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Effect of Some Medicinal Plant Seed Meals Supplementation and their Effects on the Productive Performance of Male Rabbits

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Abstract: A total number 40 male New Zealand white rabbits were weight and randomly divided into five equal groups to study the effects of using Black cumin (*Nigella sativa*), Mustard (*Sinapis alba*), Sesame(*Sesamum indicum*) and Rocket (*Eruca sativa*) seed meals as feed additions on growth performance, digestibility, carcass yield and economic evaluation. Each group received experimental diets containing nearly equal ratio of calorie: protein ratio (C: P) under the same managerial conditions. Analysis of Black cumin, Mustard, Sesame and Rocket seed meals indicated that they contained reasonable amount of protein and nitrogen free extract. Significant increment of daily body gain and feed conversion however, no-significant difference with daily feed intake were detected between all treatments. Moreover, significant increment of apparent digestibility of nutrients, feeding values and carcass characteristics with Mustard, Sesame, Rocket diets and significant decrease by Black cumin diet compared to the control diet. Chemical analysis of the 9, 10 and 11th ribs (CP and EE contents) were significantly increased CP content while EE was significantly decreased with different supplemented and control groups. Relative economic efficiency improved by inclusion of Black cumin, Mustard, Sesame and Rocket seed meals as compared to the control group. It was concluded that such supplementation of these meals could be used as a supplementation to improve their productive performance with best economical return.
Key words: Growing rabbits**,** Black cumin, Mustard, Sesame and Rocket seed meals and productive performance.

Introduction

Medicinal herbs and seeds plants has been well known since the old civilization of ancient Egyptians, Chinese and Greek. Most antibiotic growth promoters has been banned in many countries, especially in the European Union, because of public concern about their residues in the animal products and the development of antibiotics – resistant bacteria (Schwarz *et al.,* 2001 and Lee *et al.,* 2004). Therefore, search for alternative safe growth promoters is urgent. The new trend in rabbit production is using of many medicinal seeds plants in rabbits and immune response of rabbits ration to enhance productive performance.

Medical seeds plants have a stimulating effect on the digestive enzyme and improve the utilization of digestive products through enhance liver function (Langhout, 2000; Williams and Losa, 2001 and Hermandez *et al.,* 2004).

Black cumin seed meal (*Nigella sativa*) is an herb and contains high protein, crude fat and minerals such as Ca, P, K, Mg and Na (Abdel-Aal and Attia, 1993). It has nigellon, thymoquinone and thymohydroquinone, which are known to possess anti-microbial effect and enhance production of interleukin- 3 and 2 beta by lymphocytes and having an effect on macrophages (Haq *et al*., 1995). Moreover, it improves health by increasing hematocrite and hemoglobin values (Zaoui *et al*., 2002). At the same time, Abdel-Magid *et* *al.* (2007) investigated that *N. sativa* meal could be used to promote growth performance and improved feed conversion and importantly reducing feed cost and hence increased economic efficiency.

Mustard seed meal (*Sinapis alba*) is a by-product that is obtained following oil extraction from Mustard seeds. Mustard meal is cheaper than other conventional oil meals also rich in sulphate and its well balanced amino acid composition (Pastuszewsk *et al.,* 2000). Mustard seed contain sinapine, protoalkaloid, sinalbin and isothiocyanate glycoside, which exhibit biological activity (Josefsson and Uppstrom, 2006).Mustard seed are characterized by a pungent taste and aroma, they stimulate the secretion of gastric juice and enhance digestion. In folk medicine, Mustard seed extracts was used mainly in the treatment of gastric ailments (Liu *et al.,* 2005). However, Andrzej Gugolek *et al.* (2011) found that diets supplemented with 1% Mustard meal were characterized by satisfactory palatability. The performance indicators health condition of rabbits, with special emphasis on coccidian infection rats.

Sesame seed meal (*Sesamum indicum*) contain two unique substances: Sesamin and sesamolin known to have a cholesterol lowering effect in humans and to provent high blood pressure. Both of these were also reported to increase the hepatic mitochondrial and the peroxisomal fatty acid oxidation rate in experimental animals. Cephalic, a phospholipid from Sesame seed has been reported to possess hemostatic activity. The oil has wide medical and pharmaceutical applications. It is mildly laxative, emollient and demulcent. The seeds and fresh leaves may be used as a poultice. The anti-bacterial activity of seeds against staphylococcus and streptococcus as well as common skin fungi, such as athlete's food fungus has also been well recognized. The oil is also known to maintain high density lipoprotein cholesterol and lower density lipoprotein cholesterol (Anilakumar *et al.,* 2010).

Rocket seed meal *(Eruca sativa)* locally known as jarjeer contain carotenoids, vitamin C, flavonoids such as appin and luteolin and glucosinolates the precursors of isothiocyanates and sulfaraphene (Talalay and Fahey, 2001) volatile oils like myristicin, apiola and -B- phellandrene (Bradley, 1992 and Leung and Foster, 1996). Glucosinolates were found to have several biological activities including anti-carcinogenic, anti-fungal, and anti-bacterial plus its anti-oxidant action (Kim *et al*., 2004). They also contain Zn, Cu, Fe, Mg, Mn and other elements (Abdo, 2003) which increase immune response and the reproductive performance carotenoids can protect phagocytic cell from anti-oxidative damage. Enhance T and B lymphocyte proliferative responses and increase the production of certain interlcukins (Bendich, 1989). Also, they increase plasma IgG concentration (Chew *et al.,* 2000). It known as diuretic, anti-inflammatory and affects blood circulation. Eruca seeds have high oil, protein glucosinolate and erucic acid contents and commonly used as animal feed in Asia, particularly in India and Pakistan (Kim and Ishii, 2006).

The present study was aimed to shed some light on the effects of supplemental Black cumin, Mustard, Sesame and Rocket seed meals and their effects on the growth performance, nutrients digestibility coefficients, carcass characteristics and economical efficiency of growing rabbits.

Materials and Methods

A Total number of 40 male New Zealand white rabbits aged (7 weeks with an average body weight of 819.5±10.43 g body weight) were randomly divided into five equal groups of 8 rabbits in each.

The basal experimental diet was formulated and pelleted to cover the nutrient requirements of rabbits as a basal diet according to NRC (1977) as shown in Table (2). The feeding period was extended for 68 days, and the experimental groups were classified as follow:

- Group 1 fed the basal diet served as control (G_1)
- Group 2 fed the basal diet +3% Black cumin seed meal (G_2)
- Group 3 fed the basal diet +3% Mustard seed meal (G_3)
- Group 4 fed the basal diet +3% Sesame seed meal (G_4)
- Group 5 fed the basal diet +3% Rocket seed meal (G_5)

Rabbits individually housed in galvanized wire cages (30x35x40 cm). Stainless steel ripples for drinking and feeder allowing recording individual feed intake for each rabbit were supplied for each cage. Feed and water were offered *ad- libitum*. Rabbits of all groups were kept under the same managerial conditions were weighted, and feed consumption was individually recorded weekly during the experimental period.

At the end of the experimental period four rabbits in feeding trials were used in digestibility trials over period of 7 days to determine the nutrient digestibility coefficient and nutritive values of the tested diets. Feces were daily collected quantitatively. Feed intake of experimental rations and weight of feces were daily recorded.

Representative samples were dried at 60ºCfor 48 hrs, ground and stored for later chemical analysis. At the end of the experimental period, four representative rabbits from each treatment were randomly chosen and fasted for 12 hours before slaughtering according to Blasco *et al*. (1993) to determine the carcass measurements. Edible offal's (giblets) included heart, liver, kidneys, lungs and spleen were removed and individually weight. External offals included blood, fur, legs, tail and ears removed an individually weight. Full and empty weights of digestive tract were recorded. The 9, 10 and 11th ribs were frozen in polyethylene bags for later chemical analysis. The ribs of samples were dried at 60ºC for 24hrs.

The air-dried samples were analyzed for DM, EE, CP and ash according to the A.O.A.C. (2000) methods. Chemical analysis of experimental diets and feces were analyzed according to A.O.A.C. (2000) methods. Composition of the experimental rations have been done according to the NRC (1977) requirements as shown in (Table 2). Diets were offered pelleted at 4mm diameter.

Table (2): Composition and chemical analysis of the tested diets.

Ingtedient	Control	Black cumin seed meal	Mustard seed meal	Sesame seed meal	Rocket seed meal
Clover hay	33.00	33.00	33.00	33.00	33.00
Yellow corn	21.00	21.00	21.00	21.00	21.00
Wheat bran	30.00	30.00	30.00	30.00	30.00
Soybean meal	14.00	14.00	14.00	14.00	14.00
Black cumin seed meal	-	3.00	-	-	-
Mustard seed meal	-	-	3.00	-	-
Sesame seed meal	-	-	-	3.00	-
Rocket seed meal	-	-	-	-	3.00
Limestone	1.13	1.13	1.13	1.13	1.13
Vit. &Min. Mix*	0.30	0.30	0.30	0.30	0.30
Common salt	0.40	0.40	0.40	0.40	0.40
DL-Methionine	0.17	0.17	0.17	0.17	0.17
Total	100.0	103.0	103.0	103.0	103.0
Chemical analysis determined (DM%)					
Dry matter (DM)	92.49	92.49	92.43	92.46	92.44
Organic matter (OM)	90.41	90.70	91.00	90.81	90.86
Crude protein (CP)	17.00	18.07	18.50	18.39	18.47
Crude fiber (CF)	11.73	11.72	12.76	12.16	11.94
Ether extract (EE)	3.19	3.40	3.24	3.50	3.40
Crude ash	9.59	9.30	9.00	9.19	9.14
Nitrogen free extract (NFE)	58.49	57.51	56.50	56.76	57.05
Calculated analysis DE** (Kcal/Kg DM)	2485.8	2528.0	2537.4	2529.5	2543.9

*** One kilogram of Premix provides: 20000000 IU vit.A, 150000 IU vit. D,8.33 g vit. E, 0.33 g vit. B1, 1.00 g vit. B2, 0.33 g vit. B6, 8.33 g vit. B5, 1.70 mg vit. B12, 3.33 g Pantothenic acid, 33.00 mg Biotin, 0.83 g Folic acid, 200.00 g Choline chloride,11.70 g Zinc, 12.50 g Iodine, 16.60 mg Selenium, 16.60 mg Cobalt, 66.70 g Magnesium and 5.00 g Manganese. **DE (Kcal/Kg DM))= 4253-32.6 (CF%) – 144.4 (ash%), according to Fekete and Gippert (1986).**

Economical efficiency of experimental diets was calculated according to the local market price of ingredients and rabbit live body weight as following:

Net revenue= total revenue – total cost.

Economical efficiency (%) = net revenue /total cost%.

Collected data were subjected to statistical analysis as one way analysis of variance using the general linear model procedure of SPSS (1998). Duncan's Multiple Range Test (1955) was used to separate means when the dietary treatment effect was significant.

Results and Discussion

1. Chemical composition of the tested meals

Black cumin, Mustard, Sesame and Rocket seed meals contained a reasonable amount of protein, nitrogen free extract with little amount of crude fiber and promising sources of energy (Table 1). These contents may be considered as a preliminary indication of their feeding values for rabbits. Digestible energy values for the four tested meals were 2963, 2764, 2433 and 2949 (K cal/kg DM) for Black cumin, Mustard, Sesame and Rocket seed meals, respectively. These variations were related to the differences in chemical composition of the tested meals. The results of this study did not vary far from those of El-Adawy (2004), who reported that Black cumin seed meal contained 6.5% moisture and remaining components on dry matter basis were 94.5%, also, its meal contains most of the essential amino acids, with crude protein about 33%. While, Mustard seed meal where found to be 5.89, 93.84, 36.60, 18.38, 11.00, 27.86 and 6.16% for moisture, OM, CP, CF, EE, NFE and ash, respectively (Table 1). This data agree with Tripathi and Singhal (1994), they found that Mustard meal obtained from the Indian varieties contains 300 to 395g CP/kg DM and is also rich in sulphur with content ranging from 14.3 to 23.0g/kg DM (Papas *et al*., 1978 and Tyagi *et al*., 1996). In spite of its well balanced amino acid composition (Pastuszewsk *et al*., 2000).

Table (1): Chemical analysis of feedstuffs for tested diets.

Item	DM %	Chemical analysis, % (DM basis)						
		OM	CP	CF	EE	NFE	Ash	DE*
Feedstuffs:								
Yellow corn	89.00	98.50	8.47	2.19	4.37	83.47	1.50	3965
Soybean meal	98.00	94.50	44.00	7.10	0.70	42.70	5.50	3227
Wheat bran	89.00	88.70	14.00	24.10	2.70	47.90	11.30	1836
Clover hay	89.00	87.49	14.80	24.10	2.70	45.89	12.51	1660
Black cumin seed meal	93.39	93.81	30.14	12.14	12.90	38.63	6.19	2963
Mustard seed meal	94.11	93.84	36.60	18.38	11.00	27.86	6.16	2764
Sesame seed meal	94.56	90.61	42.13	14.22	15.0	19.26	9.39	2433
Rocket seed meal	93.70	94.26	37.11	14.56	19.90	22.69	5.74	2949

***DE (Kcal/Kg DM)= 4253-32.6 (CF%) – 144.4 (ash%), according to Fekete and Gippert (1986).**

Proximate analysis of Sesame seed meal was found to be 5.44, 42.13, 15.0, 19.26, 14.22 and 9.39% for moisture, CP, EE, NFE, CF and ash, respectively (Table 1). The chemical composition of Sesame oil varies depending on the method of processing Sesame seed, mechanical or solvent extraction, and the reported DM content ranges 83-96%, while CP, ash, EE, NFE and crude fiber are 23-46%, 7.5-17%, 1.4-27%, 25-32% and 5-12%, respectively (FAO, 1990). These data are in a good agreement with those reported by El-Hawary (1975) and NRC (1977), but disagreed with those obtained by El- Husseiny *et al*. (2001) and Hashem (1997). Variations in CP and EE are mainly due to the type of Sesame seeds and the method of oil extraction. Rocket meals contained 6.3% moisture, 37.11% CP, 14.56% CF, 19.9% EE, 22.69% NFE and 5.74% ash. However, Srinibas *et al*. (2001) showed that EE content of Rocket full fat was 24.87%, while the crude protein content was 30.24% on dry matter basis. While, Rocket seeds contain carotenoids, vitamin C, flavonoids such as appin and luteolin and glucosinolates the precursors of isothiocyanates and sulfaraphene (Talalay and Fahey, 2001), glucosinolates were found to have several biological activities including anti-carcinogenic, anti-fungal, anti-bacterial plus its anti-oxidant action (Kim *et al.,* 2004).

Aherne and Kenelly(1982) reported that the differences between chemical composition of oils seeds meals may be due to type of seeds and processing method.

2. Rabbit performance

Daily body weight gain for rabbit fed experimental diets showed a significant (P<0.05) change from control due to Black cumin, Mustard, Sesame and Rocket diet (Table 3). Mustard and Sesame diets were higher than Black cumin and Rocket seed meal diets in average daily body weight gain compared to the control diet. However, no significant difference were detected between experimental group diets in daily feed intake, feeding Sesame diet insignificantly lower daily feed intake compared to the control diet.

Table (3): Growth performance of growing rabbits fed Black cumin, Mustard, Sesame or Rocket seed meals.

Ingredient	Control	Black cumin seed meal	Mustard seed meal	Sesame seed meal	Rocket seed meal	±SE	Sig.
Initial body weight (g)	825.0	808.75	813.75	822.5	827.5	10.43	NS
Final body weight (g)	2201.39^{d}	2370.00^{c}	2453.29^{b}	2538.37^{a}	2437.33^{b}	25.00	*
Total body weight gain(g)	1376.39^{d}	1561.25^{c}	1639.54^{b}	1715.87^{a}	1609.83^{b}	18.2	*
Average daily gain (g)	20.24^{c}	22.95^{b}	24.11^{a}	25.23^{a}	23.67^{b}	1.38	*
Daily feed intake, (g)	83.89	80.00	85.21	77.71	83.38	4.08	NS
Feed conversion ratio: g DM intake/g gain	4.14^{a}	3.48^{b}	3.53^{b}	3.08^{b}	3.52^{b}	0.20	*

a, b, c and d means in the same row bearing different letters that differ sgnificantly at P<0.05.
NS: Non significant. * P<0.05.

Feed conversion ratio for rabbit received different diets showed a significant (P<0.05) improved by 15.9, 14.7, 25.6 and 14.9% for Black cumin, Mustard, Sesame and Rocket seed meals, respectively compared to the control diet, indicating that these diets improved feed conversion ratio compared to the control diet.

The results of growth performance are in agreement with Naser and Attia (1998) they found that addition of 12g *Nigella sativa* (NS) seeds/kg to the diet offered to 40- day-old NZW rabbits significantly increase daily weight gain, feed efficiency, blood albumin and decreased age at first mating and at first kindling. Omar *et al*. (2002) stated that use of diet supplemented with NS seed oil improved the growth performance and increased feed conversion efficiency, immune response and economic return of chickens. However, Gaafar *et al*. (2014) found that rabbits fed diets supplemented with combination of Pumpkin and Black seeds oils (2.5 and 2.5g/kg diet) showed the best results concerning body weight gain, feed conversion and economic efficiency. Moreover, Taha (1997) reported that using Black cumin cake as a feed additive at levels of 3, 6 and 9% had insignificant effect on live weight gain, feed intake and feed conversion of NZW rabbits.

However, Tripathi *et al.* (2003) found that when Mustard seed meal (MM) was incorporated at the levels of 80, 160 and 245 g/kg of rabbit diets in replacement of soybean meal and compared with a soybean meal (SBM) basal diet, feed intake on MM diets was significantly lower than the feed intake on soybean meal diet. However, feed conversion efficiency was significantly better on MM diet compared to that of SBM. Andrzej *et al.* (2011) indicated that diets supplemented with 1% Mustard meal for rabbit diets were characterized by satisfactory palatability with performance indicators and health condition of rabbits, with special emphasis on coccidial infection rates. Moreover, Ibrahim *et al*. (2012) observed that inclusion Mustard seeds at 0.5% or 1% significantly (P<0.05)improved the final weight, total body weight gain, average daily gain and feed conversion compared to control diet. On the other hand, inclusion of Mustard seeds at 1% significantly (P<0.05) increased the total body weight gain and average daily gain by 24.3% while at 0.5% significantly (P<0.05) increased the total body weight gain and average daily gain by 14.5% compared to the control group.

Supplemented Sesame seed meal (SSM) to rabbit diets improved daily gain and better feed conversion efficiency compared to control. Similar results were obtained with Rahimian *et al.* (2013)who indicated that consumption of SSM increased live body weight and body weight gain of 6-week old broiler chicks than the control diet. However, Osman *et al*. (2004)found that by feeding either Radish or Rocket meals up to 15% instead of a part of soybean meal had no effect on broiler chicks live body weight. Abdo (2003) found that the best body weight gain in broiler rations were for Rocket seed meal at levels of 10 and 25% substitution of soybean protein. El-Tohamy and El-Kady (2007) found that using Rocket meal at 50% crude protein level as a replacement of soybean meal showed significant increment of daily body gain, daily feed intake and feed conversion of rabbits. Such improvement of tested materials may be attributed to the properties of those materials that could act as anti-bacteria, anti-protozoal, anti-fungal and anti-oxidants. Thus incorporation of such additions had no adverse effect on palatability and voluntary feed intake in rabbits.

3-Digestibility coefficient and nutritive values

Apparent digestibility of almost nutrients OM, CP, CF, EE and NFE were significantly (P<0.05) increased with Black cumin and Sesame seed meals compared with the control diet, while those of CP, EE and NFE digestibility were significantly (P<0.05) increased by Mustard seed meal and non – significantly difference was detected with OM and CF compared with the control diets. However, digestibility of OM, CP, EE and NFE were significantly increased by Rocket seed meal and non- significantly increase with CF digestibility compared with the control diets. Nutritive values in terms of TDN and DCP of the different dietary treatments increased significantly (P<0.05) than the control (Table 4). Similar results have been observed with Amber *et al.* (2001), who found that digestibility of CF and EE increased significantly as Black cumin cake level increased in rabbit diet. While, Gaafar *et al.* (2014)found that Pumpkin and Black seed oil showed a slight increase in the digestibility of DM, OM, CP, CF, EE and NFE and subsequently nutritive values in terms of TDN, DCP and DE in rabbit diets as compared to the control. However, Ibrahim *et al*. (2012)found that inclusion Mustard seed at 1% in rabbit diets significantly (P<0.05) increased all nutrients digestibility and nutritive values compared to control diet. El-Tohamy and El-Kady (2007) found that using Rocket seed meal at 50% crude protein level as a replacement of soybean meal slightly increased apparent digestibility of nutrients and feeding values compared to control diet. This may be due to flavonoid and essential oils, which had beneficial effect or stimulation and activity of digestive system. However, Mulugeta and Gebrehiwat (2013) found that there were significant differences in DM, OM and CP ($P \leq 0.05$) digestibility between Sesame cake supplemented and control group in the sheep ration.

Table (4): Nutrients digestibility coefficients and nutritive values as affected by different experimental diets.

Ingtedient	Control	Black cumin seed meal	Mustard seed meal	Sesame seed meal	Rocket seed meal	±SE	Sig.
Digestibility coefficients, %							
DM	60.80	61.68	57.84	64.08	61.08	1.55	NS
OM	57.32^{b}	65.16^{a}	59.03^{b}	65.47^{a}	62.47^{a}	0.82	*
CP	58.18^{c}	62.65^{b}	64.81^{b}	72.22^{a}	60.59^{b}	0.81	*
CF	31.41^{c}	38.39^{b}	32.86^{c}	44.87^{a}	33.49^{c}	0.70	*
EE	54.76^{c}	62.44^{b}	70.90^{a}	72.73^{a}	67.97^{b}	0.79	*
NFE	59.23^{c}	77.41^{a}	75.07^{b}	79.46^{a}	74.66^{b}	0.72	*
Nutritive value, % on DM basis							
TDN	50.16^{c}	62.00^{b}	62.07^{b}	67.36^{a}	59.43^{b}	0.73	*
DCP	9.89^{c}	11.32^{b}	11.99^{b}	13.28^{a}	11.19^{b}	0.23	*

a,b and c means in the same row bearing different letters that differ significantly at P<0.05.
NS: Non sgnificant. * P<0.05.

4- Carcass characteristics and chemical composition of meat

Inclusion of Black cumin, Mustard, Sesame and Rocket seed meal diets did not affect on empty body weight, carcass weight and carcass weight plus total giblets. However, decreased (P<0.05) with Black cumin diet carcass and dressing percentage compared with the control diet (Table 5). Similar results were obtained by Zeweil (1996) who found that carcass percentage significantly (P<0.01) decreased for groups fed 38 and 48% Black cumin meal as a replacement of dietary protein. Taha (1997) also found that dressing percentage was the lowest value in rabbit fed diet with 9% Black cumin meal. Moreover, El-Tohamy and El-Kady (2007) used

Black cumin meals at 50% crude protein level as a replacement of soybean meal and found a significantly effect on the carcass yield and dressing percentage compared with the control rabbit diets. On the other hand, Ibrahim *et al.* (2012) found that inclusion Mustard seeds in rabbit diets significantly decreased the dressing percentages by increasing the level of Mustard seeds from 0.5 to 1.0% in rabbit diets. This result may be due to the presence of some fatty acids in Mustard oil that are not usually present in edible oils and fats that reduced calorie fats as reported by Kanjilal *et al.* (1999).On the other hand, there were no significant ($P<0.05$) differences detected between Sesame supplemented and control group in dressing percentages as (DP_1), (DP_2) and (DP_3). These observations were below expectations, while, Hassan *et al.* (2013) found that carcass yield and carcass characteristics (slaughter weight, empty body weight, hot carcass weight, cold carcass weight, carcass traits %, whole sale cuts out of carcass weight and non-carcass traits, dressing % on live weight, dressing % on empty body weight, total muscles, bone fat and total connective tissue % of carcass) of experimental lambs fed different levels (0, 15 and 20%) of Sesame cake were not significantly ($P>0.05$) different between the different treatment groups. Moreover, Abdo (2003) found that there was no significant difference between the carcass value of the 0% *Eruca sativa* seed meal diets (71.86%) and 25% *Eruca sativa* seed meal substitution (71.25%) for soybean meal protein in broiler ration. While, Hopper and Sattarlee (1984) indicated that carcass and abdominal fat plus carcass weight were depressed in chicks treated with Mustard meal which belongs to the same family of *Eruca sativa*.

Table (5): Carcass characteristics and meat composition of rabbits fed different experimental diets.

Item	Experimental diets						
	Control	Black cumin seed meal	Mustard seed meal	Sesame seed meal	Rocket seed meal	±SE	Sig.
Empty bodyweight (EBW)g	2022.0	1933.0	2193.0	1983.0	2130.0	77.3	NS
Carcass weight (CW_1)g	1261.0	1118.2	1335.6	1229.8	1273.7	47.2	NS
Carcass weight+total giblets(CW_2)g	1368.2	1224.1	1461.1	1345.5	1384.9	53.5	NS
Dressing percentages (DP) %							
DP_1-	56.37[a]	52.27[b]	55.03 [ab]	56.05 [a]	54.03[ab]	0.48	*
DP_2-	62.36 [a]	57.84[b]	60.90 [ab]	62.01 [a]	59.79 [ab]	0.54	*
DP_3 -	67.66 [a]	63.32[b]	66.62[ab]	67.85[a]	65.01 [ab]	0.52	*
Carcass cuts, g:							
For part-	253.0[ab]	245.0 [b]	312.3[a]	268.3[ab]	273.0[b]	11.11	*
Middle part-	365.0	326.0	330.0	332.0	366.2	25.4	NS
Hind part-	454.2[ab]	375.2 [b]	499.3[a]	450.0[ab]	450.0[ab]	33.8	*
Head	114.3[b]	121.7 [ab]	132.3[a]	121.5[ab]	125.0 [ab]	6.68	*
Neck	74.5[a]	50.3 [b]	61.5 [ab]	58.0 [ab]	59.5 [ab]	6.84	*
Slaughter weight (SW)	2237.0	2139.0	2427.0	2194.0	2357.0	114.2	NS
External offal's, g:							
- Blood	103.7	80.3	90.3	89.3	96.7	1.80	NS
- Fur	274.7	317.3	330.5	245.3	276.7	24.2	NS
- Legs	67.7 [b]	88.7 [a]	75.7 [ab]	76.0 [ab]	83.0 [ab]	5.98	*
- Tail	13.2	14.2	16.5	15.0	14.7	1.29	NS
- Ears	34.2 [b]	42.5 [ab]	40.5 [ab]	46.5 [a]	44.0 [ab]	3.16	*
- Total	493.5	543.0	553.5	472.1	515.1	23.4	NS
Edible offal's, g:							
- Kidneys	17.6	16.3	18.4	20.0	19.5	1.27	NS
- Liver	61.7 [ab]	59.7[b]	72.3 [a]	64.5 [ab]	61.2 [ab]	5.20	*
- Heart	7.2	8.7	9.5	7.7	8.5	0.99	NS
- Lungs	19.7	20.2	24.3	22.6	21.0	1.88	NS
-Spleen	1.0	1.0	1.0	1.0	1.0	0.00	NS
- Total	107.2	105.9	125.5	115.8	111.2	23.4	NS
Digestive tract, g:							
- Full	375.0	372.0	413.0	377.0	458.0	22.0	NS
- Empty	160.0	166.0	179.0	166.0	231.0	20.6	NS
- Content	215.0	206.0	234.0	211.0	227.0	23.5	NS
Chemical analysis of the 9, 10and 11^{th} ribs:							

Dry matter	31.11^b	32.05^b	36.24^a	32.66^b	31.05^b	1.47	*
Chemical compostion on DM basis:							
Crude protein (CP)	56.21^c	61.11^b	59.80^b	61.85^a	59.60^a	0.81	*
Ether extract (EE)	36.82^a	32.79^b	34.75^a	30.69^c	32.57^b	0.83	*
Ash	6.97^b	6.10^b	5.45^b	7.46^a	7.83^a	0.30	*

$DP_1=CW_1/SW$ $DP_2=CW_1/EBW$ $DP_3=CW_2/EBW$

a and b: means in the same row within each treatment having different superscripts differ significantly at P<0.05. SE: Strandard error of the mean. NS: Non sgnificant. *: P<0.05.

5- Meat composition

Chemical analysis of the 9, 10 and 11^{th} ribs (CP and EE contents)were significantly increased CP content, while EE was significantly decreased with different supplemented than control group (Table 5).Dry matter and ash contents were nearly similar for all groups. However, there were significant differences (P<0.05) in the contents of protein and ether extract in meat among the different groups. In this respect, Gaafar *et al* (2014) were fed rabbits on commercial pelleted diet without addition (control) and the control diet supplemented with 2.5g Pumpkin oil plus 2.5g *Nigella sativa* oil showed significantly (P<0.05) the highest protein and the lowest EE contents. However, Ibrahim *et al.* (2012) found that dietary 90% of protein requirements with 1% Mustard seed in rabbit diets increased CP content of meat from 58.97 to 63.45% and decrease EE from 33.38 to 28.51%.

Moreover, Abdo (2003) used *Eruca sativa* seed meal as a substitute for soybean meal protein in broiler rations. He found a clear trend for only EE and CP, where EE values decreased by increasing *Eruca sativa* seed meal from level 0, 25 and 50% of soybean meal protein, while CP values were increased in the chicken meat.

6- Economical evaluation

There was considerable cost saving with inclusion Black cumin, Mustard, Sesame and Rocket seed meals as compare to the control group (Table 6). Differences in relative economic efficiency showed that diet supplemented with Black cumin, Mustard, Sesame and Rocket seed meals had the best values (119, 119, 140 and 120%), respectively compared to the control diet. Similar results obtained by Mahmoud and Bendary (2014)who found that the use of *Nigella sativa* and Sesame seed meals reduced feed cost and therefore it can be used to improve total revenue, net revenue, economic efficiency and relative economic efficiency in ration on performance of growing lambs and calves. However, Ibrahim *et al.* (2012) found that dietary 90% of protein requirements with 0.5% or 1%Mustard seeds in rabbit diets showed higher value of net revenue, economical efficiency and relative economic efficiency. Moreover, El-Tohamy and El-Kady (2007) concluded that Rocket seed meals could be used for partial replacement up to 50% of soybean meal protein to obtained best economical return.

Table (6): Effect of experimental diets on economic efficiency of growing rabbits.

Item	Experimental diets				
	Control	Black cumin seed meal	Mustard seed meal	Sesame seed meal	Rocket seed meal
Total feed consumption/rabbit (Kg)	5.70	5.44	5.79	5.28	5.67
Price/Kg feed (L.E)	2.360	2.450	2.450	2.450	2.450
Feed cost/rabbit (L.E)	13.45	13.33	14.19	12.93	13.89
Total cost (L.E)(A)	24.95	24.83	25.69	24.43	25.39
Final body weight (Kg)	2.201	2.370	2.453	2.538	2.437
Cost/Kg body weight (L.E)	11.33	10.47	10.47	9.63	10.42
Total revenue (L.E)(B)	44.02	47.4	49.06	50.76	48.74
Net revenue (L.E)(1)	19.07	22.57	23.37	26.33	23.35
Economic efficiency (2)	0.764	0.909	0.909	1.077	0.919
Relative economic efficiency (%)	100	119	119	140	120

A) Including fixed cost (11.50 L.E/ rabbit).
B) Assuming that the selling price is (20 L.E/ kg body weight).
1) Net revenue = (B – A).
2) Economic efficiency= $\frac{B - A}{A}$ **.**

***Price kg of control diet was 2.360 L.E .**
***Price kg of each additive 3.000 L.E .**

In general, it is recommended that use of Black cumin, Mustard, Sesame and Rocket seed meals as supplements at 3% level in broiler rabbit diets in order to get higher economical efficiency without adverse effect on the rabbit performance. Screw press or solvent extraction and temperature used for roasting the seed might have altered the availability of the basic amino acids (Mamputu and Buhr, 1995) and in term affected the feeding value of these additives for rabbit diets.

Future field trials are encourage in order to clarify possible utilization of these feed ingredients in rabbit feed diets and study the long term effects of these cakes on immunity and reproduction of rabbit bucks.

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