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EFFECTS OF ROSEMARY AND MARJORAM SUPPLEMENTATION ON GROWTH PERFORMANCE, DIGESTIBILITY AND ECONOMIC EFFICIENCY OF GROWING RABBITS

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This study was conducted to investigate the effects of dietary inclusion of different levels of Rosemary and Marjoram plants ongrowth performance and digestion coefficientsof New Zealand White (NZW) rabbits.Seventy two weaned rabbits were divided into six groups. The 1st group was fed basal diet and served as control group, the 2nd and 3rd groups were fed the basal diet supplementedwithRosemary dry plant powder (1.5% and 3.0%, respectively), 4th and 5thgroups were fed the basal diet supplemented with Marjoram dryplant powder (1.5% and 3.0%, respectively), the 6th group was fed the basal diet supplemented with mixture of (1. 5% Rosemary dry +1.5% Marjoram dry).At the end of the experiment eighteen rabbit males were used in digestibility trail. Carcass traits and blood metabolites were determined by slaughtering 3 rabbits from each group at the end of the growth period.

The obtained results revealed that,final body weight and daily body weight gain were significantly (P≤0.05) higher with 1.5 % rosemary, 1.5 % marjoram and their mixture compared to control and other treatment groups. Feed conversion significantly (P≤0.05) improved in rabbits fed diet containing 1.5% marjoram compared with control group. Also, rabbits fed diet supplemented with 1.5% marjoramshowed the lowest (P≤0.05) feed intake compared with control group and other treatments.

The digestibility of DM, OM, CP and EE and NFE, significantly (P≤0.05) improved with diet supplemented with 1.5% rosemary. The same trend was observed in TDN%. However, The DCP % in rabbits fed diet supplemented with 1.5 % rosemary and 1.5 % marjoram was significantly (p≤0.05) higher than of those the other diets. Rabbits fed diet with 1.5% rosemary and 3% marjoram significantly increased dressing percentage.

Rabbit of the 3 % rosemary group had higher (P<0.05) blood globulin level. Serum glucose significantly increased in group fed mixture (1.5% rosemary +1.5% marjoram).Rabbit of the 3 % marjoram group had higher (P<0.05) blood cholesterol and total lipids. Rabbit of the 3 % rosemary group had higher (P<0.05) blood globulin and creatinine. Serum blood AST and ALT increased (P≤0.05) in rabbits fed 3 % rosemary. Feeding growing rabbits in control, 1.5 rosemary and 1.5% marjoram had a significant tendency (P ≤ 0.05) to increase serum hemoglobin and hematocrit .Rabbits fed diets without any medicinal additives had significant (P ≤ 0.05) red blood cells.

In conclusion, *inclusion of 1.5% of rosemary (Rosmarinus officinalis) or marjoram (Origanum majorana) plants in NZW rabbit rations as a natural source of antioxidants improved live body weight, body weight gain, carcass traits, digestibility of nutrients and economic efficiency under north Sinai conditions without any adverse effects in on performance.*

Keywords: Rosemary; Marjoram; growth performance; nutrient digestibility; carcass traits; blood parameters

There are a large number of feed additives available for inclusion in rabbit's diets to improve their performance (Ewuola*et al.*,2011). However, the use of chemical products especially (hormones and antibiotics), may cause unfavorable side effects. Moreover, there is evidence indicating that these products are currently considered as risky pollutants for human and may threaten their health on the long–run (Omer*et al.*, 2013).

Currently, there is an increasing interest in using herbs in animal nutrition, in order to replace the use of antibiotics and ionophore anticoccidials. Herbs, Medicinal and aromatic plants are preferable as feed additives and growth promoters causing safe improvements in growth traits, feed intake, feed conversion and nutrient digestibilityin rabbits, chicks, sheep, cows or buffaloes (Aboul-fotouh *et al.*, 1999, EL-Ayek, 1999 and Allam *et al.*, 2005), body weight gain, growth performance and mortality rate (Ibrahim, 2005 and Tipu*et al.*, 2006), carcass traits (Evans and Pharm, 1975) and physical conditions of gut ecosystem (Guo, 2003).

Accordingly, the current study was carried out to evaluate the effects of Rosemary (*Rosmarinus officinalis* L.) and Marjoram (*Origanum majorana* L.) plantsalone or the mixture on growth performance, nutrient

digestibility, carcass characteristics, blood constituents and economical evaluation under the prevailed circumstances of North Sinai, Egypt.

MATERIALS ANDMETHODS

The present study was carried out at rabbit research farm of Animal and Poultry Production Department, Faculty of Environmental Agriculture Sciences, Arish University from March to May 2015. The geographical and climatic characteristics of this region (Long. , 33.75E and Lat. 31.27N) is semi- arid with an average annual rain fall of about 94 mm and average ambient temperature of about 20.47°C.

Rosemary (*Rosmarinus officinalis* L.) and Marjoram (*Origanum majorana* L.) plants were collected from a private commercial farm located in North Sinai governorate. The plants were air-dried under shade until the moisture of collected plants roughly reached 10%. The plants were finally milled, sieved (1 mm mesh) and stored in a well tight polyethylene bags at room temperature of 25°C.

This study was carried out to study the effects of either dietary Rosemary or Marjoram on growth performance of growing rabbits. A total number of 72 (36 males and 36 females) weaned NZW rabbits with 5 weeks of age were weighed (560 ± 20.5g) and were randomly assigned to the six groups(12 each). Each group was distributed into 4 replicates (2 males and 2 females). The first group fed a basildiet without supplementation, second and third groups were fed the control diet supplemented withrosemary dry plant (1.5 % or 3.0%, respectively), the fourth and fifth groups were fed the basal diet supplemented with marjoram dry plant (1.5 % or 3.0%, respectively), while the sixth group was fed the basal diet supplemented with mixture of (1.5% rosemary dry plant+1.5% marjoram dry plant).

The rabbits were housed in galvanized cages commercial type measured (40 x 40x 25 cm) .The cages were provided with feeders and automatic nipple drinkers. Feed and water were available *ad libitum* during the experimental period (8 weeks. All rabbits were kept under the same managerial, hygienic and environmental conditions. Live body weight and feed consumption were weekly recorded. Body weight gain and feed conversion ratio were calculated.

Rabbits were feddiets to cover their requirementsaccording to NRC (1977). The formulation andcalculated analysis of the experimental diet were shown in Table 1.

Table 1. Ingredients of experimental diet used in this study.

Ingredients, %	Con. diet
Yellow corn	14
Barley grain	10
Wheat bran	27
Soybean meal 44%	12
Alfalfa hay	31.5
Molasses	3
Dicalcium P.	1.2
Calcium carbonate (lime stone)	0.6
Sodium chloride (salt)	0. 3
Premix	0.3
Methionine	0.1
Total	**100**
Calculated chemical composition	
Crude protein (CP)	17.38
Crude fiber (CF)	12.27
Ether extract (EE)	2.93
Digestible energy (Kcal/Kg)	2769.70

One kilogram of premix contain: Vit. A 12000 000 IU, Vit.D_3 2200 00 IU, Vit. E 1000 mg, Vit.K_3 2000 mg, Vit.B_1 1000 mg, Vit.B_2 4000 mg, Vit.B_6 100 mg, Vit. B_{12} 10 mg, Pantothenic acid 3.33 g, Biotin 33 mg, Folic acid 0.83 g, Choline chloride 200 g, Zn 11.79 g, Mn 5 g, Fe 12.5 g, Cu 0.5 g, I 33.3 mg, Se 16.6 mg and Mg 66.7 g.

At the termination of growth period, eighteen rabbits were used for digestibility trial whichconsisted of 7 days as a preliminary period followed by 5 days collection period. During the collection period, daily faces of each animal were taken, cleaned from hair and dried at 70^{o}C for 48 hour and stored in polyethylene bags until chemical analysis. Samples of feed and feces were chemically analyzed according to A.O.A.C. (2010).

Digestible energy (DE) of one kilogram of each experimental diet was calculated according to the equation described by Schiemann *et al.,* (1972), cited by El-Kerdawy *et al.,* (1998) as follows:

DE (kcal/kg) =5.29 (DCP, g/kg) +9.51 (DEE, g/kg)+ 4.2 (DCF+DNFE, g/kg) $\pm$ 0.30. Where DCP, DEE, DCF and DCNFE= digestible CP, EE, CF and NFE, respectively

At the end of the growthtrail, three representative rabbits from each treatment were randomly chosen and fasted for 16 hours before slaughtering according to Steven *et* al., (1981) to determine the carcass traits.

At slaughter time blood samples were collected. Half of eachsamplewasexpelled gradually into graduated tubes containing heparin; then, tubes were immediately capped and mixed gently by repeated

inversion. The rest of the samples were collected in sterile tubes without anticoagulant. All blood samples were transported to the laboratory at +4°C within 3 hours. Serum was centrifuged at 3,000 rpm for 20 min and frozen at -20°C for biochemical analyses. Hematological analyses on heparin samples were completed on the day of collection.

The serum total protein was determined by the Biuret method (Reinhold, 1953) using a commercial kit (Randox Laboratories Ltd, U.K.), while the albumin value was obtained by bromocresol green method (Henry and Cannon, 1974). The globulin and albumin-globulin ratio were determined according to the method of Coles (1986). The serum urea nitrogen and creatinine were determined according to the methods described by Patton and Crouch, (1977) and Husdan and Rapoport (1968) respectively. Also the free cholesterol and glucose were determined as described by (Deutsche Veterinaer Medizinische Gesellschaft, 1976), Total lipids were determined by the colorimetric determination according to (Schmit, 1964) using sulfophospho vanillic mixture. While the serum enzymes Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST) were assayed by the methodof Reitman and Frankel (1957).

Blood haemoglobin (Hb) and platelets (PLT) were determined colorimetrically using readymade kits provided by Randox, United Kingdom, using cyanomethaemoglobin method according to Schalm (1979). Red blood cell (RBCs) counts and total white blood cell (WBCs) counts concentration parameters were determined following standard procedures described by Bauer (1970). Packed cell volume (PCV %) was determined according to Wintrobe (1967).

Mean Corpuscular Hemoglobin (MCH) (Pg) = HbX10/ Red blood cell.

Mean Corpuscular Hemoglobin Concentration (MCHC) (g/dl) = HbX100/ Packed cell volume. MCV = (PCV% × 10) / RBC

The prevailing market prices of ingredients and medicinal plants used during the period of the study were used for the economic evaluation of the feeds.

Economic efficiency is defined as the net revenue per unit feed cost calculated from input output analysis as described by Asar *et al.,* (2010).

The economic efficiency was calculated by the following:

Feed cost = number of kg feed per rabbit x price of kg feed.

Selling revenue = Body weight gain per rabbit x Price of kg for live body weight.

Net revenue = Difference between selling revenue and feed cost.

E.FE (Economic feed efficiency) = (net revenue/feed cost) x 100.

R.E.E (Relative economic efficiency), assuming control treatment = 100%.

Data were analyzed using general linear model procedure of SAS software (SAS Institute, 2004). Difference among treatment means were tested for significance using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Feeding values of medicinal plants:

Data presented in Table (2) showed the chemical composition of Rosemary (*Rosmarinus officinalis* L.) and Marjoram (*Origanum majorana* L.*)* and tested diets. The highest value of crude protein and ash were observed of Marjoram (13.22 and8.62%), while the lowest (5.02and 5.23%) were recorded with Rosemary. However, the highest value of ether extract, crude fiber and nitrogen free extract were recorded withRosemary (9.23, 21.71and 58.81 %, respectively), while the lowest value (3.21, 19.07 and 55.88%, respectively) were recorded with Marjoram. The obtained results are in agreement with (Ghazalah and Ali ,2008, Osman *et al.* 2010 and Ali, 2014).

Table 2. Chemical analysis (%) of medicinal plants and the experimental diets.

Items	DM	% On DM basis					
		OM	CP	EE	CF	NFE	ASH
Rosemary	89.96	94.77	5.02	9.23	21.71	58.81	5.23
Marjoram	89.82	91.38	13.22	3.21	19.07	55.88	8.62
Chemical composition of experimental diets given to NZW rabbits							
Control	90.53	91.40	17.38	2.93	12.26	58.83	8.60
Rosemary 1.5%	90.20	91.45	17.19	3.02	12.40	58.84	8.55
Rosemary 3%	89.58	91.50	17.01	3.20	12.54	58.75	8.50
Marjoram 1.5%	90.20	91.40	17.32	2.93	12.36	58.79	8.60
Marjoram 3%	90.50	91.40	17.26	2.94	12.46	58.74	8.60
Mixture	90.40	91.45	17.13	3.03	12.50	58.79	8.55

Live body weight and body weight gain:

Results of live body weight and body weight gain are shown in Table 3. Feeding rabbits diets supplemented with the 1.5% rosemary, 1.5% marjoram and their mixture (1.5% rosemary +1.5% marjoram) significantly ($P \leq 0.05$) increased final live body weight (2117.67, 2139.67 and 2129.25 g, respectively) and daily body weight gain (25.65, 25.95 and 25.83 g/d, respectively) compared with the control group and the other treatments.

In this respect, .Osman *et al.* (2010) and Ali (2014) with broiler and Seleem*et al*. (2007) with growing New Zealand rabbits indicated that body weight and gain in weight were significantly improved by feeding various levels of *Origanum majorana*.. In addition, Ahmed and Abdel-Ghany (2015) observed that diet containing 0.8%*Origanummajorana* significantly improved body weight and weight gain in turkey. In contrary, Taha *et al*., (2011) found no significant effect on body weight and weight gain of broiler fed diet containing 0 ,2.5 , 5.0 or 7.5 g/kg of Oregano.

For rosemary, ELnaggar *et al.*, (2016). observed that broilers chicks fed 0.25 and 0.5% rosemary leaves meal had significantly ($P<0.05$) increased in live body weight and body weight gain than those fed diet with, 0.75 and 1.0 % of rosemary leaves and control group.On the other hand, El-Wardany *et al*. (2015) found that no significant effects in growing rabbits fed diets supplemented with 0.5 or 1 % rosemary dry leaves on growth performance.

These progressive positive effects of marjoram and rosemary on live body weight and body weight gain may be due to the ability of these plants to increase the efficiency of digestion by increasing digestive enzymes and saliva, calming the stomach and digestive system, improving appetite, curing or preventing basic intestinal infections and relieving diarrhea and constipation (Hallnet, 2014). Also, Ezz El-Arab, (2008) mentioned that, ability of natural feed additives to enhance animal appetite, is due to the fact that it is rich in a wide variety of secondary metabolites, such as, trepenoids, which have been found to have antimicrobial properties (Cowan, 1999), and antioxidant activity (Triantaphyllou *et al.*, 2001), which in turn improves the lower gut health, bacterial population, improves nutrients absorption, utilization and eventually improves bird's health and increases body weight and weight gain.

Feed Intake and conversion

Feed intake and conversion data of rabbits fed diets supplemented with natural feed additives (rosemary and marjoram) are presented in Table (3). Generally, it is clear that growing rabbits fed diets supplemented with 1.5 % rosemary consumed significantly more feed ($P\leq0.05$) of 116.81 g compared with control group and other treatments. While, rabbits fed diets with marjoram at 1.5% consumed the lowest amounts (106.69 g) as compared with that of the other dietary treatments, and the control group.

These results are in agreement with Ghazalah and Ali (2008) who found that 0.5% rosemary herb supplementation in the diet gave better feed intake than the control treatment at 49 days of age.On the other hand, in

growing rabbits, El-Wardany *et al.* (2015) found that no significant effects on feed intake when using diets supplemented with rosemary leaves.

The marjoram results are in agreement with those obtained by Ali (2014) and Ahmed and Abdel-Ghany (2015) reported significant decrease of feed intake with addition of marjoram to broiler diet during most the age periods.

Feeding growing NZW rabbits on diets supplemented with of marjoram at the lower level (1.5%) significantly ($P<0.05$) improved feed conversion ratio (4.11g feed/g gain) followed by rabbits fed diet supplemented with mixed (4.26 g feed/g gain)) compared with the other dietary treatments, and the control group, which had the highest feed conversion value of 4.80 g feed/g gain. This results agreement with, (Seleem*et al*. 2007, Osman *et al*.2010 and Ali 2014)they found improvement in New Zealand White and broiler forfeed conversion when feeding diets containing marjoram versus control. In contrast, Ahmed and Abdel-Ghany (2015) reported that feeding diets containing 0.4 or 0.8 % marjoram to turkey diets insignificantly improved effect in daily feed intake and feed conversion ratio.

The previous results may be due to the ability of this plants to increase the efficiency of digestion by increasing digestive enzymes, curing or preventing basic intestinal infections and relieving diarrhea which resulting in maximizes the benefit of feed without increase in feed intake (Hallent, 2014).

Economic efficiency:

The economic efficiency of dietary treatments is presented in Table 3. Costing of one kg feed, (LE) was increased byinclusion medicinal plants in the diets compared to control diet. It is obvious that feeding dietary supplemented treatments increased the feed cost (LE/60) as compared to that of the control. It is worthy to note that supplementing low level (1.5%) of marjoram to the basal diet resulted in decreasing in feed cost (17.15 L.E) followed with the control group (17.42 L.E) compared with other dietary treatments. Rabbits received 1.5% rosemary, marjoram and their mixture recorded the best totalrevenue, net revenue, economical efficiency and relativeeconomic efficiency compared with control and other treatments. These results agree with the findings of (Abdel El-Latif *et al.*, 2004 and Osman *et al.*, 2010).

Digestibility coefficients and nutritive values:

Results given in Table (4) showed that the digestion coefficients of nutrients as affected by the different supplementation with Rosemary and

Table 4. Digestibility and nutritive value of growing rabbits fed basal diet supplemented with levels of Rosemary and Marjoram.

Items	Experimental diets (%)					
	Control	Rosemary 1.5	Rosemary 3.0	Marjoram 1.5	Marjoram 3.0	Mixture (1.5+1.5%)
Digestion coefficients %						
DM	63.22^{b} ±1.13	65.80^{a} ± 0.28	62.90^{b} ± 0.95	64.88^{ab} ± 0.78	62.58^{b} ± 0.38	63.62^{ab} ± 0.36
OM	67.45^{b} ± 1.13	70.37^{a} ± 0.26	67.10^{b} ± 0.87	68.82^{ab} ± 0.95	67.14^{b} ± 0.32	68.13^{ab} ± 0.53
CP	72.12^{bc} ± 1.97	76.10^{a} ± 0.71	72.80^{abc} ± 0.86	75.37^{ab} ± 0.51	74.36^{abc} ± 0.83	71.63^{c} ± 0.62
EE	72.00^{b} ± 1.83	77.74^{a} ± 1.45	73.77^{ab} ± 0.58	73.03^{b} ± 1.84	73.51^{ab} ± 1.12	72.80^{b} ± 1.06
CF	34.69 ± 1.75	36.13 ± 3.77	34.60 ± 2.99	36.82 ± 1.77	32.30 ± 0.51	34.69 ± 2.69
NFE	72.89^{b} ± 0.84	75.61^{a} ± 0.99	72.85^{b} ± 1.16	73.27^{ab} ± 0.64	72.82^{b} ± 0.18	73.25^{ab} ± 0.29
Nutritive value (%)						
TDN	64.41^{b} ±1.00	67.33^{a} ±0.22	64.79^{b} ± 0.41	65.52^{b} ± 0.52	64.41^{b} ± 0.08	63.98^{b} ± 0.41
DCP	12.87^{ab} ± 0.41	13.07^{a} ± 0.12	12.65^{ab} ± 0.13	13.05^{a} ± 0.09	12.83^{ab} ± 0.14	12.27^{b} ± 0.11
DE (kcal/kg)	2841.90^{b} ± 45.96	2971.12^{a} ± 10.08	2872.24^{b} ± 31.42	2893.01^{ab} ± 22.07	2849.76^{b} ± 5.47	2849.03^{b} ± 15.28

$^{a, b, and\ c}$: means within the same row with different superscripts are significantly different (P<0.05).

Marjoram. It could be observed that digestibility coefficients of DM, OM, CP, EE and NFE increased significantly (P≤0.05) by feeding NZW growing rabbit on diets supplemented with 1.5% rosemary compared with the other treatments. On the other hand, digestion coefficients of CF showed no significant differences among treatments. The present results are in agreement with those obtained by Abd El-Galil (2007) who found that feeding Japanese quail on 0.5, 1.0 and 1.5 gm. marjoram leaves/kg diet improved (P≤0.05) digestibility coefficients of OM; CP; CF; EE and NFE when compared with control group. Medicinal plants could have stimulated the appetite of rabbits, enhanced the process of digestion and absorption of food and encouraged secretion of different digestive enzymes of the stomach (Tipu *et al.*, 2006).

The present results showed that the total digestible nutrients (TDN) and digestible energy (DE) values were increased (P≤0.05) for diet

supplemented with 1.5% rosemary compared with control group and other treatments (Table, 4). The nutritive values as digestible crude protein (DCP) significantly increased (P≤0.05) when rabbits were fed diets supplemented with 1.5% rosemary and 1.5% marjoram compared with the other treatments (Table, 4). These results are in agreement with, Abousekken*et al*., (2007) found that growing rabbit group fed 36% mixture of fennel and Marjoram significantly had the best TDN compared with control group. On the other hand, Aboelazab (2015)observed no significant effect on digestibility of DM, NDF, ADF and CP when growing rabbits fed diets containing 0.5% and 1.0% rosemary leaves.

Carcass traits

Data of carcass traits of the growing rabbits at 90 days fed diets supplemented with natural feed additives (rosemary and marjoram and their mixture) are summarized in Table 5.

Dietary treatment had no significantly affect (P>0.05) onpre slaughter, carcass weight, head, kidney, and heart weights compared to the control group.Rabbits fed diet supplemented with 1.5% marjoram had highest values for fur and lung weights (333.00 and 12.71 g, respectively) compared with control group and other treatments. However, rabbits fed high marjoram level (3%) were the best liver and spleenweight (58.12 and 1.32g, respectively) compared with control group and other treatments. Supplemented growing rabbit diet with 1.5% rosemary significantly (P≤0.05) increased tests weight (8.64g) compared with control group and other treatments.Feeding growing rabbits diets supplemented with 1.5% and 3% of marjoram increased dressing percentage (66.86 and 66.45, respectively) compared with the other treatments. These results may be attributed to growth promoting effects of medicinal plants and to enhancement of metabolism of essential and volatile oils included in medicinal plants (Evans and Pharm, 1975).

These results agreement withSeleem*et al.* (2007) who reported that supplementing *Origanummajorana* to growing diets of New Zealand White rabbits significantly increased dressing percentage by 6.1%.Also,Omer *et al.* (2013) indicated that relative to the slaughter weight, hot carcass, giblets, and total edible parts percentage, were not significantly affected by supplement of 1% oregano. Same trend was observed by, bits.

For rosemary, ELnaggar *et al.,* (2016). showed that broilers chicks fed 0.25% rosemary leaves meal had significantly (P<0.05) higher dressing percentage and edible parts than that in control and 0.50 and those having

Table 5. Effect of dietary levels of natural feed additives on carcass traits and dressing percentage of growing NZW rabbits**.**

Items	Treatments					
	Control	Rosemary (%)		Marjoram (%)		Mixture
		1.5	3.0	1.5	3.0	
Traits weight (gm.):						
Pre–slaughter wt.	2083 ±76.00	2102.67 ±19.52	2033.33 ± 88.19	2020.33 ±10.33	2097.67 ±134.04	2213.33 ±20.48
Carcass wt.	1327.33 ±59.74	1383.33 ± 60.11	1334.67 ±35.05	1412.00 ±18.58	1396.33 ±109.88	1370.33 ±24.03
Head wt.	122.33 ±5.93	117.00 ± 5.57	118.67 ± 4.58	120.00 ±2.89	118.67 ±6.94	121.33 ±0.882
Fur wt.	305.33^{a} ±10.33	311.00^{a} ±6.43	296.00^{b} ±11.53	333.00^{a} ±17.04	284.67^{b} ±29.06	321.00^{a} ±8.33
Liver wt.	50.81^{ab} ±1.67	54.85^{ab} ±2.38	45.97^{b} ±6.37	48.44^{ab} ±3.74	58.12^{a} ±5.08	47.29^{ab} ±5.29
Kidneys wt.	12.72 ±0.68	12.41 ±1.24	13.62 ±1.110	12.87 ±0.29	14.11 ±1.01	12.71 ±1.01
Heart wt.	5.63 ±0.41	6.29 ±0.27	6.08 ±0.84	5.56 ±0.32	5.37 ± 0.49	6.71 ±0.19
Lungs wt.	10.11^{ab} ±1.93	10.49^{ab} ±1.68	9.37^{b} ±1.37	12.71^{a} ±1.11	12.04^{a} ±0.77	10.19^{ab} ±0.32
Spleen wt.	0.52^{b} ±0.044	0.53^{b} ±0.046	1.08^{a} ±0.17	0.91^{ab} ±0.13	1.32^{a} ±0.44	0.71^{ab} ±0.03
Tests wt.	6.64^{ab} ±1.75	8.64^{a} ±0.66	7.11^{ab} ±0.26	6.64^{ab} ±1.26	7.19^{ab} ±0.43	5.09^{b} ±0.035
Abdominal fat wt.	19.83^{c} ±3.91	46.18^{a} ±7.00	33.56^{b}±5. 11	30.07^{b} ±6.32	42.52^{a} ±18.74	22.57^{c} ±4.87
Dressing, %	63.01^{ab} ±0.410	64.63^{ab} ±2.28	60.85^{b} ±0.15	66.81^{a} ±0.61	66.45^{a} ±1.19	64.61^{ab} ±0.87

[a, b, and c]: means within the same row with different superscripts are significantly different ($P<0.05$).

0.75% of rosemary leaves. On the other hand, Aboelazab (2015) showed that carcass characteristic traits were not affected in treated rabbits when growing rabbits fed diets containing 0.5% and 1.0% rosemary leaves.

Blood parameters

Biochemical parameters

Serum biochemical parameters could be used as indicators of the nutritional and physiological status of experimental growing rabbits; data are presented in Table 6. It is obvious that dietary rosemary, marjoram or their mixture did not significantly affect total protein, albumin and A/G ratio.

Table 6. Effect of dietary levels of natural feed additives on blood biochemical parameters of growing New Zealand White rabbits.

Items	Treatments					
	Control	Rosemary(%)		Marjoram(%)		Mixture
		1.5	3.0	1.5	3.0	
Blood metabolite						
Total protein, (g/dl)	6.29 ±0.12	6.33 ±0.15	6.22 ±0.07	6.36 ±0.16	6.26 ±0.110	5.94 ±0.18
Albumin, (g/dl)	4.80 ±0.09	4.56 ±0.26	4.43 ±0.08	4.70 ±0.26	4.84 ± 0.30	4.42 ±0.24
Globulin, (g/dl)	1.49^{ab} ±0.087	1.76^{ab} ±0.11	1.78^{a} ±0.13	1.66^{ab} ±0.13	1.42^{b} ±0.11	1.52^{ab} ±0.06
A/ G ratio	3.25 ± 0.21	3.41 ± 0.61	2.52 ± 0.23	2.92 ± 0.31	3.48 ± 0.51	2.92 ± 0.26
Glucose, (mg/dl)	109.87^{ab} ±5.54	89.17^{c} ±1.12	100.87^{bc} ±1.22	93.97^{c} ±3.37	113.87^{a} ^{b} ±5.64	118.20^{a} ±6.03
Cholesterol, (mg/dl)	76.43^{c} ±1.13	74.22^{c} ±1.74	73.37^{c} ±0.94	93.80^{b} ±0.70	100.87^{a} ±2.23	74.67^{c} ±0.96
Total lipids, (mg/dl)	221.67^{c} ±1.20	235.33^{abc} ±7.36	227.67^{bc} ±1.21	238.33^{ab} ±3.84	249.00^{a} ±7.00	225.00^{b} ^{c} ±3.46
Kidney function						
Urea-N, (mg/dl)	35.40 ±1.91	42.70 ±3.34	39.87 ±0.755	38.70 ±1.37	41.80 ±3.45	42.37 ±1.410
Creatinine, (mg/dl)	1.46^{ab} ±0.17	1.83^{a} ±0.08	1.55^{ab} ±0.047	1.34^{b} ±0.081	1.54^{ab} ±0.14	1.59^{ab} ±0.12
Liver function						
AST, (IU/ml)	$24.26b^{c}$ ±0.94	28.03^{b} ±1.94	34.06^{a} ±0.94	17.25^{d} ±0.54	21.56^{c} ±2.16	26.96^{b} ±1.08
ALT, (IU/ml)	17.25^{c} ±0.54	28.03^{b} ±1.94	42.25^{a} ±1.53	25.88^{b} ±0.93	29.11^{b} ±1.62	26.47^{b} ±0.59

$^{a, b, and\ c}$: Means within the same row with different superscripts are significantly different ($P<0.05$).

Rabbits fed 3% rosemary had higher serum globulin, (1.78, g/dl) as compared to the control, 1.5% rosemary, 1.5% , 3% marjoram and mixture (1.49, 1.76, 1.66, 1.42 and 1.52, respectively). The increase in the globulin fraction indicates the effective role of rosemary in increasing immunity due to its role in developing and protecting cells and inhibiting non-enzymatic oxidation (Houghton *et al*., 1995). These results in agreement with Ghazalah and Ali (2008) showed that rosemary leaves meal (at 0.5 and 1% of the diet) increased the globulin level in broilers as compared to the control group. However, Aboelazab (2015)observed no significant effect on serum globulin

due to feeding rabbits diet supplemented with diets containing 0.5% and 1.0% rosemary leaves.

Rabbits fed mixture (1.5%rosemary and 1.5% marjoram) diet had higher serum glucose (118.20 g/dl) compared to control group and other treatments. However, feeding rabbits on 1.5 % of rosemary or marjoram significantly (P<0.05)reduced serum glucose compared with the control group and other treatments. This result is in the same trend with Osman *et al.* (2010) indicated that feeding broilers with rosemary *(Rosmarinus officinalis)* at the level of 1g/ kg diet significant decreased serum glucose. On contrary, ELnaggar *et al.,* (2016). showed that broilers chicks fed 0.25, 0.50, 0.75 and 1 % rosemary leaves meal had significantly (P<0.05) higher blood glucose compared with control group.

Rabbits fed diets supplemented with 1.5% and 3% marjoram had the highest (P<0.05)serum cholesterol (93.80 and 100.87 mg/ dl) respectively. However, Feeding diets supplemented with 1.5% and 3% rosemary had tendency to decrease serum concentration of cholesterol (74.22 and 73.37 mg/ dl), respectively as compared to the other treatments. The reduced content of total cholesterol may reflect the hypocholesterolemic properties attributed to the defatted part of the leaves which are rich in fibrous (21.71%) content and may block intestinal cholesterol absorption (Lansky *et al.*, 1993). This finding is consistent with a study of total cholesterol performed by Ghazalah and Ali (2008), who fed chickens diets supplemented with 0.5, 1.0 and 2.0 % dried *Rosmarinus officinalis* L. Their results showed that addition of rosemary leaves in the broiler diet lowered plasma content of total cholesterol levels. Also, Alagawany and Abd El-Hack (2015) demonstrated that serum cholesterol decreased by supplementation of 3000 mg/kg rosemary powder to laying hen diets. In another study, Polat *et al.,* (2011) observed that serum levels of cholesterol were reduced by supplementation of rosemary essential oils to broiler diets.

Growing rabbits fed diet supplemented with 1.5 and 3% marjoram had significantly higher serum total lipids (238.33 and 249.00 mg/dl) compared with control andother treatments. However the rabbits fed control diet had the lower total lipids (221.67 mg/dl). This result is in agreement with Alagawany and Abd El-Hack (2015) who found that chicks fed diet supplemented with rosemary decreased serum total lipids.

Kidney function

Data in Table (6) indicated that there is no significant effect in serum urea-N due to feed medicinal plants. Serum creatinine significantly (P≤0.05) increased (1.83 mg/ dl) in rabbits fed diet supplemented with 1.5

rosemary as compared to the lowest creatinine 1.34 mg/ dl as a result of feeding lower dietary marjoram (1.5%). However rabbits fed 1.5% and 3% marjoram decreased blood serum creatinine (1.34 and 1.54 mg/ dl). This result is in agreement with Ali (2014) who showed that supplementing marjoram to broiler diet significantly reducing blood serum creatinine. However, Ahmed and Abdel-Ghany (2015).reported non-significant effect of marjoram on turkey birds fed diet supplemented with marjoram.

Liver function

Regarding the liver function, data indicated that supplementing growing rabbits diets with rosemary (3 %) caused a significant ($P \leq 0.05$) increase in AST and ALT (34.06 and 42.25 IU/ml) when compared to those of the control of 21.26 and 17.25g/dl, respectively. This result is in agreement with Chiofalo *et al.* (2012) who found that rosemary *Rosmarinus officinalis* extract supplementation in dairy ewes increased ($P \leq 0.05$) blood concentrations of AST and ALT. However, Osman *et al.* (2010) indicated that feeding broilers with rosemary *(Rosmarinus officinalis)* at the level of 1g/ kg diet had no significant effect on AST and ALT.

Seleem *et al.* (2007) found that adding 3% marjoram (*Origanum majorana*) to growing NZW rabbits diets increased significantly ($P \leq 0.05$) the concentrations of serum transaminase enzymes(AST and ALT), but this increase was still within normal range.

Hematological parameters

Hematological traits data for growing rabbits at 90 days of age fed basal diets supplemented with rosemary, marjoram and their mixture are summarized in Table (7). Addition of any of natural feed additives to rabbit diets did not significantly affect mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC), White blood cells (WBC) and platelets. These results are in the same trend with Al-Shuwaili (2014) who did not find any significant difference in MCV, MCH, MCHC. WBCs of broiler chickens that fed on diets supplemented with 0.5% rosemary dry leaves.

Feeding growing rabbits on control, 1.5 rosemary and 1.5% marjoram had a significant tendency ($P \leq 0.05$) to increase serum hemoglobin (12.36, 11.82 and 12.32 g/dl), respectively as compared to the lowest hemoglobin 10.93, 11.13 and 10.94 g/dl as a result of feeding upper dietary rosemary, marjoram (3%) and their mixture.

Table 7. Effect of dietary levels of natural feed additives on blood hematological parameters of growing NZW rabbits.

Items	Treatments					
	Control	Rosemary		Marjoram		Mixture
		1.5 %	3 %	1.5 %	3 %	
Hemoglobin , (g/dl)	12.36^{a} ±0.21	11.82^{a} ±0.12	10.93^{b} ±0.15	12.32^{a} ±0.28	11.13^{b} ±0.07	10.94^{b} ±0.14
Red blood cells , (N x 10^6 /mm^3)	4.77^{a} ±0.27	4.31^{abc} ± 0.04	4.08^{c} ±0.05	4.67^{ab} ±0.23	4.19^{bc} ±0.052	4.13^{c} .±0.07
Hematocrit (%)	36.83^{a} ±0.65	35.65^{a} ±0.41	32.57^{b} ±0.42	37.05^{a} ±0.85	33.28^{b} ±0.095	32.79^{b} ±0.35
MCV(fl)	77.57 ±3.19	82.77 ±0.58	79.37 ±0.32	79.50 ±2.24	79.40 ±0.75	80.43 ±0.72
MCH (pg)	25.97±1. 08	27.40 ±0.17	26.53 ±0.12	26.40 ±0.83	26.53 ±0.27	26.80 ±0.20
MCHC (%)	33.47 ±0.09	33.13 ±0.07	33.27 ±0.03	33.20 ±0.15	33.40 ±0.15	33.30 ±0.06
White blood cells (N x 10^3 /mm^3)	7.51 ±0.28	6.91 ±0.33	7.48 ±0.29	7.78 ±0.188	6.92 ±0.35	7.53 ± 0.39
Platelets (mm)	319.33 ±7.22	309.67 ±13.04	308.67 ±14.66	337.33 ±9.74	308.67 ±14.66	314.00 ±12.34

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

Rabbits fed diets without any medicinal additives had significant (P ≤ 0.05) higher red blood cells (4.77 N x 10^6 /mm^3) compared with other treatments. However, the rabbits fed 3 % rosemary had the lowest red blood cells (4.08 N x 10^6 /mm^3) followed with mixed group (4.13 N x 10^6 /mm^3).

Plasma hematocrit significant increased (P≤0.05) in rabbits fed control, 1.5% rosemary and 1.5% marjoram (36.83, 35.65 and 37.05 %, respectively) compared with the other groups. The lowest hematocrit level was in rabbits fed diet supplemented with 3% rosemary, 3%marjoram and their mixture (32.57, 33.28 and 32.79 %).

In conclusion, inclusion of 1.5% of rosemary (*Rosmarinus officinalis*) or marjoram (*Origanum majorana*) plants in NZW rabbit rations as a natural source of antioxidants improved live body weight, body weight gain, carcass traits, digestibility of nutrients and economic efficiency under north Sinai conditions without any adverse effects in on performance.

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تأثيرالتغذية علي علائق الحصالبان والبردقوش علي النمو والهضم والكفاءة الاقتصادية في الارانب النامية

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أجريت هذه الدراسة لتقييم تأثيرإضافة نباتي حصالبان والبردقوش علىمعاملات الهضم و الخصائص الانتاجية الارانب النيوزيلندى الأبيض تحت ظروف شمال سيناء. تم تجميع هذه النباتات من مزارع خاصة بمحافظة شمال سيناء ثم تم تجفيفها وطحنها واضافتها لعلائق الارانب النامية.اشتملت الدراسة علي تجربيتين اساسيتين، اجريت التجربة الاولي علي 18 ذكر نيوزلاندي ابيض عمر 3 شهور ومتوسط وزن 2.200 كجم لتقدير معاملات الهضم والقيمة الغذائية للعلائق التجريبية ، اما التجربة الثانية اجريت علي عدد 72 ارنب نيوزلاندي ابيض نامي عمر 35 يوم ومتوسط وزن 620 كجم. وفي كل من التجربتين تم تقسيم الارانب عشوائيا الي ست مجاميع متماثلة غذيت علي ست علائق تجريبية. المجموعةالأولى غذيت علي عليقة مقارنة دون اضافات أما المجموعة الثانية و الثالثة تغذت على نفس العليقة و لكن مضافاً إليها 1.5% و3% نبات الحصالبان أما المجموعة الرابعة والخامسة تغذت علي العليقة الكنترول مضاف اليها 1.5% و 3% نبات البردقوش بينما غذيت المجموعة السادسة علي خليط من تباتي الحصالبان والبردقوش بنسب (1.5% حصالبان + 1.5% بردقوش).

أوضحت النتائج أن قيم كل من وزن الجسم النهائى، الزيادة اليومية فى وزن الجسم و كفاءة تحويل الغذاء عند عمر 90 يوماً لأرانب النيوزيلندى البيضاء النامية

كانت أعلى معنوياً (عند مستوى 5%) في المجموعات المغذاة علي علائق مضاف اليها خليط من (1.5% نبات الحصالبان+ 1.5% نبات البردقوش) مقارنة بمجموعة الكنترول والمعاملات الأخرى.

أظهرت نتائج تجارب الهضم على الذكور البالغة ارتفاعاً معنوياً لمعاملات هضم كل من المادة الجافة ، المادة العضوية ،البروتين الخام والمستخلص الأثيري و المركبات الغذائية المهضومة والطاقة المهضومة في الارانب المغذاة علي 1.5% نبات الحصالبان مقارنة بباقي المعاملات . بينما اظهرت النتائج تفوق المجموعات المغذاة علي 1.5% نبات الحصالبان و 1.5% نبات البردقوش في البروتين الخام المهضوم بالمقارنة بباقي المعاملات.

اما بنسبة لصفات الذبيحة أظهرت أرانب المجموعة المعاملة زيادة معنوية (عند مستوى 5%) فى نسبة التصافى في مجموعة الارانب المغذاة علي علائق مضاف اليها 1.5% نبات الحصالبان و 3% نبات البردقوش. اظهرت النتائج ارتفاع نسبة الجلوبيولين في مجموعة 3% نبات الحصالبان. زاد مستوي الجلوكوز في المجموعة التي غذيت علي خليط من (1.5% نبات الحصالبان+ 1.5% نبات البردقوش). اظهرت النتائج زيادة مستوي الكوليسترول و اللبيدات الكلية في الارانب المغذاة علي 3% نبات البردقوش. زاد معنويا مستوي الكرياتنين في دم الارانب المغذاة علي 1.5% نبات الحصالبان. سجلت مستويات إنزيمي الـ ALT & AST الدالة على نشاط الكبد زيادة معنوية (عند مستوى 5%) كنتيجة لاحتواء العلف على 3% نبات الحصالبان مقارنة بالمجموعة الكنترول والمجموعات الاخري.

زاد مستوي الدم من الهيموجلوبين و الهيماتوكريت في المجموغات المغذاة علي 1.5% نبات الحصالبان و 1.5% نبات البردقوش.

اظهرت الارانب المغذاة علي مجموعة الكنترول الي زيادة عدد كرات الدم الحمراء مقارنة بالارانب المغذاة علي النباتات الطبية.

التوصية: من النتائج السابقة وجد ان اضافة 1.5٪ من الحاصلبان (*Rosmarinus officinalis*) أو نبات البردقوش (*Origanum majorana*) في علائق الأرانب كمصدر طبيعي لمضادات الأكسدة وتحسين وزن الجسم الحي، زيادة النمو وزن الجسم ، صفات الذبيحة ، هضم العناصر الغذائية والكفاءة الاقتصادية دون أي آثار سلبية في الأداء الانتاجى للارانب.