in each column mean significant differences at (P≤0.05).
-*Adding 6 g/kg feed of crushed *Eruca sativa* seeds.

El-Gengaihi *et al.,* (2004) also explained that the hypocholesterolemic effect of *Eruca sativa* oil may be due to its unsaturated fatty acids (85%) or due to the effect of β-sitosterol (6.5%) which reduces the cholesterol absorption from the intestine so it decreases its level in the blood.

The hypocholesterolemic effect of *Eruca sativa* may be due to the it's flavonoids compounds (Badee *et al.,* 2003).

The *Eruca sativa* seed constituents as the vitamin C and carotenoids they may have a role in improving the level of cholesterol and total lipid (Barillari *et al.,* 2005), and the existence of vitamin C as demonstrated by Seyrek *et al.,* (2004) reduce the concentration of triglyceride in the layer hens and the quail, Salah (2008) also confirmed that the addition of vitamin C resulted in a significant decrease in the concentration of triglycerides in male broiler breeders. These vitamins increase thyroid activity, Kuhn *et al.,* (1993) reported that the thyroid gland is one of the most important glands in control of cholesterol and lipid metabolism.

Mashi (2017) also noted in a study conducted on male rabbits that the Aqueous extract of the *Eruca sativa* leaves (250 mg / kg orally for 30 days) causes a significant decrease ($P \leq 0.05$) in the triglyceride concentration, cholesterol, LDL-C, VLDL-C and elevation in HDL-C Compared with the control group, the hypolipidemic effect may be due to the enzyme 7-α-Hydroxylase that activated by vitamin C (a component of *Eruca sativa* leaves) that stimulates the conversion of serum cholesterol into bile acids, thus reducing serum cholesterol level as well as the ability of vitamin C to Inhibit HDL-C oxidation (Hillstrom *et al.,* 2003), which was confirmed by Abdul-Rahman and Alkatan (2009) as they found a decrease in the concentration of triglycerides when they adds vitamin C to the laying hens.

El-Gengaihi *et al.,* (2004) confirmed that *Eruca sativa* seeds oil improve the lipid profile after 4, 8 and 12 weeks in rats (0.5 g/day orally for 3 months).The reduction of serum cholesterol and total lipid may be due to the unsaturated fatty acids (85%) of *Eruca sativa* such as linoleic acid and linolenic acid (Thomas, 2002) or due to glucosinolate (a substance that inhibits lipid peroxidation) (Al-Doghachi *et al.*, 2010).

The hypolipidemic effect of *Eruca sativa* may be due to some of its active components as saponins (Zamani *et al.,* 2007) flavonoids, phenols, turbines and alkaloids (Asaduzzaman *et al.,* 2010), as well as the glucosinolates (Wang *et al.,* 1998).

Also, table (3) revealed that *Eruca sativa* treatment reduces the stress effects on both males and females quail at 42 days and 77 days age as represented in the reduction of AST and ALT values in treated groups, and the best effects were achieved when *Eruca sativa* treatment was continued for the whole period (7 – 77 days).

Results of the current study were in agreement with the study of Razooqi *et al.* (2014) in broiler, and with Al-Daraji and Razuki (2012) in layer breeders roosters, and with Razuki (2009) in laying chickens.

The reduction of AST and ALT values may return to activation of liver regeneration and functions due to its content of antioxidants as Kaempferol and quercetin and the glucosinolates (Jin *et al.,* 2009 ; El-Fadaly *et al.,* 2017), and also to its high content of sulphur, which activate the liver function and immune system

(Alam *et al.*, 2007). Also, Abdel-Rahman *et al.*, (2015) showed that the *Eruca sativa* seed extract reduce lipid peroxidation and improve cellular antioxidants in rats.

In conclusion, the addition of crushed *Eruca sativa* seeds improve the lipid profile, and reduces stress condition and risk index in males and females quail, especially when given on the growth stage and before sexual maturity.

Table (3): Effect of adding* crushed *Eruca sativa* seeds to the ration on serum AST and ALT of males and females quail at age 42 and 77 days.

Parameters / Treatments	Male				Female			
	AST U / L		ALT U / L		AST U / L		ALT U / L	
	42 days	77 days	42 days	77 days	42 days	77 days	42 days	77 days
1st / Control (Without *Eruca sativa* seeds)	157.51 ± 8.15 A	243.92 ± 12.27 A	53.44 ± 1.47 A	17.35 ± 1.16 A	219.93 ± 15.99 A	217.12 ± 15.83 A	50.63 ± 2.55 A	82.48 ± 2.63 A
2nd / Growth stage (*Eruca sativa* seeds from 7- 42 days)	122.87 ± 3.27 B	232.08 ± 18.39 AB	25.36 ± 2.75 A	15.92 ± 1.43 AB	184.31 ± 12.14 AB	200.08 ± 14.17 AB	23.92 ± 3.03 B	70.39 ± 2.30 B
3rd / Production stage (*Eruca sativa* seeds from 42-77 days)	155.83 ± 7.28 A	193.27 ± 18.90 AB	49.17 ± 1.79 A	14.79 ± 1.17 AB	207.91 ± 20.07 A	173.42 ± 10.43 BC	48.60 ± 4.45 A	50.52 ± 3.38 C
4th / Total stage (*Eruca sativa* seeds from 7-77 days)	119.16 ± 6.61 B	178.81 ± 21.89 B	24.41 ± 2.44 B	12.40 ± 1.76 B	147.21 ± 10.30 B	137.28 ± 11.11 C	25.83 ± 2.48 B	40.47 ± 5.49 C

- Values are represent : Means ± Standard Error.
- Different letters in each column mean significant differences at ($P \leq 0.05$).
-*Adding 6 g/kg feed of crushed *Eruca sativa* seeds.

تأثير إضافة مجروش بذور الجرجير إلى العليقة في صورة دهون دم طائر السلوى قبل النضج الجنسي وبعده

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الخلاصة

أجريت هذه الدراسة لبحث تأثير الإضافة العلفية لمجروش بذور الجرجير*Eruca sativa* في صورة الدهون lipid profile ومؤشر الخطورة Risk Index في مصل دم ذكور وإناث طائر السلوى قبل النضج الجنسي وبعده.إذ وزع عشوائياً 240 طائراً غير مجنس من ذكور وإناث السلوى المحلي Quail (*Coturnix coturnix*) (بعمر 7 أيام) في أربع مجموعات (60 طائراً / وبواقع 5 مكررات / مجموعة(12 طائراً/مكرر).جهز العلف والماء بصورة حرة*ad libitum* طوال مدة الدراسة، واستمرت المعاملة لغاية عمر77 يوماً، وكانت مجموعات الدراسة كالآتي:

١- المجموعة الأولى (مجموعة السيطرة):أعطيت الطيور عليقة أساسية بدون إضافات.
٢- المجموعة الثانية: أعطيت الطيور عليقة أساسية مضافاً إليها 6 غم مجروش بذور الجرجير/كغم علف من بداية التجربة (عمر 7 أيام)ولغاية عمر النضج الجنسي (عمر 42 يوماً)، ثم استبدلت بعليقة أساسية خالية من بذور الجرجير إلى نهاية التجربة (77 يوماً).
٣- المجموعة الثالثة:أعطيت الطيور عليقة أساسية خالية من بذور الجرجير من بداية التجربة (عمر7 أيام) ولغاية عمر النضج الجنسي (عمر 42 يوماً)، ثم استبدلت بعليقة أساسية مضافاً إليها 6 غم مجروش بذور الجرجير/كغم علف إلى نهاية التجربة (77 يوماً).
٤- المجموعة الرابعة: أعطيت الطيور عليقة أساسية مضافاً إليها 6 غم مجروش بذور الجرجير/كغم علف من بداية التجربة (عمر 7 أيام)ولغاية نهاية التجربة (77 يوماً).

لم تؤدِ إضافة مجروش بذور الجرجير إلى تغير في مستوى كلوكوز مصل الدم، ولكن أدت إلى تحسّن في صورة الدهون في مصل دم ذكور وإناث طائر السلوى،ولاسيما عند إعطاء الجرجير في وقت مبكر من مرحلة النمو وقبل النضج الجنسي (جرجير من عمر 7 أيام)، إذ انخفضت معنوياً (أ≤ 0.05)مستويات الكولسترول والكليسيريدات الثلاثية و VLDL-C مقارنة مع مجموعة السيطرة.

كما أدت إضافة بذور الجرجير إلى عليقة طائر السلوى إلى تحسن وارتفاع معنوي (أ≤ 0.05) لمستوى البروتينات الدهنية عالية الكثافة HDL-C في مصل دم ذكور وإناث المجموعة الثانية والرابعة قبل النضج الجنسي، ولم تؤد إلى اختلاف معنوي في مستوى البروتينات الدهنية واطئة الكثافة LDL-C مقارنة مع مجموعة السيطرة، مما انعكس ذلك إلى تحسن معنوي لمؤشر الخطورة Risk Index (LDL/HDL) ولاسيما عند إضافة بذور الجرجير من عمر7 أيام فانخفضت قِيمَهُ في الذكور والإناث مقارنة مع مجموعة السيطرة عند مستوى احتمال (أ≤ 0.05).

ومن ناحية أخرى، أن إضافة مجروش بذور الجرجير أدت إلى تحسن في حالة الإجهاد لذكور وإناث طائر السلوى، فانخفضت معنوياً (أ≤ 0.05) قيم إنزيميّ الـ AST وALT مصل الدم مقارنة مع طيور مجموعة السيطرة.

يستنتج من ذلك، أن إضافة مجروش بذور الجرجير تُحَسّن من صورة الدهون وحالة الإجهاد ومؤشر الخطورة عند ذكور وإناث طائر السلوى ولاسيما إذا أعطيت البذور في مرحلة النمو وقبل النضج الجنسي.

الكلمات المفتاحية: الجرجير، البروتينات الدهنية واطئة الكثافة، البروتينات الدهنية عالية الكثافة، السمان.

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