The Effect of *Origanum majorana* Supplementation on Growth Performance, Blood parameters and Meat Quality in BUT9 Commercial Turkeys

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Abstract: This study was conducted to evaluate that effect of a herb marjoram (*Origanum majorana L*) supplementation on the growth performance, blood parameters, and meat quality in BUT9 commercial turkeys. 57 BUT9 commercial turkeys at 8 wk of age (initial starting age with average body weight 1533 ± 25.32 g) were divided randomly into three treatments. Each treatment had two replicates with unequal number of birds of each treatment. A group of chicks was fed a basal diet (control) and the remaining two groups of Turkeys were fed the basal diet supplemented with marjoram at a concentration of 0.4 % (T1) and 0.8% (T2), respectively, until 19th wk of age (marketing age). Results revealed that body weight and body weight gain was improved significantly ($P \leq 0.05$), feed intake was decreased and thus feed conversion was improved by feeding marjoram. These results showed that feeding on T1 diet improved non-significantly the percentage of eviscerated weight. Both creatinine and cholesterol levels of two marjoram treatments reduced significantly ($P \leq 0.05$) compared with controls. The supplementing of *Origanum majorana* to basal diet increased values of albumen, globulin, total protein while AST, ALT and ttriglycerides values reduced without significant. Significant treatments effects ($P \leq 0.05$ or $P \leq 0.01$) were detected on tenderness of breast meat, lightness color of thigh and breast meat, redness and yellowness color of thighs only. The best values of meat quality measurements generally were recorded of two groups fed on treated diets containing marjoram compared with control group. It seemed from the results, supplementing of marjoram to basal diet improved growth performance, blood parameters, and meat quality of BUT9 turkeys.

Key words**:** Medicinal plants; *Origanum majorana;* BUT9 Turkeys; Growth performance; Meat physical traits.

INTRODUCTION

Natural feed additives of plant are safer and healthier than synthetic additives. Adding Herbs and herbal products to poultry rations as replacers of the comparable synthetic products, is assumed to instigate improvement of many productive performance.

A herb, is a plant whose leaves, seeds, or flowers are used for flavoring food or in medicine. Medicinal plant extracts were developed and proposed for use in food as natural antimicrobials (Del Campo *et al.,* 2000 and Hsieh *et al.,* 2001). Bacterial and fungal infections pose greater threats to health and hence the use of natural antimicrobial compounds is important in the control of human and plant diseases of microbial origin. Craig (1999) showed that a diet with culinary herbs are used generously to flavor food provides a variety of active phytochemicals that promote health and protect against chronic diseases. Leeja and Thoppil (2007) reported that the medicinal effects of marjoram on gastrointestinal tract stimulant, tonic, carminative, diaphoretic, hypoglycemic, diuretic and antibacterial. Parry (1969) described marjoram to have properties of antiseptic, antispasmodic, carminative, stimulant, expectorant and nerve tonic. Heinonen *et al.* (1998) showed that some natural polyphenols have therapeutic effects or a protective action against cardiovascular diseases and some cancers. Also, slowing down the ageing process and in the treatment of human diseases such as atherosclerosis and cancer reported by Tiziana and Dorman (1998). 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 many growth traits (Al-Harthi, 2002 a, b; El-Kaiaty *et al.,* 2002 a, b; Soliman *et al.,* 2003 and El-Mallah *et al.,* 2005) and positive effects on immunity and viability (Soliman *et al.,* 1995 and Soliman *et al.,* 1999). Giannenas *et al.* (2005) reported that using dehydrated oregano plants improved body weight gain and feed conversion ratio when incorporated in chicken diets. Dried oregano leaves ration improved feed conversion ratio in early maturing female turkeys (Bampidis *et al.* 2005). Ayala *et al.* (2011) reported that dietary supplementation with dried oregano improved rabbit performance. Ali (2014) showed that addition of marjoram to diet improved broiler productive performance.

Origanum majorana or sweet marjoram (*Origanum majorana*, formerly *Majorana hortensis*) of the Labiatae family is indigenous to Mediterranean countries and was known to the ancient Egyptians, Greeks and Romans (Tainter and Grenis, 1993). Marjoram a common medicinal plant and contains about 0.5 to 3% oil. Hermann (1973) showed that Marjoram oil chemical composition includes borneol, terpinene, pinene, sabinene and terpineol. Also, Cowan (1999) reported that *Origanum majorana* are rich in a wide variety of secondary metabolites, such as terpenoids, which have been found to have antimicrobial properties. Triantaphyllou *et al.* (2001) gave evidence that *Origanum majorana*, sage and dittany extracts have a remarkable capacity in retarding lipid oxidation and showed antioxidant activity due to bound forms of phenolic compounds such as hydroxycinnamic acids and flavonoids.

The study aimed to estimate the effect of adding two levels (T1: 0.4% and T2: 0.8%) of marjoram (*Origanum majorana*), to basal ration (Control) on the growth performance, blood parameters and meat quality in BUT9 Turkey.

MATERIALS AND METHODS

This experimental was conducted in accordance with the guidelines of the department of Animal and fisheries production, faculty of Agriculture, Suez Canal University, Ismailia, Egypt, during the period from August to October 2010. Data of fifty seven BUT9, (light white and sex-identifiable-turkey strain from 8 wks of age (initial experimental starting age with average body weight 1533±25.32 g.) till marketing (at 19 wks of age). Birds were assigned randomly into three treatments. Each treatment had two replicates with unequal number of birds and birds in each replicate were kept in a separate floor pens with dimensions 3 X 2 meters. The experiment was conducted in open sided housing system with using fan and hood throughout the experiment. All birds were reared under the same managerial, hygienic and environmental conditions. Photoperiod was 16 h light and 8 h dark. The mean monthly minimum and maximum ambient temperature were (24.87-33.71), (23.7-32.53) and (22.4-31.76) with average relative humidity 62.18, 56.46 and 52.08 during August, September and October months, respectively. Feeds and clean fresh water were provided ad libitum.

Three different iso-caloric iso-nitrogenous experimental rations, (Table1), were used {namely: 0% (Control); 0.4 (T1) and 0.8% (T2) of dried plants of Marjoram (*Origanum majorana*)}. The approximate chemical composition of the used *Origanum majorana* on an air dried basis was: Moisture, 7.56%; Dry matter, 92.44%; Organic matter, 70.86%; Crude protein, 13.93%; Ether extract, 3.30%; Crude fiber, 14.50%; Ash, 21.58% and Nitrogen free extract (NFE), 39.13%. Feeding rations were adjusted according to the light turkey requirements stated by NRC, 1994. Experimental rations were formulated accordingly into two age stages (The first growing stage from 8 to 12 wk and the second finishing stage from 13 to 19 wk). Composition and calculated chemical analysis of all tested experimental diets are presented in (Table 1).

Individual body weight was recorded weekly to the nearest gram, from 8 to 19 wk of age. Gain in weight was computed, as the difference in weight between two consecutive periods. Feed intake was recorded weekly and then feed conversion was determined by dividing feed intake on gain in weight for each replicate at a certain period. At the end of the experiment, at least one bird per replicate of different treatments was slaughtered for meat physical and chemical evaluations. Organs carcass were weighed, relative organ weights were calculated on live body weight basis.

At marketing age (19 wk), individual blood samples were taken into dry clean heparinized centrifuge tubes from two birds /treatment (One male and one female), and centrifuged at 3000 rpm for 20 min. The clear plasma samples were carefully drawn and transferred to dry, clean small glass bottles, and stored at $\leq$ -20^{o} C in a deep freezer until the time of chemical determination**.** Evaluated biochemical characteristic of blood plasma encompassed the total cholesterol, g/100 ml according to Richmond (1973); Triglycerides, mg/100 ml (Bernd and George, 1977); Creatinine,, mg/100 ml (Bartels *et al*., 1972); Total protein, g/100 ml according to Weichselbaum (1946) and Albumin, g/100 ml (Doumas *et al.,* 1971). Globulin concentration was calculated as the difference between total protein and albumin concentrations.

Table (1): Determined chemical compositions of experimental rations (0.0 %: Control, 0.40%: T1 and 0.80%:T2) of *Origanum majorana* during the growing (till 12wk) and finishing (from 13 till 19 wk of age) stages.

Ingredient	First stage (grower)			Second stage (Finisher)		
	Control	T1	T2	Control	T1	T2
Yellow corn	61.60	61.20	60.80	68.80	68.40	68.00
Soya bean (44 %)	26.00	26.00	26.00	18.50	18.50	18.50
Broiler concentrate	10.00	10.00	10.00	10.00	10.00	10.00
Animal fat	1.50	1.50	1.50	2.00	2.00	2.00
Di-Calcium phosphate	0.30	0.30	0.30	0.10	0.10	0.10
NaCl	0.50	0.50	0.50	0.50	0.50	0.50
Dl-Methionine	0.10	0.10	0.10	0.10	0.10	0.10
Marjoram	0.00	0.40	0.80	0.00	0.40	0.80
Determined analysis						
Crude protein	21.62	21.24	21.50	18.86	18.93	19.15
Moisture	10.52	10.40	10.28	10.22	10.17	10.54
Ether extract	2.57	2.77	2.82	2.65	2.73	2.75
Crude fiber	3.22	3.36	3.58	3.15	3.26	3.55
Ash	6.44	6.58	6.54	6.18	6.27	6.34
ME (Kcal/kg)	3025	3014	3002	3143	3132	3120

(vitamin and minerals mixture premix was added at the ratio of 3 kg per ton as a part of the Broiler concentrate): Each 3 kg of vitamin and minerals mixture contained 12,000,000 IU Vit. A; 2,000,000 IU Vit. D_3; 10,000 mg Vit. E; 2,000 mg Vit. K_3; 1,000 mg Vit. B_1; 5,000 mg Vit. B_2; 1,500 mg Vit. B_6; 10 mg Vit. B_{12}; 10,000 mg pantothenic acid; 30,000 mg Nicotinic acid, 1,000 mg Folic acid; 50 mg Biotin; 250,000 mg choline chloride, 10,000 mg Cu, 1,000 mg I; 30,000 mg Fe; 50,000 mg Zn, 60,000 mg Mn, 100 mg Co and 100 mg Se.

In addition, Alanine transaminase (ALT U/L, Formerly sGPT), Aspartate transaminase (AST U/L, Formerly sGOT) were determined according to Tietz (1995). These entire biochemical characteristic were colorimetrically determined using commercial kits purchased from the Egyptian American Company of Laboratory Services and El-Nasr Pharmaceuticals Chemical Company, Cairo, Egypt.

Six BUT9 birds (three from each sex) at the 19th wk. of age were randomly selected and scarified to obtain meat physical (*i.e.* color intensity, pH, water holding capacity and tenderness for thigh and breast muscles samples, measured directly after slaughter) and chemical (*i.e.* uric acid in blood plasma, liver as well as thigh and breast muscles, were enzymatically determined according to Kageyama (1971) after a period of preserving in a refrigerator) characteristics. Tenderness and water holding capacity (WHC) were determined according to Jauregui *et al.* (1981); pH according to Jeacocke (1977) and color intensity according to (CIE - International Commission on Illumination, 1978).

Data of BUT9 turkeys were analyzed using general linear model procedure of SAS software (SAS Institute, 1998). Difference among treatment means or between sexes were tested for significances using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Body weight and weight gain

Body weight differences due to various treatments were significant ($P \leq 0.05$) at 12, 13, 14, 15 and 16 wk of age, as well as gain in weight at 11-12 and 8-19 wk of age (Tables 2 and 3). For the two trait classes, the highest values of treatment means were generally for T2, followed in most cases by T1 then the control group (Tables 2 and 3). In this respect, Abdo *et al*. (2003), Soliman *et al*. (2003) with broiler and Seleem *et al*. (2007) with growing New Zealand rabbits indicated that body weight and gain in weight improved significantly by various feeding substitutes with *Origanum majorana*. Mona Osman *et al.* (2010) and Ali (2014) showed that supplementing marjoram leaves powder to broiler diet improved significantly body weight and weight gain at most ages studied. Also, Giannenas *et al.* (2005) and Florou-Paneri *et al.* (2006) reported that using oregano plants improved body weight gain when incorporated in chicken diets.

These progressive positive effects of marjoram on body and gain weight could be ascribed to the positive effects on immunity, Craig (1999); antifungal activity, Tiziana and Dorman (1998), antibacterial properties, Yadava and Saini (1991), wide variety of secondary metabolites such as terpenoids, Cowan (1999) and antioxidant activity, Triantaphyllou *et al.* (2001). Guo (2003) showed that medicinal plants components mechanism may include improving the physical conditions of gut ecosystem and enhancing function of immune system of chickens.

Sex differences on body weight and gain in weight were generally significant ($P \leq 0.05$; $P \leq 0.01$; $P \leq 0.001$; $P \leq 0.0001$) at most ages for body weight, throughout the whole age intervals and those intervals from 8-9, 10-11 and 11-12 wk for gain in weight (Tables 2 and 3). BUT9 turkey toms were superior to females in body weight and gain in weight at all ages considered. The difference in values between males and females increased progressively with advance of age till marketing for body weight and throughout the intervals from 8-14 wk and declined subsequently till age of marketing for gain in weight.

Similar results were also obtained by Mostafa and Nofal (2000), Isguzar (2003), Ersoy and Çelik (2007), Zaky and Amin (2007) and Ilori *et al.* (2010) with different breeds. Zaky and Amin (2007) demonstrated significant sex differences in turkeys' body weight (Bronze vs. Baladi) at all ages from 4 to 20 wks of age along with males were heavier than females. Also, Significant sex differences with males being heavier for body weight at different ages and from 20 to 24 wk of ages for two acclimatized breeds of turkey (Broad Breasted Bronze, White Holland and their reciprocal crosses) reported by Mostafa and Nofal (2000). This substantial body weight performance of turkey males, versus females, is expected to be hormonal mediated which elaborates and amplifies as approaching puberty. In addition, the presence of such sexual dimorphism in favor of males in the growth performance can be partially attributed to aggressiveness and dominance of males when are not reared separately (Hancock *et al.* 1994).

Feed intake and conversion

Treatments affected feed intake significantly ($P \leq 0.05$; $P \leq 0.01$ or $P \leq 0.001$) at the 9, 17 and 19 wk of age as well as during the age intervals from 9-19 wk of age. Apart of treatments effect, feed intake increases with advance of age (Table 4). During the periods from 16 to 19 wk. and from 9 to 19 wk of age, the lowest feed intake values were recorded by T1, control and T2, respectively. Soliman *et al*. (2003) with broiler and Seleem *et al*. (2007) with New Zealand White rabbits reported that total feed intake values reduced insignificantly in contrast with the marjoram untreated group. Mona Osman *et al.* (2010) and Ali (2014) reported that significant decrease of feed intake with addition of marjoram to broiler diet during most the age periods.

Non-significant treatment effects on feed conversion were detected during all studied intervals from 9 to 19 wk. (Table 5). Apart from significance, a trend was detected for T1 to give the best (lowest), values of feed conversion followed by T2 and finally control treatment. In this respect, Abdo *et al*. (2003), Soliman *et al*. (2003), Mona Osman *et al.* (2010) and Ali (2014) with broiler and Seleem *et al*. (2007) with New Zealand White rabbits found conversion improvement for fed diets containing *marjoram* versus control. Giannenas *et al.* (2005) and Florou-Paneri *et al.* (2006) reported that using oregano plants improved feed conversion ratio when incorporated in chicken diets. Dried oregano leaves at 1.25, 2.5, and 3.75 g/kg ration improved feed conversion ratio in early maturing female turkeys (Bampidis *et al.,* 2005). The improvement in feed intake and conversion may be due to the ability of

marjoram to increase the efficiency of digestion by increasing digestive enzymes, curing or preventing basic intestinal infections and relieving diarrhea (Hallent, 2015). Cowan (1999) concluded that the positive effects of *Origanum majorana* may be due to abundance and wide variety of secondary metabolites, such as terpenoids, which have been found to have antimicrobial properties.

Slaughter parameters

Differences in slaughter parameters due to treatments and sex effects were non-significant (Table 6). These results showed that T1diet improved the percentage of eviscerated weight; but the percentage of eviscerated weight of male was better than female. These results agreement with Bampidis *et al.* (2005) who reported no significant effect of oregano content in diet on carcass weights, carcass yield, and the relative weights of the heart and liver of early maturing female turkeys. On another hand, Seleem *et al.* (2007) reported that supplementing *Origanum majorana* to growing diets of New Zealand White rabbits significantly increased dressing percentage by 6.1%.0. The improvement in carcass traits for treated diet with marjoram may be related with the increase in body weight of birds. Isguzar (2003), Ersoy and Çelik (2007) and Shamseldin *et al.* (2014) evidenced significant effects of sex on hot carcass of turkeys where males were better than females.

Table (2): Least square means, standard errors (S.E) and coefficients of variation (CV%) for body weight (g) of BUT9 turkeys at different ages fed on diets contained 0.0 (control), 0.4% (T1) or 0.8% (T2) *Origanum majorana*.

Age (wk)		Control	T1	T2	Sig.	Male	Female	Sig	Overall mean
	Mean	1534.69	1534.55	1532.11		1613.17	1445.56		1533.77
8†	SE	40.09	63.98	59.11	NS	39.11	49.82	NS	32.98
	CV%	10.45	19.56	16.82		13.28	17.91		16.23
	Mean	1954.06	1905.91	1970.00		2037.50	1833.33		1940.79
9	SE	53.06	83.30	71.21	NS	47.61	66.42	NS	42.11
	CV%	10.86	20.50	15.76		12.80	18.83		16.38
	Mean	2453.75	2451.82	2503.68		2594.33	2331.11		2469.65
10	SE	54.87	95.03	80.11	NS	60.32	65.08	NS	47.24
	CV%	8.94	18.18	13.95		12.73	14.51		14.44
	Mean	2917.19	2975.23	3007.89		3136.67	2784.44		2969.82
11	SE	70.17	110.36	100.70	NS	72.98	75.04	*	56.94
	CV%	9.62	17.40	14.59		12.74	14.00		14.48
	Mean	3420.63^{b}	3580.91^{ab}	3660.00^{a}		3781.67	3318.52		3562.28
12	SE	77.22	119.77	139.76	*	79.57	97.63	**	69.11
	CV%	9.03	15.69	16.64		11.53	15.29		14.65
	Mean	4088.13^{b}	4260.00^{ab}	4348.95^{a}		4547.00	3901.85		4241.40
13	SE	92.35	143.43	166.49	*	92.24	108.84	***	82.33
	CV%	9.04	15.79	16.69		11.11	14.49		14.65
	Mean	4886.88^{b}	5044.55^{ab}	5198.42^{a}		5437.00	4623.33	***	5051.58
14	SE	108.01	152.21	194.35	*	88.85	125.11	*	92.42
	CV%	8.84	14.15	16.30		8.95	14.06		13.81
	Mean	5560.63^{b}	5724.55^{ab}	5916.32^{a}		6194.00	5240.74		5742.46
15	SE	122.24	164.52	217.19	*	95.47	133.40	***	102.19
	CV%	8.79	13.48	16.00		8.44	13.23	*	13.44
	Mean	6198.75^{b}	6360.91^{ab}	6566.05^{a}		6926.17	5781.11		6383.77
16	SE	145.05	182.66	240.34	*	111.06	131.00	***	113.90
	CV%	9.36	13.47	15.96		8.78	11.77	*	13.47
	Mean	6863.13	6962.27	7246.32		7615.00	6378.15	***	7029.12
17	SE	159.26	191.03	259.31	NS	122.73	133.62	*	121.83
	CV%	9.28	12.87	15.60		8.83	10.89		13.09
	Mean	7351.88^{b}	7569.55^{ab}	7847.37^{a}		8245.67	6884.81	***	7601.05
18	SE	185.76	212.83	283.91	NS	147.87	139.21	*	135.89
	CV%	10.11	13.19	15.77		9.82	10.51		13.50
	Mean	7861.25^{b}	8045.00^{ab}	8394.21^{a}		8801.00	7341.85	***	8109.82
19	SE	188.90	220.92	307.88	NS	160.05	139.23	*	143.96
	CV%	9.61	12.88	15.99		9.96	9.85		13.40

8† = Initial body weight at 8 wk of age

a, b, ... Treatment means having different superscript litters within the same raw are significantly different at ($P \leq 0.05$) using Duncan's Multiple Range test.

Table (3): Least square means, standard errors (S.E.) and coefficients of variation (CV%) for gain in weight (g) of BUT9 turkeys at different ages fed on diets contained 0.0 (control), 0.4% (T1) or 0.8% (T2) *Origanum majorana*.

Period (Wk)		Control	T1	T2	Sig.	Male	Female	Sig	Overall mean
	Mean	419.38	371.36	437.89		424.33	387.78		407.02
8-9	SE	32.44	28.30	29.65	NS	23.54	25.90	NS	17.45
	CV	30.94	35.75	29.52		30.38	34.70		32.37
	Mean	499.69	545.91	533.68		556.83	497.78		528.86
9-10	SE	20.36	26.75	22.55	NS	18.84	19.46	NS	13.99
	CV	16.30	22.98	18.41		18.54	20.32		19.97
	Mean	463.44	523.41	504.21		542.33	453.33		500.18
10-11	SE	26.70	28.53	31.07	NS	22.76	22.25	*	16.89
	CV	23.04	25.57	26.86		22.99	25.50		25.50
	Mean	503.44^{b}	605.68^{ab}	652.11^{a}		645.00	534.07		592.46
11-12	SE	26.68	37.93	58.54	*	34.26	37.93	NS	26.29
	CV	21.20	29.38	39.13		29.09	36.90		33.50
	Mean	667.50	679.09	688.95		765.33	583.33		679.12
12-13	SE	37.48	41.50	36.30	NS	27.14	26.03	***	22.30
	CV	22.46	28.66	22.96		19.42	23.19		24.79
	Mean	798.75	784.55	849.47		890.00	721.48		810.18
13-14	SE	48.44	28.99	45.21	NS	27.51	30.06	***	23.05
	CV	24.26	17.33	23.20		16.93	21.65	*	21.48
	Mean	673.75	680.00	717.89		757.00	617.41		690.88
14-15	SE	44.14	39.56	35.45	NS	29.27	29.71	***	22.68
	CV	26.20	27.29	21.52		21.18	25.00		24.78
	Mean	638.13	636.36	649.74		732.17	540.37		641.32
15-16	SE	47.47	49.70	40.20	NS	36.87	27.52	***	26.47
	CV	29.76	36.63	26.97		27.58	26.46		31.16
	Mean	664.38	601.36	680.26		688.83	540.37		645.35
16-17	SE	55.52	32.62	37.63	NS	34.82	27.52	*	23.66
	CV	33.43	25.44	24.11		27.69	26.46		27.68
	Mean	488.75	607.27	601.05		630.67	506.67		571.93
17-18	SE	48.81	50.94	41.62	NS	46.98	23.20	**	28.08
	CV	39.95	39.34	30.18		40.81	23.80		37.07
	Mean	509.38	475.45	546.84		555.33	457.04		508.77
18-19	SE	46.52	32.67	46.02	NS	36.73	26.09	**	23.67
	CV	36.53	32.23	36.69		36.23	29.66		35.13
	Mean	6326.56^{b}	6510.45^{ab}	6862.11^{a}		7187.83	5896.30		6576.05
8-19	SE	210.76	185.60	275.40	*	155.72	121.47	***	131.45
	CV	13.33	13.37	17.49		11.87	10.70	*	15.09

a, b, ... Treatment means having different superscript litters within the same raw are significantly different at ($P \leq 0.05$) using Duncan's Multiple Range test.

Plasma constituents

Results revealed that both cholesterol and creatinine levels in two *Origanum* treatments were significantly reduced while triglycerides were non significantly reduced compared with controls (Table 7). The reduction in circulating cholesterol by *Origanum* can be attributed to its high unsaturated fatty acids' contents which may stimulate the cholesterol excretion through the intestine and/or enhance oxidation of cholesterol to bile salts and/or to the affluent presence of isoflavones which prevent intestinal absorption of cholesterol by competition for its absorption sites. From another hand, Mona Osman *et al.* (2010) and Ali (2014) reported that no significant effect of broiler marjoram diet on cholesterol, triglycerides and creatinine.

Also, Dina EL Bushuty and Naglaa, Shanshan (2012) reported that rat males fed with marjoram at 5 and 10% showed a significant decrease in the values of serum cholesterol, triglyceride and low density lipoprotein–cholesterol ($P< 0.05$) but showed a significant increase in the values of serum in high density lipoprotein–cholesterol ($P< 0.05$) in comparing with control rat group. Also, Nagm (2002) found that feeding with marjoram extract has led to significantly lowering triglyceride serum levels for treated rats ($p<0.01$) compared with control. Rang and Dale (1991) reported that the hypocholesterolemic effect of marjoram can be attributed to presence of isoflavones which prevent intestinal absorption of cholesterol by competition for its absorption sites.

Table (4): Least square means, standard errors (S.E.) and coefficients of variation (CV%) for feed intake (g) of BUT9 turkeys at different ages fed on diets contained 0.0 (control), 0.4% (T1) or 0.8% (T2) *Origanum majorana*.

Age (wk)		Control	T1	T2	Sig.	Overall mean
	Mean	755.00[a]	685.00[b]	712.00 [ab]		717.33
9	SE	5.00	5.00	18.00	*	13.82
	CV	0.93	1.03	3.57		4.72
	Mean	904.00	882.00	895.50		893.83
10	SE	14.00	9.00	15.50	NS	7.13
	CV	2.19	1.44	2.44		1.95
	Mean	940.00	990.00	986.50		972.16
11	SE	20.00	80.00	86.50	NS	32.49
	CV	3.00	11.42	12.40		8.18
	Mean	1170.00	1207.00	1275.50		1217.50
12	SE	70.00	43.00	174.50	NS	53.49
	CV	8.46	5.03	19.34		10.76
	Mean	1315.50	1245.50	1308.00		1289.66
13	SE	25.50	9.50	22.00	NS	16.69
	CV	2.74	1.07	2.37		3.17
	Mean	1515.00	1459.00	1560.00		1511.33
14	SE	25.00	14.00	90.00	NS	30.59
	CV	2.33	1.35	8.15		4.95
	Mean	1489.00	1513.50	1631.50		1544.66
15	SE	71.00	13.50	73.50	NS	38.50
	CV	6.74	1.26	6.37		6.10
	Mean	1700.00	1620.50	1831.00		1717.16
16	SE	50.00	70.50	72.00	NS	48.47
	CV	4.15	6.15	5.56		6.91
	Mean	1920.00[ab]	1792.50[b]	2077.50[a]		1930.00
17	SE	30.00	62.50	22.50	*	55.42
	CV	2.21	4.93	1.53		7.03
	Mean	2041.50	2031.50	2239.00		2104.00
18	SE	118.50	13.50	71.00	NS	55.76
	CV	8.20	0.94	4.48		6.49
	Mean	2241.50[ab]	2038.50[b]	2400.00[a]		2226.66
19	SE	18.50	88.50	10.00	*	70.21
	CV	1.16	6.14	0.58		7.72
	Mean	15992.00[b]	15465.00**c**	16917.00[a]		2226.66
9-19	SE	78.00	72.00	145.00	**	70.21
	CV	0.69	0.65	1.21		7.72

a, b, ... Treatment means having different superscript litters within the same raw are significantly different at ($P \leq 0.05$) using Duncan's Multiple Range test.

Birds fed on the control diet has probably acquired the highest levels (not supported by significance) of ALT and AST levels compared with two *Origanum* treated groups. In this respect, Dina EL Bushuty and Naglaa, Shanshan (2012) showed that the values of serum ALT, AST were significantly decreased in treated rat groups with marjoram ($P \leq 0.05$) compared with control rat group. From another hand, Seleem *et al*. (2007) reported that supplementing 3% *Origanum majorana* to growing diets of New Zealand White rabbits had higher values of ALT and AST. Also, Mona Osman *et al.* (2010) with broiler reported that increase no significantly of ALT and AST levels related with fed on marjoram diet.

EL-Ashmawy *et al.* (2005) reported that the reduction in serum levels of aminotransferases enzymes (ALT, AST) may be due to the presence of isoflavones, polyphenols and other antioxidants in herbal plants. Also, Rodriguez-Meizoso *et al.* (2006) demonstrated that the effect of administration of marjoram (volatile oil, alcoholic and aqueous) induced a significant decrease in serum activities of aminotransferases enzymes.

The results showed that T1 but not T2, revealed the highest levels of albumen, globulin, and total protein and that indicate better immunity or immune enhancement for this treatment which may be due to better balance between albumen and globulin values and the higher concentration of globulin value. In this respect, Also, Seleem *et al*. (2007) reported that supplementing 3% *Origanum majorana* to growing diets of New Zealand White rabbits, had higher blood parameters (total protein, albumin, globulin and A/G ratio). From another hand, Mona Osman *et al.* (2010) reported that increase significant of globulin and decrease significant of albumin and A/G ratio for broiler marjoram diet compared with control treatment. However, Ali (2014) showed that supplementing marjoram of broiler diet reduce significantly albumin,

globulin and A/G ratio than the control group and did not have any effect on total protein levels.

Some studies on different poultry species (turkey, broiler, layers and Japanese quail) reported that adding medicinal, aromatic plants or herbal additive compounds to control diets significantly decreased serum cholesterol and/or triglycerides (Abdel-Azeem, 2002; and Osman *et al.,* 2004; El-Mallah *et al.,* 2005) increased total protein, albumin and globulin by (Azouz, 2001); and no adverse effects on ALT, AST and creatinine by Abdel-Azeem (2002), Abdo *et al*. (2003), Al-Harthi (2004) and Tollba *et al*. (2005). Mahdi *et al.* (2015) reported that adding some herbal plant to the turkey diets decreasing the AST and ALT levels while showed that no differences were detected in cholesterol, total protein and creatinine. However, Emam (2006) reported that females of Japanese quail when fed medicinal and aromatic plants had higher serum cholesterol, triglycerides, total protein and globulin.

Sex effects were generally non-significant, though apparently males showed higher values of albumen, globulin, total protein, ALT, cholesterol and triglycerides while females surpassed males in A/G ratio and AST. These results agreement with Ogundu Uduak *et al.* (2013) who reported that non-significant effect of sex on total protein, albumen, globulin, cholesterol, ALT, and AST in turkeys. Ghazalah *et al*. (1994) reported that the numeric variations in total protein, albumin and globulin could be interpreted due to many factors such as genetic, age, sex, physiological status, rearing condition, feeding as well as pathological factors.

Table (5): Least square means, standard errors (S.E.) and coefficients of variation (CV%) for feed conversion of BUT9 turkeys at different ages fed on diets contained 0.0 (control), 0.4% (T1) or 0.8% (T2) *Origanum majorana*.

Age (wk)		Control	T1	T2	Sig.	Overall mean
	Mean	1.79**ab**	1.84**a**	1.62**b**		1.75
9	SE	0.05	0.03	0.03	NS	0.04
	CV	3.95	2.68	3.04		6.36
	Mean	1.81**a**	1.61**b**	1.67**ab**		1.70
10	SE	0.04	0.01	0.05	NS	0.04
	CV	3.12	0.43	4.64		5.83
	Mean	2.01	1.90	1.94		1.95
11	SE	0.03	0.08	0.01	NS	0.03
	CV	2.11	5.95	0.36		3.75
	Mean	2.27	1.99	1.99		2.08
12	SE	0.07	0.01	0.09	NS	0.06
	CV	4.66	0.71	6.39		7.90
	Mean	1.98	1.83	1.89		1.90
13	SE	0.07	0.07	0.02	NS	0.03
	CV	5.34	5.78	1.86		5.06
	Mean	1.88	1.86	1.83		1.85
14	SE	0.05	0.01	0.09	NS	0.02
	CV	3.76	0.76	7.32		3.82
	Mean	2.29	2.22	2.27		2.26
15	SE	0.15	0.05	0.07	NS	0.04
	CV	9.26	3.49	4.36		5.05
	Mean	2.73	2.62	2.81		2.72
16	SE	0.15	0.39	0.01	NS	0.11
	CV	8.01	21.05	0.25		10.26
	Mean	2.87	2.99	3.05		2.97
17	SE	0.03	0.10	0.05	NS	0.04
	CV	1.47	4.73	2.54		3.78
	Mean	4.20	3.40	3.73		3.78
18	SE	0.12	0.46	0.02	NS	0.19
	CV	4.20	19.31	0.94		12.46
	Mean	4.42	4.36	4.48		4.42
19	SE	0.04	0.48	0.53	NS	0.18
	CV	1.28	15.56	16.73		10.31
	Mean	2.53a	2.38b	2.46 ab		2.46
9-19	SE	0.00	0.02	0.04	NS	0.03
	CV	0.27	1.18	2.58		3.09

a, b, ... Treatment means having different superscript litters within the same raw are significantly different at ($P \leq 0.05$) using Duncan's Multiple Range test.

Table (6): Least square means, standard errors (S.E.) and coefficients of variation (CV%) for slaughter parameters (%) of BUT9 turkeys fed on diets contained 0.0 (control), 0.4% (T1) or 0.8% (T2) *Origanum majorana*.

		Control	T1	T2	Sig.	Male	Female	Sig	Overall mean
Feather	Mean	5.80	5.80	5.44		5.43	5.98		5.73
	SE	1.14	0.91	1.28	NS	0.66	0.93	NS	0.57
	CV	39.18	35.03	33.26		27.22	38.05		32.85
Blood	Mean	4.49	4.35	4.27		4.76	4.07		4.38
	SE	0.25	0.32	0.56	NS	0.17	0.24	NS	0.18
	CV	11.31	16.68	18.49		7.86	14.36		13.64
Head	Mean	2.04	1.98	1.93		2.11	1.90		1.99
	SE	0.18	0.09	0.23	NS	0.09	0.11	NS	0.08
	CV	17.41	10.52	17.13		9.88	14.59		13.06
Abdominal Fat	Mean	0.16	0.10	0.06		0.11	0.12		0.11
	SE	0.03	0.01	0.01	NS	0.03	0.02	NS	0.02
	CV	38.64	25.51	32.19		65.38	36.35		48.23
Heart	Mean	0.40	0.42	0.30		0.38	0.39		0.39
	SE	0.05	0.02	0.00	NS	0.04	0.04	NS	0.02
	CV	27.36	11.44	1.88		21.98	22.12		20.98
Liver	Mean	1.43	1.40	1.78		1.38	1.57		1.48
	SE	0.11	0.08	0.16	NS	0.06	0.11	NS	0.07
	CV	15.09	12.59	12.90		10.21	16.98		15.64
Gizzard	Mean	1.64	1.63	1.70		1.56	1.72		1.65
	SE	0.06	0.09	0.25	NS	0.03	0.09	NS	0.06
	CV	6.80	12.76	21.08		5.02	12.88		11.30
Eviscerated weight	Mean	79.00	79.42	78.70		78.95	79.29		79.14
	SE	1.36	0.49	0.12	NS	0.71	0.76	NS	0.50
	CV	3.45	1.37	0.22		2.02	2.35		2.11

Table (7): Least square means, standard errors (S.E) and coefficients of variation (CV%) for plasma constituents of BUT9 turkeys fed on diets contained 0.0 (control), 0.4% (T1) or 0.8% (T2) *Origanum majorana*.

		Control	T1	T2	Sig.	Male	Female	Sig	Overall mean
Albumin (g/dl)	Mean	0.91	0.95	0.80		0.87	0.90		0.89
	SE	0.09	0.05	0.10	NS	0.03	0.10	NS	0.05
	CV	13.99	7.44	17.68		5.29	19.25		12.89
Globulin (g/dl)	Mean	3.09	3.75	3.25		4.03	2.70		3.36
	SE	1.09	1.25	0.35	NS	0.61	0.47	NS	0.46
	CV	49.89	47.14	15.23		26.28	30.32		33.16
A/G ratio	Mean	34.81	29.00	25.24		22.88	36.48		29.68
	SE	15.19	11.00	5.80	NS	4.10	9.00	NS	5.37
	CV	61.71	53.64	32.48		31.03	42.71		44.28
Total Protein (g/dl)	Mean	4.00	4.70	4.05		4.90	3.60		4.25
	SE	1.00	1.20	0.25	NS	0.61	0.38	NS	0.43
	CV	35.36	36.11	8.73		21.50	18.22		24.93
ALT (GPT) (U/L)	Mean	10.00	5.70	4.85		7.13	6.57		6.85
	SE	1.00	1.00	0.85	NS	1.95	1.44	NS	1.09
	CV	14.14	24.81	24.79		47.46	38.11		39.14
AST (GOT) (U/L)	Mean	117.40	113.30	111.95		113.30	115.13		114.22
	SE	0.40	2.80	0.35	NS	2.27	1.44	NS	1.27
	CV	0.48	3.49	0.44		3.47	2.17		2.73
Creatinine (mg/dl)	Mean	0.59	0.32	0.21		0.39	0.35		0.37
	SE	0.03	0.04	0.02	*	0.13	0.10	NS	0.07
	CV	8.46	20.20	10.35		55.53	51.31		48.55
Triglycerides (mg/dl)	Mean	67.25	37.70	24.15		49.73	36.33		43.03
	SE	1.75	22.70	0.85	NS	13.30	16.59	NS	9.97
	CV	3.68	85.15	4.98		46.31	79.07		56.74
Cholesterol (mg/dl)	Mean	211.00	121.50	107.00		152.00	141.00		146.50
	SE	15.00	1.50	3.00	*	37.11	28.04	NS	20.95
	CV	10.05	1.75	3.97		42.29	34.45		35.02

a, b, ... Treatment means having different superscript litters within the same raw are significantly different at ($P \leq 0.05$) using Duncan's Multiple Range test.

Physical characteristics of meat

Significant treatments effects ($P \leq 0.05$ or $P \leq 0.01$ or $P \leq 0.0001$) were detected on tenderness breast and thigh meat, color lightness (L*) of thigh and breast meat, redness (a*) and yellowness (b*) of thigh only (Table 8). The best values of meat color measurements were generally recorded by the groups fed on treated diets containing *Origanum majorana* compared with control group. These values demonstrated that meat color of the BUT9 commercial turkeys fed diets containing *Origanum majorana* tend to give degrees from bright, redness and yellowish more than control group (*i.e.* improved meat quality). Also, Florou-Paneri *et al.* (2006) reported that improve the oxidative stability of meat of broiler fed dietary oregano compared to the control group. Badee *et al.* (2013) showed that marjoram oil might work as reducing agent which could reduce metmyoglobin formation to some degree and improve of the color values. Li *et al.* (2006) showed that the bioactive components in the aromatic plants possess the ability to protect the body from damage caused by free radicals induced oxidative stress by quenching singlet oxygen and inducing cytochrome or other enzymes and they also contain antimicrobial compounds which contribute to the retardation of microbial growth on foods especially meat products.

Table (8): Least square means, standard errors (S.E) and coefficients of variation (CV%) for meat physical parameters of BUT9 turkeys fed on diets contained 0.0 (control), 0.4% (T1) or 0.8% (T2) *Origanum majorana*.

		Control	T1	T2	Sig.	Male	Female	Sig	Overall mean
	Mean	2.13[a]	2.13[b]	1.63[c]		2.08	1.83		1.96
Tenderness (breast)	SE	0.13	0.13	0.13	****	0.17	0.17	****	0.12
	CV	8.32	8.32	10.88		13.86	15.75		14.92
	Mean	2.63[a]	2.50[a]	2.00[b]		2.42	2.33		2.38
Tenderness (thigh)	SE	0.13	0.00	0.00	*	0.22	0.17	NS	0.13
	CV	6.73	0.00	0.00		15.80	12.37		12.89
	Mean	39.10	45.75	47.60		41.80	46.50		44.15
W.H.C (breast)	SE	1.00	5.55	0.50	NS	2.72	3.33	NS	2.19
	CV	3.62	17.16	1.49		11.26	12.41		12.16
	Mean	40.85	45.05	48.30		43.80	45.67		44.73
W.H.C (thigh)	SE	0.05	3.95	1.10	NS	2.80	2.49	NS	1.73
	CV	0.17	12.40	3.22		11.07	9.44		9.45
	Mean	5.77	5.60	5.48		5.68	5.55		5.62
Breast pH	SE	0.03	0.17	0.01	NS	0.10	0.09	NS	0.07
	CV	0.74	4.17	0.26		3.17	2.96		3.00
	Mean	5.71	5.55	5.41		5.60	5.51		5.56
Thigh pH	SE	0.01	0.15	0.02	NS	0.11	0.10	NS	0.07
	CV	0.25	3.82	0.52		3.30	3.00		2.97
	Mean	0.46[a]	0.40[ab]	0.33[b]		0.41	0.38		0.39
Uric acid in meat	SE	0.01	0.03	0.03	NS	0.03	0.05	NS	0.03
	CV	1.55	10.61	10.88		12.91	21.29		16.13
	Mean	2.75[a]	2.15[ab]	1.70[b]		2.17	2.23		2.20
Uric acid in liver	SE	0.15	0.15	0.10	NS	0.38	0.23	NS	0.20
	CV	7.71	9.87	8.32		30.73	18.10		22.45
	Mean	3.75	3.53	3.35		3.70	3.38		3.54
Uric acid in blood	SE	0.05	0.13	0.30	NS	0.05	0.19	NS	0.11
	CV	1.89	5.01	12.66		2.34	9.62		7.75
	Mean	64.86[a]	62.17[b]	67.00[a]		64.36	65.16		64.76
Lightness (thigh)	SE	1.16	0.73	1.18	**	1.03	0.98	NS	0.70
	CV	5.36	3.53	5.56		5.96	5.63		5.72
	Mean	66.83[a]	64.56 [b]	67.29[a]		64.68	67.85	***	66.26
Lightness (breast)	SE	1.00	1.99	0.51	**	1.26	0.57		0.75
	CV	4.49	9.23	2.41		7.30	3.16		5.95
	Mean	4.44b	5.30ab	6.44a		5.55	5.31		5.43
Redness (thigh)	SE	0.38	0.15	0.75	*	0.63	0.21	NS	0.33
	CV	25.53	8.22	36.75		42.73	14.59		31.95
	Mean	3.81 [b]	3.98 [b]	5.36[a]		4.05	4.79		4.42
Redness (breast)	SE	0.50	0.22	0.63	NS	0.44	0.42	NS	0.31
	CV	39.61	16.47	37.35		40.64	33.12		36.88
	Mean	4.08 [b]	3.51 [b]	4.98 [a]		4.00	4.44		4.22
Yellowness (thigh)	SE	0.51	0.20	0.20	**	0.32	0.30	NS	0.22
	CV	37.67	17.41	12.80		29.58	25.38		27.38
	Mean	4.81 [b]	6.39 [ab]	7.12 [a]		4.80	7.49		6.14
Yellowness (breast)	SE	0.70	0.67	0.99	NS	0.65	0.55	**	0.49
	CV	43.43	31.66	43.87		50.64	27.29		42.21

a, b, ... Treatment means having different superscript litters within the same raw are significantly different at ($P \leq 0.05$) using Duncan's Multiple Range test.

The control group gave the highest values of thigh and breast pH, thigh and breast tenderness, uric acid in blood, liver and meat except that for water holding capacity compared with two *Origanum majorana* treatments. Teixeira *et al.* (2013) reported that the lower pH values reflect antimicrobial properties of marjoram oil which reduces the accumulation of basic substances. Cornforth (1994) stated that meat with high pH has a higher water binding capacity, hence making it appear darker. Moreover, Kauffman and Marsh (1987) and Cornforth (1994) reported that when the pH of the meat is above the iso-electric point of the myofibril proteins in the meat, water molecules are tightly bound, and the meat appears darker in color. El-Sharkawy (1984) showed that meat containing a relatively higher protein is capable to hold much water than those of a lower protein containing meat.

The results proved significant sex effects on breast meat tenderness, lightness and yellowness breast color. These values demonstrated that meat color of females tend to give degrees of lightness, redness and yellowish better than that of males. El-Naggar *et al*. (2000) reported that most sex differences were not significantly detectable for most meat physical characteristics at various age stages. However, Smith *et al.* (2015) showed that sex affect breast meat quality of duck and the values of lightness and yellowness were higher in male than female. The least square means showed that males recorded higher values of pH, uric acid in blood, liver as well as tenderness of thigh and breast meat while the females gave the highest WHC of thigh and breast values. Hartman *et al*. (2006) reported that the concentration of plasma uric acid in birds was high in both males and females chickens and levels in males were relatively higher at evaluated ages.

These results provided evidences that diets containing *Origanum majorana* had no adverse and may have beneficial effects on turkey meat and did not restrict the use of turkey meat for further processing and product added value. Also, it seemed that females' meat quality is rather better in its show performance than that of males.

CONCLUSION

It can be concluded that supplementing of *Origanum majorana* to basal diet improved growth performance, meat quality. Also, no adverse and restrict effects of using turkey meat.

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تأثير إضافة البردقوش على الأداء الإنتاجي، صفات الدم وجودة اللحم للرومى التجاري "BUT9"

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أجريت هذه الدراسة لتقييم تأثير إضافة نبات البردقوش على الأداء الإنتاجي، مواصفات الذبيحة، صفات الدم وجودة اللحم لطيور الرومي التجارية BUT9. ٥٧ طائر من الرومي BUT9 عند عمر ٨ أسابيع (عمر إبتدائى بمتوسط وزن ١٥٣٣± ٢٥.٣٢جم) قسمت عشوائيا إلى ٣ معاملات. تكونت كل معاملة من عدد ٢ مكررة مع عدد غير متساوي من الطيور في كل معاملة. المجوعة الأولى من الكتاكيت غذيت على عليقة المقارنة (T0) والمجموعتين الأخيرتين من طيور الرومي غذيتا على عليقة المقارنة مع إضافة نبات البردقوش بتركيز ٠.٤ % **(T1)** و ٠.٨ % **(T2)** على التوالي حتى عمر ١٩ أسبوع (عمر التسويق).
أظهرت النتائج أن وزن الجسم والزيادة في وزن الجسم تحسنت معنويا، كذلك انخفضت كمية الغذاء المأكول وحدث تحسن فى معدل التحويل الغذائي بالتغذية على البردقوش. النتائج أوضحت أن إضافة البردقوش عند مستوى ٠.٤% (T1) حسنت بدون معنوية وزن الذبيحة المجوف. مستويات الكلوسترول والكرياتنين لمعاملات البردقوش انخفضتا معنويا بالمقارنة بمعاملة الكنترول. كذلك فإن إضافة البردقوش إلى عليقة الكنترول ادى إلى زيادة قيم كل من الألبومين والجلوبلين والبروتين الكلى بينما نقص قيم كل من AST, ALT والدهون الثلاثية ولكن بدون تأثير معنوي.
أظهرت النتائج وجود تأثير معنوي للمعاملات على صفات الطراوة للحم الصدر، سطوع اللون للحم الصدر والفخذ، وإحمرار واصفرار اللون للحم الفخذ. عموما، فأن أفضل القيم لمقاييس جودة اللحم سجلت للمجموعتين المغذاة على علائق تحتوى على البردقوش مقارنة بعليقة الكنترول.
يبدو من تلك النتائج أن إضافة البردقوش إلى عليقة الكنترول يحسن كل من الأداء الإنتاجي وصفات الدم وجودة اللحم للرومي BUT9.