Improving the Utilization of Rabbit Diets Containing Vegetable Oil by Using Fennel (*Foeniculum vulgare)* And Oregano (*Origanum vulgare* L) as Feed Additives

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Abstract: Forty five male New Zealand White rabbits aged 5 weeks with an average body weight 574±2.32 g were divided randomly into five equal experimental groups (9 animals in each) and used in a feeding trial lasted 56 days to investigate the response of rabbits to diets diet containing fat with or without herbal mixture formulation consisting of fennel *(Foeniculum vulgare)* seeds or oregano leaves (*Origanum vulgare* L.) and mixture of them on growth performance, nutrient digestibility, carcass characteristics, blood constituents and economical evaluation of growing rabbits. The experimental groups were classified to: group 1 fed the basal diet and served as control group (R_1); group 2 fed the basal diet + 2% sunflower oil (R_2); group 3 fed the basal diet + 2% sunflower oil + 1% Fennel seeds (R_3); group 4 fed the basal diet + 2% sunflower oil + 1% Oregano leaves (R_4) and group 5 fed the basal diet + 2% sunflower oil + 0.5% Fennel seeds + 0.5% Oregano leaves (R_5). The results showed that, tested rations were isonitrogenous but not isocaloric. Dietary treatments had no significant effect on feed intake, CP and EE digestibilities. While DM, OM and CF digestibilities were significantly ($P<0.05$) improved. Rabbits received R_5 diet recorded the highest value of OM, CF, EE digestibilities and TDN value. On the other hand, dietary treatments improved both TDN and DCP values. Dietary treatments significantly ($P<0.05$) improved final weight, body weight gain and average daily gain. Final weight was improved by 3.45, 12.37, 9.71 and 13.38% for R_2, R_3, R_4 and R_5, respectively, compared to the control R_1; while both body weight gain and average daily gain were improved by 4.37, 16.37, 12.46 and 17.48% for the same experimental groups compared to control. Adding medicinal plants (fennel seeds or oregano leaves) to rabbit diets significantly ($P<0.05$) improved feed conversion ratio. Rabbit fed on R_5 diet recorded the best feed conversion ratio. Dietary treatments significantly decreased ($P<0.05$) only EBW (R_3), total cholesterol (R_3, R_4 and R_5) and LDL (R_5). Rabbits received R_5 diet recorded the best total cost, total revenue, net revenue, economical efficiency, relative economic efficiency and feed cost / kg LBW. It can be concluded that adding 0.5% fennel seeds with 0.5% oregano leaves as feed additives to rabbit diets contained 2% oil improved daily gain; both nutrient digestibility coefficients and nutritive values as well as realized the highest value of relative economic efficiency and lowered value of feed cost/ kg live body weight.
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Introduction

There are a large number of feed additives available for inclusion in animal and poultry diets to improve their performance. However, the use of chemical products especially (hormones and antibiotics), may cause unfavorable side effects. Moreover, there is evidence indicating that these products could be considered as pollutants for human and threaten the health on the long–run. Attempts to use the natural materials such as medicinal plants could be widely accepted as feed additives to improve the efficiency of feed utilization and productive performance (Aboul-fotouh *et al.,* 1999).

Herbs and herbal extracts contain different phytochemical compounds with biological activity that may provide therapeutic effects. Several herbs help to reduce high blood cholesterol concentration, provide some protection against cancer, and/or stimulate the immune system. Furthermore, it was found that a diet in which culinary herbs are used generously to flavor food provides a variety of active phytochemicals which promote health and protect against chronic diseases (Abdo *et al.,* 2003).

Fennel (*Foeniculum vulgare)* is considered one of the oldest medicinal plants and culinary herbs. It is fairly certain that fennel was in use over 4000 years ago. It is mentioned in the famous Ebers Papyrus, an ancient Egyptian collection of medical writings made around 1500 BC. There it is referred to principally as

a remedy for flatulence. Fennel primarily describe as an aid to digestion. (MDEDEP, 2011).

Fennel now widely cultivated in Bulgaria, Romania, Hungary, Greece, Turkey, Italy, France, Germany, Egypt, India, and China. The material of commerce comes mainly from Bulgaria, Hungary, Romania, Egypt, and China. (MDEDEP, 2011).

The production of Fennel in Egypt recorded 22,000 tons according to the economic made by FAO (2008). On the other hand, the world production of fennel recorded 415027 tons.

Fennel has been used historically as a galactogogue (to stimulate milk production). It has also been used for gastrointestinal disorders and as an expectorant. The dose of the oil is 0.1-0.6 ml which is equivalent to 100-600 mg of herb. Side effects include allergic reactions and dermatitis. There are no known contraindications for fennel oil (MDEDEP, 2011).

Fennel seeds are rich in total carbohydrates (61.0%) and low in total soluble sugars (7.6%). The seeds are rich in Ca, P and Mg and contain considerable amounts of K, Fe and Zn and traces of Ma. The major fatty acid components of fennel seeds are 18:1 (71.31%) and 18:2 (11.66%). Also, fennel seeds are high in isoleucine and histidine (Abou-Raiia *et al.,* 1991). The analysis of ethanolic and methanolic seed extracts showed the presence of nine components including linoleic acid (56%), palmitic acid (5.6%) and 5.2% of oleic acid (Gulfraz *et al.,* 2008).

Oregano leaves (*Origanum vulgare* L.) essential oil is one of the many plant extracts that are used at present as supplements in animal's diets. It contains mainly carvacrol, thymol and their precursors, (terpinene and p-cypene and it possesses intense *in vitro* antimicrobial (Dorman and Deans, 2000), antifungal (Daouk *et al*., 1995) and antioxidant (Cervato *et al*., 2000) properties, making it an appropriate candidate as a replacement for antibiotic growth promoters and also a promising food additive in order to prevent meat lipid oxidation.

Oregano aids nutrient digestion and absorption, it displays antibacterial properties and prevents gut misbalances (De Koning *et al.,* 1993). Untea *et al.* (2011) considered that oregano stabilizes the gut microflora and increases nutrient digestibility. Amount of volatile oil from the *Origanum vulgare L* is varying from 0.18-0.45% and 0.32-1.02% in fresh and dried plant (Robu and Milică, 2004).

The essential oil obtained from *Origanum vulgare* sub sp. hirtum plants by a steam-distillation process contains more than 30 constituents, which are mainly phenolic antioxidants (Vekiari *et al.,* 1993). Major components are carvacrol and thymol, which amount to 78–82% of the essential oil and exhibit considerable antimicrobial and antifungal activity (Sivropoulou *et al.,* 1996).

This work was carried out to investigate the response of rabbits to diet containing fat with or without herbal mixture formulation consisting of fennel *(Foeniculum vulgare)* seeds and oregano leaves (*Origanum vulgare* L.) and their effects on growth performance, nutrient digestibility coefficients, carcass characteristics, blood constituents and economical evaluation.

2. Materials and Methods

A total number of 45 male New Zealand White rabbits aged 5 weeks with an average body weight of 574 ± 2.32 g, were divided into five equal groups. Feed additives used in this study are fennel seeds and oregano leaves.

The feeding period was extended for 56 days, and the experimental groups were classified as the following:

Group 1 fed the basal diet and served as control group (R_1),
Group 2 fed the basal diet + 2% sunflower oil (R_2),
Group 3 fed the basal diet + 2% sunflower oil + 1% fennel seeds (R_3),
Group 4 fed the basal diet + 2% sunflower oil + 1% oregano leaves (R_4) and
Group 5 fed the basal diet + 2% sunflower oil + 0.5% fennel seeds + 0.5% oregano leaves (R_5).

The basal experimental diet was formulated and pelleted to cover the nutrient requirements of rabbits according to (NRC, 1977) as shown in (Table 1).

Rabbits individually housed in galvanized wire cages (30 x 35 x 40 cm). Stainless steel nipples for drinking and feeders allowing recording individual feed intake for each rabbit were supplied for each cage (*ad libitum).* Rabbits of all groups were kept under the same managerial conditions.

At the end of the experimental period, all rabbits were used in digestibility trials over period of 7 days to determine the nutrient digestibilities and nutritive values of the tested diets. Feed intake of experimental rations and weight of feces were daily recorded. Representative samples of feces was dried at 60°C for 48 hrs, ground and stored for later chemical analysis.

At the end of the experimental period six 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, testes, kidneys, spleen and lungs were removed and individually weighed. Full and empty weights of digestive tract were recorded and digestive tract contents were calculated by differences between full and empty digestive tract. Hot carcass was weighed and divided into fore, middle and hind parts. The 9, 10 and 11th ribs were frozen in polyethylene bags for later chemical

analysis. The best ribs of samples were dried at 60 C° for 24 hrs. The air-dried samples were analyzed for DM, EE and ash according to the A.O.A.C. (2000) methods, while CP percentage was determined by difference as recommended by O'Mary *et al.* (1979).

Table (1): Composition (kg/ton) of the experimental diets.

Item	Experimental diets				
	R_1	R_2	R_3	R_4	R_5
Yellow corn	210	170	170	170	170
Wheat bran	300	300	300	300	300
Soybean meal 44% CP	140	140	140	140	140
Clover hay	325	345	335	335	335
Sunflower oil	---	20	20	20	20
Fennel seeds	---	---	10	---	5
Oregano seeds	---	---	---	10	5
Lime stone	15	15	15	15	15
Vit. & Min. mixture*	3	3	3	3	3
Sodium chloride	5	5	5	5	5
DL-Methionine	2	2	2	2	2
Price, L.E/Ton	1807	1875	1965	1965	1965

R_1: Control diet. R_2: Control diet + 2% oil. R_3: Control diet + 2% oil + 1% Fennel seeds.
R_4: Control diet + 2% oil + 1% Oregano leaves. R_5: Control diet + 2% oil + 0.5% Fennel seeds+ 0.5% Oregano leaves.
** Vit. & Min. mixture: Each kilogram of Vit. & Min. mixture contains: 2000.000 IU Vit. A, 150.000 IU Vita. D, 8.33 g Vit. E, 0.33 g Vit. K, 0.33 g Vit. B_1, 1.0 g Vit. B_2, 0.33g Vit. B_6, 8.33 g Vit.B_5, 1.7 mg Vit. B_{12}, 3.33 g Pantothenic acid, 33 mg Biotin, 0.83g Folic acid, 200 g Choline chloride, 11.7 g Zn, 12.5 g Fe, 16.6 mg Se, 16.6 mg Co, 66.7 g Mg and 5 g M*

Blood samples were taken from six rabbits in each treatment during slaughtering process in heparinized test tubes and centrifuged at 3000 rpm for 15 minutes, the plasma were collected and preserved in a deep freezer at -18°C until the time of analysis. Various blood plasma chemical parameters were calorimetrically determined using commercial kits, following the same steps as described by manufactures. Plasma total protein was determined according to Armstrong and Carr (1964); albumin according to Doumas *et al.* (1971). Globulin was calculated by subtracting the albumin value from total protein value. Plasma Glutamic Oxaloacetic Transaminase (GOT) and Glutamic Pyruvic Transaminase (GPT) activities were determined as described by Reitman and Frankel (1957). Alkaline phosphatase colorimetric method measured according to Belfield and Goldberg (1971). Creatinine colorimetric kinetic method determined according to Bartles *et al.* (1972). Total lipids (Postman and Stroes, 1968); triglycerides (Fossati and Principe 1982); total cholesterol (Pisani *et al.,* 1995) and low density lipo-protein (LDL-cholesterol) according to Wieland and Seidel (1983). Albumin: globulin ratio (A: G ratio) were also, calculated.

Chemical analysis of experimental rations and feces were analyzed according to A.O.A.C (2000) methods. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL)} were also determined in the experimental rations according to Goering and Van Soest (1970). Diets were offered pelleted and diameter of the pellets was 4 mm.

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

3. Results and Discussion

Chemical analysis:

Chemical analysis and cell wall constituents of the experimental diets are presented in Table (2). Data obtained cleared that the experimental diets were isonitrogenous but differed in energy content. These related to add sunflower oil in the tested diets.

Protein contents for the five tested diets ranged from 17.40 to 17.86 %, crude fiber ranged from 17.45 to 17.88%, ash and nitrogen–free extract were slight decreased in diets (R_2 to R_5) in comparison with the control diet (R_1). On the other hand, adding sunflower

oil to diets (R_2 to R_5) lead to increase gross energy content compared to control diet (R_1).

Digestible energy (Kcal/kg DM) content of experimental diets (R_2 to R_5) were slightly increased compared to control diet (R_1), but non fibrous carbohydrates values were slightly decreased.

Cell wall constituents (NDF, ADF and cellulose) contents of the experimental diets were slightly decreased. While, ADL content of the experimental diets were slight increased compared to the control diet.

Table (2): Chemical analysis and cell wall constituents of the experimental diets

Item	Experimental diets				
	R_1	R_2	R_3	R_4	R_5
Dry matter (%)	91.30	92.00	90.20	90.50	90.90
Chemical analysis on DM basis (%)					
Organic matter (OM)	91.93	92.02	92.20	92.05	92.17
Crude protein (CP)	17.40	17.70	17.86	17.65	17.49
Crude fiber (CF)	17.76	17.45	17.66	17.56	17.88
Ether extract (EE)	4.00	5.53	5.10	5.71	5.87
Nitrogen-free extract (NFE)	52.77	51.34	51.58	51.13	50.93
Ash	8.07	7.98	7.80	7.95	7.83
Gross energy (Kcal/kg DM)[1]	4283	4375	4362	4385	4396
Digestible energy (Kcal/kg DM)[2]	2509	2532	2545	2533	2539
Non fibrous carbohydrates (NFC)[3]	34.09	32.88	33.32	32.71	32.85
2- Cell wall constituents (%)					
Neutral detergent fiber (NDF)	36.44	35.91	35.92	35.98	35.96
Acid detergent fiber (ADF)	20.96	20.45	20.45	20.48	20.47
Acid detergent lignin (ADL)	5.87	6.00	5.92	5.93	5.93
Hemicellulose	15.48	15.46	15.47	15.50	15.49
Cellulose	15.09	14.45	14.53	14.55	14.54

[1] *Gross energy (Kcal/kg DM) was calculated according to* ***Blaxter (1968)****, where, each g of crude protein (CP) = 5.65 kcal, each g of ether extract (EE) = 9.40 kcal, and each g crude fiber (CF) and nitrogen-free extract (NFE) = 4.15 kcal.*

[2] *Digestible energy (Kcal/kg DM) was calculated according to* ***Fekete and Gippert (1986)*** *using the following equation: DE (kcal/ kg DM) = 4253 – 32.6 (CF %) – 144.4 (total ash).*

[3] *Non fibrous carbohydrates (NFC) were calculated according to (****Calsamiglia et al. 1995****) using the following equation: NFC = 100 – {CP + EE + Ash + NDF}.*

Hemicellulose = NDF – ADF.

Cellulose = ADF – ADL.

Nutrient digestibility:

Digestibility and nutritive values (%) of the experimental diets are shown in Table (3). Dietary treatments had no significant effect on CP and EE digestibilities. While DM, OM and CF digestibilities were significantly ($P<0.05$) improved.

Rabbits received R_5 (2% oil + 0.5% fennel seeds + 0.5% oregano leaves) containing diet recorded the highest value of OM, CF, EE digestibilities and TDN value. On the other hand, dietary treatment improved both TDN and DCP values.

Srihari *et al.* (2008) fed male wistar albino rats on a high-fat diet (20% fat in the diet). Group 1 served as control and group 2, 3 and 4 animals received 20, 40 and 60 mg/kg BW oregano daily for 15 weeks to study the effect of oregano (*Origanum vulgare L.*) on fecal bacterial enzyme activities in 1, 2-dimethylhydrazine (DMH)-induced experimental colon carcinogenesis. They noted that *oregano* supplementation at all 3 doses significantly suppressed the bacterial enzyme activities and modulated oxidative stress significantly compared with the unsupplemented DMH-treated group. Also, they revealed that oregano markedly inhibited DMH-induced colon carcinogenesis and that the optimal dose of 40 mg/kg BW was more effective than either the higher or lower dose.

Franz *et al.* (2010) used aromatic herbs and essential oils as feed additives in animal nutrition, they observed an improvement in the digestion resulting in reduced methanogenesis and nitrogen excretion. Simon *et al.* (1984) noted that fennel is a good herb for the entire digestive system as a laxative appetite stimulant, antispasmodic and carminative, relieves abdominal pain, and is useful for gastrointestinal and colon disorders. Also, they noted that fennel acts as a mild expectorant, useful for coughs or bronchitis and to resolve phlegm, promotes liver and kidney and health. Hernandez *et al.* (2004) reported that medicinal plants and herbs contain a

wide variety of active phytochemicals, including the flavonoids, terpenoids, lignans, sulfides, polyphenolics, carotenoids, coumarins, saponins, plant sterols, coumarins and phthalides. These plants possess biological activities such as that of antioxidants stimulate the function of animal digestive systems to increase production of digestive enzymes through enhance liver functions. Renjie *et al.* (2010) noted that the main components of the essential oil of fennel were Benzene, 1-methoxy-4-(1-propenyl)-(82%), D-Limonene (6.55%), Estragole (3.53%), 3-Carene (1.12%) and 1, 6-Octadien-3-ol, 3, 7-dimethyl-(1.12%). Fennel essential oils inhibited Enterococcus and Clostridium perfringens growth in rat's intestine. By contrast, the essential oil promoted Bacillus bifidus growth. Also, confirmed the possibility of using the fennel essential oils in maintaining useful bacteria colony on rat's intestine.

Table (3): Digestibility coefficients and nutritive values (%) of the experimental diets.

Item	Experimental diets					SEM
	R_1	R_2	R_3	R_4	R_5	
Digestibility						
Dry matter (DM)	70.03^{b}	76.15^{a}	76.13^{a}	72.94^{ab}	75.41^{a}	0.75
Organic matter(OM)	67.66^{c}	68.23^{bc}	69.76^{ab}	68.79^{abc}	70.36^{a}	0.34
Crude protein (CP)	77.53	78.98	77.27	76.90	76.98	0.33
Crude fiber (CF)	23.04^{c}	26.61^{bc}	35.48^{ab}	34.60^{b}	45.87^{a}	2.49
Ether extract (EE)	77.34	77.32	75.82	78.89	79.23	0.78
Nitrogen-free extract (NFE)	78.76^{a}	77.68^{ab}	78.30^{a}	76.60^{ab}	75.65^{b}	0.42
Nutritive values						
Total digestible nutrient (TDN)	66.07^{c}	68.13^{b}	69.15^{ab}	68.96^{ab}	70.67^{a}	0.45
Digestible crude protein (DCP)	13.49^{b}	13.98^{a}	13.80^{ab}	13.57^{b}	13.46^{b}	0.07

a, b and c: Means in the same row having different superscripts differ significantly (P<0.05).
SEM, standard error of the mean.

***Growth performance*:**

Growth performance of the experimental groups is presented in Table (4). Data collected showed that dietary treatments significantly (P<0.05) improved final weight, body weight gain and average daily gain. Final weight was improved by 3.45, 12.37, 9.71 and 13.38% for R_2, R_3, R_4 and R_5, respectively, compared to the control R_1; while both body weight gain and average daily gain were improved by 4.37, 16.37, 12.46 and 17.48% for the same experimental group compared to control.

Rabbits received R5 (2% oil + 0.5% fennel seeds+ 0.5% oregano leaves) containing diets recorded the best final weight, body weight gain and average daily gain.

Table (4): Growth performance of the experimental groups.

Item	Experimental diets					SEM
	R_1	R_2	R_3	R_4	R_5	
Initial weight, g	570	574	572	578	576	2.32
Final weight, g	2287^{d}	2366^{c}	2570^{a}	2509^{b}	2593^{a}	19.04
Body weight gain, g	1717^{d}	1792^{c}	1998^{a}	1931^{b}	2017^{a}	18.84
Duration period, day	56 days					
Average daily gain, g	30.66^{d}	32.00^{c}	35.68^{a}	34.48^{b}	36.02^{a}	0.34
Feed intake as:						
Dry matter, g/h/d (DMI)	110	101	97	98	91	3.65
Crude protein , g/h/d (CPI)	19.14	17.88	17.32	17.30	15.92	0.64
Digestible crude protein, g/h/d (DCPI)	14.84	14.12	13.39	13.30	12.25	0.50
Total digestible nutrient, g/h/d (TDNI)	72.68	68.81	67.08	67.58	64.31	2.43
Digestible energy, kcal/h/d (DEI)	276	256	247	248	231	9.14
Feed conversion (g intake/ g gain) of						
Dry matter	3.59^{b}	3.16^{ab}	2.72^{a}	2.84^{a}	2.53^{a}	0.12
Crude protein	0.62^{b}	0.56^{ab}	0.49^{a}	0.50^{ab}	0.44^{a}	0.02
Digestible crude protein	0.48^{c}	0.44^{bc}	0.38^{ab}	0.39^{abc}	0.34^{a}	0.01
Total digestible nutrient	2.37^{b}	2.15^{ab}	1.88^{a}	1.96^{ab}	1.79^{a}	0.08
Digestible energy *(Kcal intake /g gain)*	9.00^{b}	8.00^{ab}	6.92^{a}	7.19^{a}	6.41^{a}	0.30

a, b, c and d: Means in the same row having different superscripts differ significantly (P<0.05).
SEM, standard error of the mean.

Radwan and Abdel-Khalek (2007) supplemented 0.5% a herb mixture of equal parts of sage+oregano+sweet basal or 1.0% of the previous herb mixture to investigate the response to some growth promoters as safe alternatives to antibiotics on some performance aspects of rabbits. They revealed that total weight gain (P<0.01) and feed conversion ratio (P<0.05) were improved. The improvement occurred may be due to synergistic properties of different oils (Moleyar and Narasimham, 1992).

Botsoglou *et al.* (2004) fed rabbits on diets supplemented with oregano essential oil at levels of 100 and 200 mg/kg diet, whereas the remaining group was given a diet supplemented with α-tocopheryl acetate at 200 mg/kg. They noted that body weight, feed intake feed conversion ratio were not affected. Therefore, dietary oregano essential oil exerted no growth-promoting effect on rabbits. On the other hand, Soultos *et al.* (2009) supplemented rabbit diets with oregano essential oil at levels of 0, 100 and 200 mg/ kg diet, respectively. They found no significantly effect on rabbit performance parameters (final live body weights, average daily gain and feed conversion ratio).

Data obtained in Table (4) also cleared that dietary treatment insignificant decreased feed intake as dry matter (g/h/d), crude protein (g/h/d), digestible crude protein (g/h/d), total digestible nutrient (g/h/d) and digestible energy (kcal/h/d). The present results might indicate that the dietary treatment had no adverse effect on palatability of rabbits.

Özdoğan *et al.* (2011) reported that the total dry matter intake of Karya lambs fed diet contained a blend of essential oil compounds showed better results. George *et al.* (2010) supplemented oregano essential oil dietary (at level 0, 100 and 250 mg oregano essential oil added per Kg of feed, respectively) to evaluated the effect of oregano essential oil supplementation on the feeding and drinking behaviour of broilers. They found that the probabilities of a bird feeding, drinking and moving were significantly decreased by the oregano essential oil supplementation with the higher inclusion level having the greater effect. Schöne *et al. (*2006) fed piglets on diets contained 100 mg oil/ kg of fennel. They found that there were no differences in the performance between the groups fed fennel oil and the control without additives. If the diet contained 100 mg fennel oil/kg, the decrease of feed intake was significant.

Data obtained in Table (4) also showed that dietary treatment had significant effect (P<0.05) on feed conversion. Adding medicinal plants (fennel seeds or oregano leaves) to rabbit diets significantly (P<0.05) improved feed conversion ratio presented as (g intake/ g gain) of dry matter, crude protein, digestible crude protein, total digestible nutrient and digestible energy (Kcal intake /g gain). Rabbit fed on R_5 (2% oil + 0.5% Fennel seeds+ 0.5% Oregano leaves) recorded the best feed conversion ratio, the improving (g DM intake/ g gain) was 29.53% compared to control. These results were in agreement with those obtained by Untea et *al.* (2011) found that supplementation 3% of oregano in weaned piglet's diet resulted in significant differences between the control and experimental groups. The highest feed conversion ratio (kg feed/ kg gain) was improved with adding oregano. Soultos *et al.* (2009) supplemented rabbit diets with oregano essential oil at levels of 0, 100 and 200 mg/ kg diet, respectively. They found no significantly effect on feed conversion ratio.

Carcass characteristics:

Effect of experimental diets on dressing percentages**,** carcass cuts and chemical analysis of the 9, 10 and 11^{th} ribs are illustrated in Table (5). Dietary treatment had no significantly effect (P>0.05) on slaughter weight (SW); full, empty and content of digestive tract presented as (weight, or % of SW); edible offal's; carcass weight (CW); carcass weight (CW*) included edible offal's (Liver, heart, kidneys, spleen, testes and lungs); dressing percentages; carcass cuts and chemical analysis of the 9,10 and 11^{th} ribs.

Effect of experimental diets on external and internal offal's (giblets) are shown in Table (6). Dietary treatments had no significant effect on external offal's included (head, fur, legs, ears, and blood) that presented as % of SW and except spleen was significant (P<0.05) dietary treatments also had no significant effect on the other parameters of internal offal's (giblets) included (liver, heart, kidneys, testes and lungs).

These results were in agreement with those found by Radwan and Abdel-Khalek (2007) who, indicated that relative to the slaughter weight, hot carcass, giblets, and total edible parts percentage, were not significantly affected by supplement 0.5% or 1% herb mixture composed of equal parts of sage+oregano+sweet basal.

Ibrahim *et al.* (2000) found that sweet basil or oregano at the level of 0.5% increased significantly dressing and giblets % of rabbits. Bampidis *et al.* (2005) reported that carcass weights, carcass yield, and the relative weights of the heart and liver of turkeys were not significantly affected by oregano content. Çabuk *et al.* (2006) showed that carcass yield and some internal organ weights such as the liver, pancreas, proventriculus, gizzard and small intestine were not affected by the addition of the essential oil mixture to the diet. Özdoğan *et al.*

(2011) noted that all the slaughter traits and internal organs weights were not significantly affected by feeding Karya lambs on diet containing a blend of essential oil compounds, while the conformation score and lung weight were significantly (P<0.05) affected.

Botsoglou *et al.* (2004) suggested that dietary oregano essential oil exerted a significant antioxidant effect. Dietary supplementation of oregano essential oil at the level of 200 mg/kg was more effective in delaying lipid oxidation compared with the level of 100 mg/kg, but inferior to dietary supplementation of 200 mg α tocopheryl acetate per kg. Antioxidant compounds occurring in oregano essential oil were absorbed by the rabbit and increased the antioxidative capacity of tissues. Janz *et al.* (2007) reported that improving carcass quality of rabbits associated with feed additives supplementation is likely due to the effects of funnel and oregano bioactive compounds on improving antioxidant status of the rabbits and improving protein and fat metabolism.

Blood plasma constituents:

Blood plasma constituents of the experimental groups are established in Table (7). Data obtained cleared that dietary treatments had no significant effect on total protein; albumin; globulin; albumin: globulin ratio; total lipids; triglycerides; creatinine; alkaline phosphatase; glutamic oxaloacetic transaminas (GOT) and glutamic pyruvic transaminase (GPT).

Table (5): Effect of experimental diets on dressing percentages, carcass cuts and chemical analysis of the 9, 10 and 11th ribs.

Item	Experimental diets					SEM
	R_1	R_2	R_3	R_4	R_5	
Slaughter weight (SW), g	2695	2693	2625	2668	2658	18.14
Digestive tract, g						
Full weight, g	545	522	573	566	545	11.49
% of SW	20.22	19.38	21.83	21.21	20.50	0.56
Empty weight, g	255	244	222	242	256	6.62
% of SW	9.46	9.06	8.46	9.07	9.63	0.26
Content weight, g	290	278	351	324	289	5.77
% of SW	10.76	10.32	13.37	12.14	10.87	0.29
Empty body weight (EBW), g	2405^{a}	2415^{a}	2274^{b}	2344^{ab}	2369^{ab}	25.51
Edible offal's, g (Giblets)	125	122	116	122	120	2.11
Carcass weight (CW)	1313	1377	1340	1356	1398	22.31
Carcass weight (CW)*	1438	1499	1456	1478	1518	21.95
Dressing percentages (DP)%						
DP^{1}	48.72	51.13	51.05	50.82	52.60	0.65
DP^{2}	54.59	57.02	58.93	57.85	59.01	0.58
DP^{3}	59.79	62.07	64.03	63.05	64.08	0.53
Carcass cuts						
Fore part weight, g	488	507	449	500	494	8.38
% of CW	37.17	36.82	33.51	36.87	35.34	0.23
Middle part weight, g	312	351	312	346	350	6.50
% of CW	23.76	25.49	23.28	25.52	25.04	0.37
Hind part weight, g	513	519	579	510	554	9.59
% of CW	39.07	37.69	43.21	37.61	39.62	0.23
Chemical analysis of the 9,10 and 11th ribs						
Dry matter	34.64	34.83	34.67	34.21	34.76	0.57
Chemical composition on DM basis						
CP	60.48	57.32	63.22	63.59	64.22	1.53
EE	32.10	34.75	28.97	28.67	28.15	2.07
Ash	7.42	7.93	7.81	7.74	7.63	0.33

a and b: Means in the same row having different superscripts differ significantly (P<0.05).
SEM, standard error of the mean
** Carcass weight: included edible offal's (Liver, heart, kidneys, spleen, testes and lungs).*
DP ^{1}: Dressing percentages calculated as (carcass weight / slaughter weight).
DP ^{2}: Dressing percentages calculated as (carcass weight / empty body weight).
DP ^{3}: Dressing percentages calculated as (carcass weight + edible offal's / empty body weight).
EBW: Empty body weight = Slaughter weight – digestive tract content..

Total lipids; triglycerides; total cholesterol and LDL- cholesterol in rabbits fed (R_2) were higher than that of control diet (R_1). On the other hand inclusion fennel seeds or oregano leaves or the mixture of them with sunflower oil (R_3, R_4 and R_5) significantly ($P<0.05$) decreased total cholesterol and LDL-cholesterol (R_5 only).

Rabbits received R_5 showed the best values of total lipids; triglycerides; total cholesterol and LDL-cholesterol. These results were agreement with those found by Radwan and Abdel-Khalek (2007) who fed rabbits on diets contained 0.5% or 1% of a herb mixture of equal parts of sage+oregano+sweet basal. They noticed a significant decreasing effect ($P<0.05$) in plasma cholesterol.

Ibrahim *et al.* (2000) found that sweet basil or oregano at the level of 0.5%, each significantly had a hypo-lipidemic effect. Also, the decrease in cholesterol level with adding the mixture of herbs may be due to that pure components of essential oils inhibit hepatic 3-hydroxy-3-methy glutaryl coenzyme A (HMG-CoA) reduced activity (Crowell, 1999), Which is a key regulatory enzyme in cholesterol synthesis, yet, Khayyal (2006) reported a slight decrease in rabbits' plasma total lipids and cholesterol when fed diets fortified with sage leaves at levels ranged between 0.25 and 1.0%.

Chang and Borensztajn (1993) noted that the accumulation of cholesterol-rich beta-very-low-density lipoproteins (beta-VLDL) in the plasma of rabbits fed a high-fat high-cholesterol diet is due to a defect in the clearance of these lipoprotein remnants from circulation by the liver. In view of the evidence that hepatic lipase participates in the process of rapid removal of remnants from circulation, and considering that rabbits are naturally deficient in hepatic lipase, we examined whether this defect in the clearance of beta-VLDL could be reversed by exogenous hepatic lipase. They also suggested that the accumulation of beta-VLDL in the circulation of rabbits fed on a high-fat high-cholesterol diet is the result of the saturation of the available hepatic lipase by abnormally high levels of lipoprotein.

Table (6): Effect of experimental diets on external and internal offal's (Giblets).

Item	Experimental diets					SEM
	R_1	R_2	R_3	R_4	R_5	
Slaughter weight (SW), g	2695	2693	2625	2668	2658	18.14
External offal's:						
Head weight, g	133^{ab}	135^{a}	119^{b}	126^{ab}	125^{ab}	2.41
% of SW	4.94	5.01	4.53	4.72	4.70	0.11
Fur, legs, ears and blood weight, g	580^{a}	537^{b}	577^{a}	512^{b}	590^{a}	8.40
% of SW	21.52	19.94	21.98	19.19	22.20	0.21
Total weight, g	713^{a}	672^{bc}	696^{ab}	638^{c}	715^{a}	8.38
% of SW	26.46	24.95	26.51	23.91	26.90	0.21
Internal offal's (Giblets):						
Liver weight, g	75.00	72.00	66.00	73.00	69.00	2.13
% of SW	2.78	2.67	2.51	2.74	2.60	0.09
Heart weight, g	9.00	8.25	9.25	8.00	8.50	0.28
% of SW	0.33	0.31	0.35	0.30	0.32	0.01
Kidneys weight, g	16.50	17.50	17.25	17.50	17.50	0.45
% of SW	0.61	0.65	0.66	0.65	0.66	0.02
Spleen weight, g	1.25^{ab}	1.50^{ab}	1.00^{b}	1.75^{a}	1.50^{ab}	0.11
% of SW	0.05^{ab}	0.06^{ab}	0.04^{b}	0.07^{a}	0.06^{ab}	0.004
Testes weight, g	9.25	9.25	9.25	8.75	9.50	0.26
% of SW	0.34	0.34	0.35	0.32	0.36	0.01
Lungs weight, g	14.00	13.50	13.25	13.00	14.00	0.54
% of SW	0.52	0.50	0.50	0.49	0.53	0.02
Total giblets weight, g	125	122	116	122	120	2.11
% of SW	4.63	4.53	4.42	4.57	4.53	0.10

a, b and c: Means in the same row having different superscripts differ significantly ($P<0.05$).
SEM, standard error of the mean.

Naderi *et al.* (2004) noted that the affinity of LDL to its classic receptor is reduced due to oxidation. Instead, it is taken up by scavenger molecules in macrophages, as a result of which foam cells are, formed that have a major role in increasing the sub endothelial fat layers of the blood vessels. They also showed that eugenol and thymol have the highest antioxidant effect, on the uptake of LDL (intact and oxidized) by the adrenal cells. The compounds, particularly thymol and eugenol, have an antioxidant property and can change the affinity of

the LDL particles for the LDL receptor probably due to their lipophylic property.

Table (7): Blood plasma constituents of the experimental groups.

Item	Experimental diets					SEM
	R_1	R_2	R_3	R_4	R_5	
Total protein (g/dl)	6.33	6.10	6.22	6.13	6.10	0.10
Albumin (g/dl)	3.21	3.19	3.26	3.20	3.10	0.07
Globulin (g/dl)	3.12	2.91	2.96	2.93	3.00	0.09
Albumin: Globulin ratio	1.03	1.10	1.10	1.09	1.03	0.04
Lipids						
Total lipids (g/ L)	413	448	410	392	381	11.07
Triglycerides (mg/ dl)	154	162	153	151	149	3.07
Total cholesterol (mg/ dl)	4.83^{a}	4.93^{a}	4.24^{b}	4.13^{b}	4.00^{b}	0.12
LDL-Cholesterol (mg/ dl)	3.02^{ab}	3.51^{a}	2.54^{bc}	2.45^{bc}	2.16^{c}	0.16
Kidney function						
Creatinine (mg/dL)	1.56	1.44	1.42	1.40	1.35	0.09
Liver function						
Alkaline phosphatase (IU/L) GOT	76.16	75.51	73.46	72.95	72.26	0.59
(U/ml)	14.43	15.20	15.10	15.10	14.33	0.37
GPT (U /ml)	12.31	12.69	12.44	12.63	12.16	0.20

a, b and c: Means in the same row having different superscripts differ significantly (P<0.05).
SEM, standard error of the mean; GOT: Glutamic Oxaloacetic Transaminase. GPT: Glutamic Pyruvic Transaminase.

Amin and Nagy (2009) recorded that feeding rat on high fat diet (HFD) significantly increased triglycerides (TG), total cholesterol & low density lipoprotein (LDL) cholesterol concentration compared with controls, while significantly decreasing high density lipoprotein (HDL) cholesterol; meanwhile treatment with L-carnitine, or Egyptian herbal mixture formulation (HMF) (consisting of T. chebula, Senae, rhubarb, black cumin, aniseed, fennel and licorice) significantly normalized the lipid profile. Serum ALT, urea, uric acid and creatinine were significantly higher in the high fat group compared with normal controls; and administration of L-carnitine or herbal extract significantly lessened the effect of the HFD. Hyperglycemia, hyperinsulinemia, and high insulin resistance (IR) significantly increased in HFD in comparison with the control group.

Akkol *et al.* (2009) studied the effects of the antihypercholesterolaemic, antioxidant and anti-steatohepatitic activities of the diethyl ether (DEE), ethyl acetate (EtOAc) and remaining aqueous (RA) extracts from *Thymbra spicata* var. *spicata* on the plasma total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), triglyceride (TG) and glucose; blood malondialdehyde (MDA) and reduced glutathione (GSH); erythrocyte superoxide dismutase (SOD) and catalase activity (CAT) in mice fed with high-fat diet (HFD). They found that the HFD induced an increase in plasma TC, TG, LDL, MDA concentrations compared to control group. However, administration of DEE with HFD reduced TC, LDL, TG and MDA concentrations, while increased HDL concentration, as well as GSH, SOD and CAT activities compared to HFD. On the other hand, administration of EtOAc extract with HFD decreased plasma TC, TG and MDA, while GSH concentration was increased. Histopathologically, best liver conditions were observed in DEE and lesser in RA extracts. Ozdemir *et al.* (2008) concluded that consumption of *origanum* onites distillate had beneficial effects on lipid profiles, antioxidant status and endothelial function in patients with mild hyperlipidaemia when they studied the effects of *origanum* onites on endothelial function and antioxidative status.

Economical evaluation:

The economical efficiency of dietary treatments is presented in Table (8). The profitability of using medicinal plants such as fennel seeds or oregano leaves or mixture of them as supplementation in rabbit diets depends on upon the price of tested diets and the growth performance of rabbits fed these diets. Costing of one kg feed, (LE) was increased by inclusion the sunflower oil or medicinal plants in the diets (R_2 to R_5) compared to control diet (R_1). However, total feed cost for different tested diets were decreased compared to control, this reason related to increase marketing weight with decreasing feed consumed by rabbits. Dietary treatments improved total cost, total revenue, net revenue, economical efficiency, relative economic efficiency and feed cost / kg LBW. Rabbits received R5 (2% oil + 0.5% fennel seeds + 0.5% oregano leaves) containing diet recorded the best total cost, total revenue, net revenue, economical efficiency, relative

economic efficiency and feed cost / kg LBW. These results are in agreement with those obtained by Ibrahim *et al.* (2009); Ibrahim *et al.* (2011), Ali *et al.* (2011); Ibrahim *et al.* (2012); Abedo *et al.* (2012) and Omer *et al.* (2012) with rabbits fed different sources of medicinal plants with different sources of energy or protein.

Table (8): Economical evaluation of the experimental groups.

Item	Experimental diets				
	R_1	R_2	R_3	R_4	R_5
Marketing weight, Kg	2.287	2.366	2.570	2.509	2.593
Feed consumed (as it is, kg) / rabbit,	6.776	6.160	6.048	6.048	5.600
Costing of one kg feed, (LE)[1]	1.807	1.875	1.965	1.965	1.965
Total feed cost, (LE)	12.24	11.55	11.88	11.88	11.00
Management/ Rabbit, (LE)[2]	4	4	4	4	4
Total cost, (LE)[3]	32.24	31.55	31.88	31.88	31.00
Total revenue, (LE)[4]	50.31	52.05	56.54	55.20	57.05
Net revenue	18.07	20.50	24.66	23.32	26.05
Economical efficiency[5]	0.5605	0.6498	0.7735	0.7315	0.8403
Relative economic efficiency[6]	100	115.9	138.0	130.5	149.9
Feed cost / kg LBW (LE)[7]	5.35	4.88	4.62	4.73	4.24

[1] *Based on prices of year 2012.*
[2] *Include medication, vaccines, sanitation and workers.*
[3] *include the feed cost of experimental rabbit which was LE 16/ rabbit + management.*
[4] *Body weight x price of one kg at selling which was LE 22.*
[5] *net revenue per unit of total cost.*
[6] *Assuming that the relative economic efficiency of control diet equal 100.*
[7] *Feed cost/kg LBW = feed intake * price of kg / Live weight*

Conclusion

Under these conditions of this study it can be concluded that adding 0.5% fennel seeds with 0.5% oregano leaves as feed additives improved nutrient digestibility, nutritive values and decreased total cholesterol and LDL as well as realized the highest value of relative economic efficiency and lowered value of feed cost/ kg live body weight. Also, medicinal plants used can be considered as growth promoter that is effective for improving the utilization of diets that contained oils by lowering circulating glucose levels through enhancing insulin sensitivity.

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References

1. Abdo, Z.M.A., A.Z.M. Soliman and O.S. Barakat (2003). Effect of hot pepper and marjoram as feed additives on the growth performance and the microbial population of the gastrointestinal tract of broilers. Egypt. Poult. Sci., 23: 91-113.
2. Abedo, A.A., F. A. F. Ali, H. A. A. Omer and Sh. A. M. Ibrahim (2012). Response of growing rabbits to diets containing different levels of protein and radish (*Raphanus sativus L*) seeds. Journal of Agricultural Science, 4, (3): 281-290. Published by Canadian Center of Science and Education.
3. Aboul-fotouh, G.E., S.M. Allam, E. Shehat and S.N. Abdel-Azeem (1999). Effect of some medicinal plants as feed additives on performance of growing sheep. Egypt. J. Nutr. and Feeds, 2: 79-87.
4. Abou-Raiia, S.H., N.M. Abdel-Moein and M.Y. Khalil (1991). Chemical evaluation of common dill and bitter fennel seeds. Bulletin of Fac. of Agric. Cairo Univ., 42: 1133-1148.
5. Akkol EK, G. Avci , I. Küçükkurt , H. Keleş , U. Tamer , S. Ince and E. Yesilada (2009). Cholesterol-reducer, antioxidant and liver protective effects of *Thymbra spicata L.* var. *spicata*. J. Ethnopharmacol., 126 (2): 314-319.
6. Ali, F. A. F., H. A. A. Omer, A. A. Abedo, Soha S. Abdel-Magid and Sh. A. M. Ibrahim (2011). Using mixture of sweet basal and black cumin as feed additives with different levels of energy in growing rabbit diets. American-Eurasian J. Agric. & Environ. Sci., 10 (5): 917-927.
7. Amin, K.A and M.A. Nagy (2009). Effect of carnitine and herbal mixture extract on obesity induced by high fat diet in rats. Diabetology & Metabolic Syndrome 2009, 1:17.
8. A.O.A.C. (2000). Official Methods of Analysis, 17th ed. Association of Official Analytical Chemists, Washington, D.C, USA.
9. Armstrong, W.D. and C.W. Carr (1964). Physiological Chemistry: Laboratory directions 3:

75 Buger Puplishing Co. Minneapolis, Minnesota, U.S.A.
10. Bampidis, V.A., V. Christodoulou, P. Florou-Paneri, E. Christaki, P.S. Chatzopoulou, T. T. Siligianni and A.B. Spais (2005). Effect of dietary dried oregano leaves on growth performance, carcass characteristics and serum cholesterol of female early maturing turkeys. Br. Poult. Sci., 46 (5): 595-601.
11. Bartles, H., M. Bohmer and C. Heirli (1972). Clin. Chem. Acta., 37, 193.
12. Belfield, A. and D.M. Goldberg (1971). Enzyme 12: 561.
13. Blasco, A., J. Quhayaun and G. Masoscro (1993). Hormonization of criteria and terminology in rabbit meat research. World Rabbits Sciences, 1: 3-10.
14. Blaxter, K.L. (1968). The energy metabolism of ruminants. 2nd ed. Charles Thomas Publisher. Spring field. Illinois, U.S.A.
15. Botsoglou, N.A., P. Florou-Paneri, E. Christaki, I. Giannenas and A.B. Spais (2004). Performance of rabbits and oxidative stability of muscle tissues as affected by dietary supplementation with oregano essential oil. Archives of Animal Nutrition, 58 (3): 209–218.
16. Çabuk, M., M. Bozkurt, A. Alçiçek, Y. Akbaş and K. Küçükyılmaz (2006). Effect of a herbal essential oil mixture on growth and internal organ weight of broilers from young and old breeder flocks. South African Journal of Animal Science, 36 (2): 135-141.
17. Calsamiglia, S., Stem, M.D. and Frinkins, J.L. (1995). Effects of protein source on nitrogen metabolism in continuous culture and intestinal digestion *in vitro*. J. Anim. Sci., 73: 1819.
18. Cervato, G., M. Carabelli, S. Gervasio, A. Cittera, R. Cazzola and B. Cestaro (2000). Antioxidant properties of oregano (*origanum vulgare*) leaf extracts. J. Food Biochem., 24: 453-465.
19. Chang, S. and J. Borensztajn (1993). Hepatic lipase function and the accumulation of beta-very-low-density lipoproteins in the plasma of cholesterol-fed rabbits. Biochem. J., 1: 293 (3): 745-750.
20. Crowell, P.L. (1999). Prevention and therapy of cancer by dietary monoterpenes. J. Nutrition, 129: 775–778.
21. Daouk, R.K., S.M. Dagher and E.J. Sattout (1995). Antifungal activity of the essential oil of *origanum syriacum* L. J. Food Prot., 58: 1147-1149.
22. De Koning, W.H., D.H. Biao, W.X. Fu and R. Yi (1993). Chinese herbs in animal nutrition. London, England: Nottingham University Press, 31–74.
23. Dorman, H.J.D. and S.G. Deans (2000). Antimicrobial agents from plants: Antibacterial activity of plant volatile oils. J. Appl. Microbiol., 88: 308-316.
24. Doumas, B., W.W. Wabson and H. Biggs (1971). Albumin standards and measurement of serum with bromocrfsol green. Clin. Chem. Acta, 31: 87.
25. Duncan, D.B. (1955). Multiple Rang and Multiple F–Test Biometrics, 11: 1- 42.
26. F.A.O. (2008). Food and Agricultural Organization of United Nations: Economic And Social Department: The Statistical Division
27. Facet, S. and T. Gippert (1986). Digestibility and nutritive value of nineteen important feedstuffs for rabbits. J. Applied. Rabbit Res., 9 (3): 103-108.
28. Fossati, P and L. Principe (1982). Clin. Chem. 28, 2077.
29. Franz, C., K.H.C. Baser and W. Windisch (2010). Essential oils and aromatic plants in animal feeding – a European perspective. A review. Flavour and Fragrance Journal, 25: 327–340.
30. George, K. Symeon, Costantinos Zintilas, Nikolaos Demiris, Iosif A. Bizelis and Stelios G. Deligeorgis (2010). Effects of oregano essential oil dietary supplementation on the feeding and drinking behavior as well as the activity of broilers. International Journal of Poultry Science 9 (4): 401-405.
31. Goering, H. K. and P.J. Van Soest (1970). Forge fiber analysis (apparatus, reagents, procedure and some applications). Agric. Hand Book 379, USDA, Washington, and DC., USA.
32. Gulfraz, M., S. Mehmood, N. Minhas, N. Jabeen, R. Kausar, K. Jabeen and G. Arshad (2008). Composition and antimicrobial properties of essential oil of *Foeniculum vulgare*. African Journal of Biotechnology, 7 (24): 4364-4368.
33. Hernandez, F., J. Madrid, V. Garcia, J. Orengo and M.D. Megias (2004). Influence of two plant extract on broiler performance, digestibility and digestive organ size. Poult. Sci., 83: 169-174.
34. Ibrahim, Sh.A.M., A.A. Abedo, H.A.A. Omer and F.A.F. Ali (2009). Response of growing New Zealand White rabbits to diets containing different levels of energy and mixture of some medical plants. World Journal of Agricultural Sciences, 5 (5) 544-551.
35. Ibrahim, Sh.A.M., H.A.A. Omer, A.A. Abedo and F.A.F. Ali (2012). Response of growing rabbits to diets containing different levels of protein and mustard seeds (*Sinapisalba Linn).* Journal of Agricultural Science, 4 (1): 190-201. Published by Canadian Center of Science and Education.
36. Ibrahim, Sh.A.M., H.A.A. Omer, F.A.F. Ali and G.M. El-Mallah (2011). Performance of rabbits fed diets containing different levels of energy and lesser galangal *(Alpinia Officinarum).* Journal of Agricultural Science, 3 (4): 241-253. Published by Canadian Center of Science and Education.
37. Ibrahim, Sh.A., A.A. El-Ghamry and G.M. El-Mallah (2000). Effect of some plants of *Labiatae* family as feed additives on growth and metabolic changes of rabbits. Egyptian J. Rabbit Sci., 10 (1): 105–120.
38. Janz, J.A. M., P.C.H. Morel, B.H.P. Wilknson and R.W. Purchas (2007). Preliminary investigation of the effects of low-level dietary inclusion of fragrant

essential oils and oleoresins on pig performance and pork quality. Meat Sci., 75: 350–355.
39. Khayyal, Amany A. (2006). Utilization of some agricultural by-products in feeding rabbits. Ph.D. Thesis, Cairo University.
40. MDEDEP (2011). MDidea Exporting Division Extracts Professional. Fennel Fructus Foeniculi Foeniculum Vulgare. Mill Xiao Hui Xiang. http://www.mdidea.com/products/new/new042paper.html.
41. Moleyar, V. and P. Narasimham (1992). Antibacterial activity of essential oil components. International J. Food Microbiol., 16: 337–342.
42. N.R.C. (1977). National Research Council. Nutrient Requirements of Rabbits, National Academy of Science, Washington, D.C, USA.
43. Naderi, G.A., S. Asgary, M. Ani, N. Sarraf-Zadegan and M.R. Safari (2004). Effect of some volatile oils on the affinity of intact and oxidized low-density lipoproteins for adrenal cell surface receptors. Mol. Cell Biochem., 267 (1-2): 59-66.
44. O'Mary, C.C., Everett, L.M. and Graig, A.D. (1979). Production and carcass characteristics of Angus and Charolais x Angus steers. J. Anim. Sci., 48: 239.
45. Omer, H.A.A., Sh.A.M. Ibrahim, A.A. Abedo and F.A.F. Ali (2012). Growth performance of rabbits fed diets containing different levels of energy and mixture of some medicinal plants. Journal of Agricultural Science, 4, (2): 201-212. Published by Canadian Center of Science and Education.
46. Ozdemir, B., A. Ekbul, N.B. Topal, E. Sarandöl, S. Sağ, K.H. Başer, J. Cordan, S. Güllülü, E. Tuncel, I. Baran and A. Aydinlar (2008). Effects of *Origanum* onites on endothelial function and serum biochemical markers in hyperlipidaemic patients. J. Int. Med. Res., 36 (6):1326-1334.
47. Özdoğan1, M., S.S. Önenç and A. Önenç (2011). Fattening performance, blood parameters and slaughter traits of Karya lambs consuming blend of essential oil compounds. African Journal of Biotechnology, 10 (34): 6663-6669.
48. Pisani, T., C.P. Gebski and E.T. Leary (1995). Accurate direct determination of low- density lipoprotein, cholesterol Assay. Arch Pathol, Lab. Med., 119: 1127.
49. Postma, T. and J.A. Stroes (1968). Lipids screening in clinical chemistry clinica chimica, Acta. 22: 569.
50. Radwan, N.L. and A.M. Abdel-Khalek (2007). Response of summer stressed growing rabbits to some dietary growth promoters. ISAH-Tartu, Estonia, 350-358.
51. Reitman, S. and S. Frankel (1957). Calorimetric determination of GOT and GPT activity. American Journal Clinical Pathology, 28: 56.
52. Renjie, L., L., Zhenhong and S. Shidi (2010). GC-MS analysis of fennel essential oil and its effect on microbiology growth in rats' intestine. African Journal of Microbiology Research, 4 (12): 1319-1323.
53. Robu, T. and C. Milică (2004). *Plante medicinale autohtone*. Ed. Institutul European, Iaşi
54. Schöne, F., A. Vetter, H. Hartung, H. Bergmann, A. Biertümpfel, G. Richter, S. Müller and G. Breitschuh (2006). Effects of essential oils from fennel (*Foeniculi aetheroleum*) and caraway (*Carvi aetheroleum*) in pigs. J. Anim. Physiol. Anim. Nutr. (Berl)., 90 (11-12): 500-510.
55. Simon, J.E., A.F. Chadwick and L.E. Craker (1984). Herbs: An Indexed Bibliography.1971-1980. The Scientific Literature on Selected Herbs, and Aromatic and Medicinal Plants of the Temperate Zone. Archon Books, 770 pp., Hamden, CT, USA. *http//www.hort.purdure.edu/newcrop/med.aro/.html*
56. Sivropoulou, A., E. Paranikolaou, C. Nikolaou, S. Kokkini, T. Lanaras and M. Arsenakis (1996). Antimicrobial and cytotoxic activities of Origanum essential oils. J. Agric. Food Chem., 44: 1202–1205.
57. Soultos, N. Z. Tzikas, E. Christaki, K. Papageorgiou and V. Steris (2009). The effect of dietary oregano essential oil on microbial growth of rabbit carcasses during refrigerated storage. Meat Science, 81: 474–478.
58. S.P.S.S. (1998). Statistical Package for Social Sciences, Chicago, U.S.A.
59. Srihari, T., V. Balasubramaniyan and N. Nalini (2008). Role of oregano on bacterial enzymes in 1, 2-dimethylhydrazine-induced experimental colon carcinogenesis. Can J Physiol. Pharmacol., 86 (10): 667-674.
60. Untea, A., R. Criste, T. Panaite and I. Costache (2011). Effect of the dietary oregano (*Origanum vulgare*) on Cu and Zn balance in weaned piglets. Journal of Trace Elements in Medicine and Biology 25S: S35–S40.
61. Vekiari, S.A., V. Oreopoulou, C. Tzia and C.D. Thomopoulos (1993). Oregano flavonoids as lipid antioxidants. J. Am. Oil Chem. Soc., 70: 483– 487.
62. Wieland, H and D. Seidel (1983). J. Lipid Res. 24: 904.

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