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RESEARCH ARTICLE

# Comparison of the Growth Performance and Carcass Characteristics of Two Slow-Growing Broiler Genotypes Fed Diets Supplemented with Dry Oregano (*Origanum vulgare* L.) or Lemon Balm (*Melissa officinalis* L.) Leaves under the Organic System [1]

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## Summary

This study was conducted to determine the growth performance and carcass characteristics of two slow-growing broiler genotypes (Hubbard S757 and Hubbard Grey Barred JA) fed diets supplemented with dry oregano (*Origanum vulgare* L. or lemon balm leaves (*Melissa officinalis* L.) as growth promoter source under an organic housing system. In this study 240 chicks (mixed-sex) were allocated randomly into 4 experimental groups according to a 2 x 2 factorial arrangement for 2 broiler genotypes and 2 diets. The effects of dry herb leaves and genotype x herb leaves interaction on studied parameters were not significant at all weeks of age (P>0.05), except neck (%). Body weight , body weight gain, feed efficiency, carcass weight and yield, leg weight and yield, breast weight and yield, back weight and yield, edible giblets weight and yield of Hubbard S757 genotype were higher (P<0.05) than those of Hubbard Grey Barred JA genotype. The female breast (P<0.01) and edible giblets yield (P<0.05) were superior to those of males. These results show that herb leaves used as a growth promoter source under organic housing system did not affect the studied parameters and that in terms of these parameters, and subsequent Hubbard S757 genotype were superior to Hubbard Grey Barred JA genotype.

***Keywords:*** *Organic system, Slow growing chicken, Growing rate, Herb leaves, Carcass traits*

# Organik Sistemde Kuru Kekik (*Origanum vulgare* L.) ve Melisa (*Melissa officinalis* L.) Katkılı Yemlerle Beslenen Yavaş Gelişen İki Etlik Piliç Genotipinin Büyüme Performansı ve Karkas Özelliklerinin Karşılaştırılması

## Özet

Bu araştırma, organik sisteminde yavaş gelişen Hubbard S757 ve Hubbard Gri çubuklu JA etlik piliçlerin; diyetlerine kuru kekik (*Origanum vulgare* L.) ve oğul otu (*Melissa officinalis* L.) yaprakları ilave edilmesinin performans ve karkas özelliklerine etkisini saptamak amacıyla yürütülmüştür. Denemede toplam 240 adet günlük etlik civciv (karışık cinsiyet) 2 genotip, 2 diyet ve 3 tekerrürlü olarak faktöriyel deneme deseninde rastgele 4 gruba dağıtılmıştır. Boyun randımanı hariç bütün haftalarda araştırmadaki parametreler üzerine bitki yaprakları ve bitki yaprakları ile genotip interaksiyonunun etkileri gözlenmemiştir (P>0.05). Hubbard S757 genotipinin canlı ağırlık, canlı ağırlık artışı, yemden yararlanma, karkas ağırlığı ve randımanı, but ağırlığı ve randımanı, göğüs ağırlığı ve randımanı, sırt ağırlığı ve randımanı, yenilebilir iç organ ağırlığı ve randımanı Hubbard gri çubuklu JA genotipindekilerden yüksek bulunmuştur (P<0.05). Dişilerin oransal göğüs parçası (P<0.01) ve yenilebilir iç organları (P<0.05) erkeklerinkinden yüksek olmuştur. Bu araştırmanın sonucunda, büyümeyi teşvik edici olarak kullanılan bitki yapraklarının ele alınan özelliklere etkisi saptanmamıştır ve bu parametreler bakımından Hubbard S757 genotipi Hubbard gri çubuklu JA genotipinden üstün bulunmuştur.

***Anahtar sözcükler:*** *Organik sistem, Yavaş gelişen genotip, Büyüme oranı, Bitki yaprakları, Karkas özellikleri*

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# INTRODUCTION

Due to the recent consumer demands for organic foods, organic poultry production has become a growing segment of the poultry industry. The use of fast growing broilers in these systems causes physiologic and metabolic problems and criticism because of the lack of consideration of animal welfare. Slow growing chickens are more suitable for organic and free-range systems and they reach to 2.2-2.5 kg body weight (BW) in 80-120 days, because organs and muscles grow in harmony and the possible metabolic and physiologic problems caused by fast growing decreases [1].

In Europe, organic poultry production is regulated by different national and international rules regarding the choice of genotype. EC regulation 1804/99 and the Network for Animal Health and Welfare in Organic Agriculture's final recommendation [2] suggest using local, slow growing breeds for their higher rusticity and capacity to use outdoor areas and pasture [3]. Slow-growing genotypes, which were designed for outdoor production [4], have growing period of at least 81 days according to European organic programs [5]. Slow-growing birds are more adapted to natural systems, and the quality of their meat is more appropriate for a specialty or gourmet market [6,7].

Thus, some researchers [3,8] stated that slow-growing chickens possess a good aptitude for pasture, which enhances the dietary intake of bioactive substances (i.e vitamins, antioxidants, and fatty acids) contained in the forage. In addition, the free-range chicken can consume young vegetative plant material and live protein sources, such as insects, worms, and grubs, which could reduce the feed cost that accounts for approximately 70% of the total variable costs [9,10] stated that compared with conventional free-range and organic systems, the pastured poultry is likely to induce considerably greater levels of pasture consumption, and thus it is an ideal system to evaluate the nutritional impact of pasture intake in broiler performance and carcass quality.

The removal of antibiotic growth promoters from poultry diets has triggered researches for suitable natural alternatives to combat the increased potential for bacterial disease development in organic growing flocks. Actually, the ban of some feed additives (antibiotics, coccidiostatic, and the other artificial agents which are helpful to growing) in poultry nutrition and its subsequent associated concerns has created efforts to use different plant compounds as possible natural alternatives [11,12].

Recently, the researchers have endeavored to use some phytobiotics (herbs and herbal products) as alternatives to in-feed antibiotics for young animals and birds [13-15]. Phytobiotics are incorporated in poultry diets to replace synthetic products in order to stimulate or promote the effective use of feed nutrients, which may subsequently result in more rapid body weight gain (BWG), higher production rates, the stimulation of appetite, improved feed efficiency, the improvement of endogenous digestive enzyme secretion, activation of immune response and antibacterial, antiviral, antioxidant and antihelminthic actions [16,17].

Oregano (*Origanum vulgare* L., OV) is an aromatic plant with a wide distribution throughout the Mediterranean area and Asia [18]. It has been suggested that the oregano possesses in vitro antimicrobial [17,19], antifungal [20,21], insecticidal [22] and antioxidant [23] properties. Lemon balm (*Melisa officinalis* L., MO) is the most common herbs used in our traditional folk herbal medicine. However, little is known about the antioxidant properties of their extracts and essential oils in poultry [24].

Lemon balm is known as a herb with high content of antioxidant active substances [24] and the antimicrobial activity [25]. Some molecules responsible for the antioxidative properties of natural plant extracts are flavonoids and phenolic compounds [26]. Research is needed to determine the suitability of different slow-growing genotypes fed dietary herbal supplement for Turkey organic and natural production systems that provide outdoor access with regard to overall growth performance and consumer acceptability.

To our knowledge, the comparison of the performance and carcass characteristics of two different slow growing genotypes fed with supplementation of dry oregano (*Origanum vulgare* L.) or lemon balm (*Melissa officinalis* L.) leaves, which are among the alternative growth promoters, into compound feed has not been reported in the organic rearing system. Therefore, the present study was conducted to compare the growth performance and carcass characteristics of two different slow growing genotypes fed using dietary dry oregano or common balm leaves as growth promoter supplement.

# MATERIALS and METHODS

The study was carried out at Cumhuriyet University. Two hundred and forty slow growing chickens consisting of equal numbers of Hubbard S757 (S757) and Hubbard Grey Barred JA (GB-JA) strains were utilized for the investigation. In the study, 240 male and female day old chicks were weighed, identified with a wing number and randomly allocated to 4 treatment combinations with 3 replications in a 2 (genotypes: S757, GB-JA) X 2 (diets: 10g *Origanum vulgare*/kg basal diet, + 10 g *Melissa officinalis*/kg basal diet) factorial arrangement in a complete randomized design. The experiment was approved by the Ethics Committee of the University of Cumhuriyet in Sivas, Turkey (20.06.2011/50).

There were 12 mobile chicken house (1.5 x 1.5 m), each containing 20 birds (wing numbered) per replication with 10 birds/m$^2$ stocking density placed in each of the 100 m$^2$ (space outside at least 4 m$^2$/bird for EU standards) grazing area. Moving shelters are secure and allow chickens access to sunlight and fresh air, while allowing them to forage and scratch the ground for food. It is made from wood and includes adequate [27] drinkers, feeders, heater and perch. The surrounding of the current research area was covered by plastic netting material against predatory and foreign birds. The experiment was ended at the end of the 14$^{th}$ week.

Starter (0-28 days), grower (29-81 days) and finisher (82-98 days) diets were formulated to provide adequate levels of all nutrients for broilers *(Table 1)*. All birds used in the experiment were cared for according to applicable recommendations of the National Research Council [28]. The basal diets were supplemented with levels of OV and MO to provide 10 g/kg of total OV and MO in the diet from the first 15 day. The specified chemical compositions of the organic diets are presented in *Table 1*, and certified as organic feed materials used. Creating artificial poultry pasture, *Lotus corniculatus* (50%) and *Bromus inermis* (50%) are used a combination of both. Organically grown herbs of oregano (*Origanum vulgare* L.) or lemon balm (*Melissa officinalis* L.) were harvested and the leaves were separated from the twigs. The herb material consisted of leaves that were spread out on a concrete floor and allowed to dry for a period of 3-4 days under room temperature.

The research in regard to the animal production, feeds and pasture was carried out according to the principles and implementation of regulation on organic agriculture [27] published by the Republic Of Turkey, Ministry of Food, Agriculture and Livestock. Barley, wheat bran, white wheat, rye, corn, triticale, oat and soybean meal provided from Buğrahan Co.Ltd. as certified organic, and the research has been followed by an independent audit organization ORTAR control certification Co.Ltd..

Initially, 14 day-old chicks were housed in mobile housing, feed and water were provided *ad libitum*, and they were not allowed go out for grazing. After this period chicks were allowed to go out and graze freely and all basal feed and water were provided between the hours 07.00-19.00 *ad libitum* for all chicks during the experimental period. Natural day length lighting is provided for chickens from the first day to slaughter age without additional lighting. The research has been conducted from 14 June to 30 September 2012. Natural lighting time at the beginning and at the end of the experiment was recorded 15 h 8 min and 11 h 57 min, respectively.

Ceramic heaters are used for heating which are sources of Far Infrared Rays and do not spread light. As required by Türkoğlu *et al.*[29], temperature at chick level was decreased every week in line with their growth to reach 20°C in the fourth week, and was then maintained at this temperature until slaughter. The chicks were vaccinated against Newcastle diseases (day old and 14 day), gumboro (on 7 and 21 days) and Infectious Bronchitis virus (IBV, 28 day). Any drug or antibiotic was not used to increase efficiency or against diseases.

***Table 1.*** *Ingredients and composition of experimental organic diets (%)*
***Tablo 1.*** *Araştırmada kullanılan organik rasyonun yapısı ve içeriği (%)*

| **Feed Ingredients** | **0–28 days** | **29–81 days** | **82–98 days** |
|---|---|---|---|
| Barley | 3.45 | 4.50 | 4.50 |
| Vegetable oil | 4.36 | 5.00 | 5.00 |
| Wheat bran | 5.00 | 5.00 | 5.00 |
| White Wheat | 12.40 | 4.00 | 4.00 |
| Rye | 3.00 | 4.00 | 4.00 |
| Corn | 40.00 | 20.00 | 20.00 |
| Triticale | - | 22.00 | 32.00 |
| Oat | 2.10 | 5.00 | - |
| Fish meal | 7.30 | 5.00 | - |
| Soybean meal | 20.00 | 22.00 | 22.00 |
| Dicalcium phosphate | 1.10 | 2.10 | 2.10 |
| Limestone | 0.74 | 0.80 | 0.80 |
| Salt | 0.30 | 0.30 | 0.30 |
| Vitamin-mineral premix* | 0.25 | 0.30 | 0.30 |
| **Calculated nutrients composition (g/kg)** | | | |
| ME (MJ/kg) | 13.00 | 12.72 | 12.91 |
| Dry matter | 899.00 | 903.00 | 901.00 |
| Crude protein | 197.00 | 201.00 | 180.00 |
| Crude ash | 4.70 | 5.90 | 4.80 |
| Lysine | 10.80 | 10.60 | 8.50 |
| Methionine + Cystine | 6.60 | 6.70 | 5.90 |
| Threonine | 7.30 | 7.20 | 6.20 |
| Calcium | 10.00 | 11.60 | 9.00 |
| Sodium | 1.90 | 1.80 | 1.50 |
| Tryptophan | 2.40 | 2.60 | 2.50 |
| Linoleic acid | 31.9 | 32.1 | 31.3 |

** Each kg of vitamin-mineral premix contained: vit A, 4.400.000 IU; vit $D_3$, 1.600.000 IU; vit E, 20.000 mg; vit $K_3$, 1.600 mg; vit $B_1$, 1.200 mg; vit $B_2$, 3.200 mg; vit $B_3$, 20.000 mg; vit $B_5$, 6.000 mg; vit $B_6$, 1.600 mg; vit $B_9$, 800 mg; vit $B_{12}$, 8 mg; biotin, 80 mg; antioxidant dry, 50.000 mg; Cu, 6.000 mg; Fe, 20.000 mg; Mn, 48.000 mg; Se, 80 mg; Zn, 40.000 mg; Co, 80 mg; I, 500 mg*

Weekly BW of birds was individually measured, feed consumption (FC) and viability were calculated for each group during the 14$^{th}$ week of the study. The average feed consumption of the group was used to calculate the individual feed conversion ratio (FCR). A total of 48 chicks were randomly chosen and weighed by selecting two male and two female birds from each subgroup. After 10 h fasting, birds were slaughtered to determine the carcass traits in 14 weeks. In order to determine hot carcass weight, edible giblets and abdominal fat was removed. Cold carcass weight was determined after chilling the carcasses at +4°C for 24 h. Cold carcass weight was divided by the slaughter weight to determine cold carcass yield. Carcass parts weights (legs, breast, wings, back, neck, edible giblets) were determined according to the Institute of Turkish Standards [30,31] scattering technique. Carcass yield (dressing percentage) and weight of edible giblets were expressed as a percentage of BW just before slaughter (g/100 g BW), and carcass parts were expressed as a percentage of the cold (chilled) carcass weight (CW) without giblets (g/100 g CW).

The 48 birds (fasted for 10 h with free access to water) were slaughtered without stunning under Turkish slaughter procedure (these birds were slaughtered under conditions acceptable to the appropriate ethics committee) by severing the throat and major blood vessels in the neck in local processing plant in organic system [31]. The significance of the mean scores between the treatments for BW, BWG, FC, FCR, CW and carcass yield were studied by multifactor ANOVA, including the effects of genotype, herb leaves, sex and genotype and their interaction. The statistical analysis was conducted using the SPSS 16.0 (Inc. Chicago. IL. USA) program. Treatment effects were considered to be significant at P<0.05. Data were expressed as mean values with pooled standard errors (standard errors of the mean, SEM).

## RESULTS

During the entire experimental period birds showed excellent health (no signs of footpad burns and good plumage state). There were no reports of predation because the 12 experimental plots were fenced to keep out foxes and were covered with nylon nets to avoid avian predation.

In the present study, BW, BWG and FC and the feed efficiency of two different genotypes fed with two dry herb leaves during the experiment were presented in *Table 2* and *Table 3*, respectively. Significant differences were observed in BW, BWG and FCR, but not FC due to genotypes.

Mean values for carcass measurements derived from dissection and proportions of carcass parts are given in *Table 4* and *Table 5*. Weight of hot and cold carcass, legs, breast, wings, back, neck and edible giblets were significantly higher (P<0.01) for S757 genotype chicken than GB-JA genotype. Weight of abdominal fat have also significant difference between genotypes (P<0.05; *Table 4*).

Genotype by dietary dry herb leaves interaction was not significant at all weeks of age for BW, BWG, FC and FCR. All carcass parts yields did not effect by genotype *X* herb leaves interaction except neck yield (P>0.05). Concerning genotype *X* herb leaves and genotype *X* herb leaves *X* sex effects had no significant influence on mass of carcass parts (P>0.05; *Table 4* and *Table 5*).

Weight of hot and cold carcass, legs, breast, wings, back, neck and edible giblets and abdominal fat did not differ significantly between both dry herb leaves (P>0.05). As the weight of hot and cold carcass, legs, breast, wings, back, neck and edible giblets and abdominal fat yields

***Table 2.*** *The BW and BWG of two different slow growing broiler genotypes*
***Tablo 2.*** *Yavaş gelişen iki farklı etlik piliç genotipinde canlı ağırlık ve canlı ağırlık artışları*

| Items | | | Body Weight, g | | | | Body Weight Gain, g | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Age (week) | | | | Age (week) | | | |
| Genotype [1] | Herb [2] | Sex [3] | 0 | 4 | 8 | 14 | 0-4 | 4-8 | 8-14 | 0-14 |
| GB-JA | OV | M | 35.26 | 216.50 | 494.28 | 2143.22 | 172.73 | 483.70 | 1438.57 | 2095.00 |
| | | F | 34.48 | 178.17 | 416.30 | 1614.11 | 149.16 | 397.02 | 1020.95 | 1567.13 |
| | MO | M | 35.11 | 207.67 | 516.59 | 2173.00 | 168.80 | 499.21 | 1445.35 | 2113.36 |
| | | F | 35.40 | 185.50 | 467.62 | 1641.06 | 168.95 | 427.17 | 1069.92 | 1666.04 |
| S757 | OV | M | 36.63 | 306.55 | 749.63 | 2847.33 | 255.48 | 692.49 | 1876.35 | 2824.31 |
| | | F | 35.63 | 273.83 | 648.93 | 2184.11 | 240.69 | 570.39 | 1368.48 | 2179.56 |
| | MO | M | 36.62 | 304.78 | 764.28 | 2792.83 | 267.17 | 686.70 | 1852.79 | 2806.66 |
| | | F | 35.33 | 285.17 | 681.23 | 2256.33 | 257.42 | 587.51 | 1426.24 | 2271.17 |
| SEM | | | 0.175 | 9.043 | 21.610 | 67.79 | 8.287 | 17.248 | 43.954 | 66.678 |
| **Main and interaction effects** | | | | | | | | | | |
| Genotype | | | ** | ** | ** | ** | ** | ** | ** | ** |
| Herb leaves | | | - | NS | NS | NS | NS | NS | NS | NS |
| Sex | | | * | * | ** | ** | NS | ** | ** | ** |
| [4] G X H | | | - | NS | NS | NS | NS | NS | NS | NS |

[1] ***GB-JA***=*Hubbard Grey Barred JA;* ***S757***=*Hubbard S757;* [2] ***OV***= *Origanum vulgare;* ***MO***= *Melissa officinalis;* [3] ***M*** *= male;* ***F*** *= female;* [4] *Genotype X Herb leaves;* **P<0.05; **P<0.01;* ***NS***= *P>0.05;* **SEM:** Standard eror of the mean

***Table 3.*** *The feed consumption and feed convertion ratio of two different slow growing broiler genotypes*
***Tablo 3.*** *Yavaş gelişen iki farklı etlik piliç genotipin yem tüketimi ve yemden yararlanma oranları*

| Items | | Feed Consumption (g) | | | | Feed Consumption Ratio (g feed:g weigth gain) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Age (week) | | | | Age (week) | | | |
| Genotype [1] | Herb [2] | 0 – 4 | 4 – 8 | 8 – 14 | 0 – 14 | 0 – 4 | 4 – 8 | 8 – 14 | 0 – 14 |
| GB-JA | OV | 687.40 | 1424.78 | 4945.45 | 6370.24 | 4.21 | 3.17 | 3.94 | 3.41 |
| | MO | 770.91 | 1461.50 | 5187.31 | 6648.81 | 4.77 | 3.26 | 4.16 | 3.58 |
| S757 | OV | 719.06 | 1423.28 | 5125.32 | 6548.61 | 2.99 | 2.32 | 3.26 | 2.70 |
| | MO | 768.74 | 1428.00 | 5189.75 | 6617.75 | 2.95 | 2.31 | 3.29 | 2.70 |
| SEM | | 13.739 | 18.548 | 64.863 | 80.921 | 0.251 | 0.149 | 0.129 | 0.130 |
| Main and interaction effects | | | | | | | | | |
| Genotype | | NS | NS | NS | NS | ** | ** | ** | ** |
| Herb leaves | | * | NS | NS | NS | NS | NS | NS | NS |
| [3] G X H | | NS | NS | NS | NS | NS | NS | NS | NS |

[1] ***GB-JA****=Hubbard Grey Barred JA;* ***S757****=Hubbard S757;* [2] ***OV****= Origanum vulgare;* ***MO****= Melissa officinalis;* [3] *Genotype X Herb leaves;* ****P<0.05; **P<0.01;*** ***NS****= P>0.05;* ***SEM:*** Standard eror of the mean

***Table 4.*** *The carcass characteristics of two different slow growing broiler genotypes in organic system (g)*
***Tablo 4.*** *Organik sistemde yavaş gelişen iki farklı genotipin karkas özellikleri (g)*

| Items | | | Slaughter (g) | Hot Car. (g) | Cold Car. (g) | Legs (g) | Breast (g) | Wings (g) | Back (g) | Neck (g) | E. Giblets (g) | Abdominal Fat (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Genotype [1] | H [2] | S [3] | | | | | | | | | | |
| GB-JA | OV | M | 2113 | 1473 | 1438 | 469 | 279 | 151 | 441 | 72 | 79 | 34 |
| | | F | 1628 | 1150 | 1112 | 347 | 264 | 121 | 343 | 44 | 63 | 28 |
| | MO | M | 2143 | 1480 | 1447 | 481 | 270 | 148 | 466 | 68 | 76 | 34 |
| | | F | 1639 | 1154 | 1115 | 337 | 228 | 123 | 351 | 63 | 63 | 27 |
| S757 | OV | M | 2821 | 1998 | 1951 | 614 | 420 | 204 | 641 | 73 | 94 | 46 |
| | | F | 2151 | 1528 | 1497 | 450 | 356 | 157 | 473 | 53 | 80 | 38 |
| | MO | M | 2872 | 2048 | 1998 | 628 | 427 | 211 | 654 | 69 | 99 | 47 |
| | | F | 2237 | 1549 | 1525 | 444 | 347 | 156 | 519 | 50 | 82 | 32 |
| SEM | | | 65.31 | 47,86 | 47,28 | 15,31 | 11,76 | 4,70 | 17,17 | 1,92 | 2,02 | 2,47 |
| Main and interaction effects | | | | | | | | | | | | |
| Genotype | | | ** | ** | ** | ** | ** | ** | ** | ** | ** | * |
| Herb leaves | | | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| Sex | | | ** | ** | ** | ** | ** | ** | ** | ** | ** | NS |
| [4] G X H | | | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| [5] G X S | | | * | * | * | NS | NS | ** | NS | NS | NS | NS |
| [6] H X S | | | NS | NS | NS | NS | NS | NS | NS | * | NS | NS |
| [7] G X H X S | | | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

[1] ***GB-JA*** *= Hubbard Grey Barred JA;* ***S757*** *= Hubbard S757;* [2]***OV****= Origanum vulgare;* ***MO****= Melissa officinalis;* [3] ***M*** *= male;* ***F*** *= female;* [4] *Genotype X Herb leaves;* [5] *Genotype X Sex;* [6] *Herb leaves X Sex;* [7] *Genotype X Herb leaves X Sex;* ****P<0.05; **P<0.01;*** ***NS****= P>0.05;* ***SEM:*** Standard eror of the mean

did not differ significantly between both dry herb leaves (P>0.05). Wings and neck yield had significant differences in herb leaves *X* sex interaction (P<0.05).

## DISCUSSION

### *Effect of Genotype*

The BW and BWG of S757 chickens were higher than GB-JA genotype, while those of chickens whose diets were supplemented by dry oregano or lemon balm leaves did not differ significantly during all weeks in the organic system. The growth rates of genotypes studied under the conditions of the present experiment were accurately measured for the GB-JA and S757 and their live market weights were different from one another. From 3 to 14 weeks of age, S757 genotype grew faster (P<0.05) than GB-JA genotype. FC of two different slow growing broiler

***Table 5.*** *The carcass characteristics of two different slow growing broiler genotypes in organic system (%)*
***Tablo 5.*** *Organik sistemde yavaş gelişen iki farklı genotipin karkas özellikleri (%)*

| Items | | | Hot Car. (%) | Cold Car. (%) | Legs (%) | Breast (%) | Wings (%) | Neck (%) | E. Giblets (%) | Abdominal Fat (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Genotype** [1] | **H** [2] | **S**[3] | | | | | | | | |
| GB-JA | OV | M | 69.74 | 68.08 | 32.64 | 19.45 | 10.52 | 4.24 | 5.50 | 2.38 |
| | | F | 70.62 | 68.23 | 31.18 | 23.64 | 10.92 | 3.57 | 5.76 | 2.57 |
| | MO | M | 69.03 | 67.51 | 33.26 | 18.65 | 10.27 | 4.32 | 5.33 | 2.34 |
| | | F | 70.37 | 67.99 | 30.31 | 20.50 | 11.08 | 5.27 | 5.74 | 2.45 |
| S757 | OV | M | 70.83 | 69.15 | 31.47 | 21.56 | 10.50 | 4.49 | 4.88 | 2.33 |
| | | F | 70.98 | 69.55 | 30.07 | 23.67 | 10.55 | 4.01 | 5.41 | 2.60 |
| | MO | M | 71.29 | 69.53 | 31.49 | 21.38 | 10.63 | 3.85 | 4.98 | 2.44 |
| | | F | 69.23 | 68.14 | 29.18 | 22.64 | 10.27 | 3.66 | 5.48 | 2.10 |
| SEM | | | 0.29 | 0.26 | 0.23 | 0.39 | 0.09 | 0.12 | 0.09 | 0.14 |
| **Main and interaction effects** | | | | | | | | | | |
| Genotype | | | NS | * | ** | ** | NS | NS | * | NS |
| Herb leaves | | | NS | NS | NS | NS | NS | NS | NS | NS |
| Sex | | | NS | NS | ** | ** | NS | NS | * | NS |
| [4]G X H | | | NS | NS | NS | NS | NS | * | NS | NS |
| [5]G X S | | | NS | NS | NS | NS | NS | NS | NS | NS |
| [6]H X S | | | NS | NS | NS | NS | * | * | NS | NS |
| [7]G X H X S | | | NS | NS | NS | NS | NS | NS | NS | NS |

[1] ***GB-JA***=*Hubbard Grey Barred JA;* ***S757***=*Hubbard S757;* [2]***OV***= *Origanum vulgare;* ***MO***= *Melissa officinalis;* [3] ***M*** *= male;* ***F*** *= female;* [4] *Genotype X Herb leaves;* [5] *Genotype X Sex;* [6] *Herb leaves X Sex;* [7] *Genotype X Herb leaves X Sex; *P<0.05; **P<0.01;* ***NS,*** *P>0.05;* ***SEM:*** Standard eror of the mean

genotypes and both herb leaves treatments were similar during all weeks in the organic system. Feed efficiency of S757 slow growing broiler genotype were greater than GB-JA genotype while those of chickens fed supplemented dry oregano or lemon balm leaves were similar during all weeks in the organic system. It seems possible that slow growing genotypes in organic system could be slaughtered at 12 weeks according to feed efficiency indicators. As it is seen *Table 2* and *Table 3*, slow growing S757 genotype fed with supplemented both dry herb leaves diet showed higher BW, BWG and feed efficiency which were associated with the growing rate. This increasing positive effect is not reflected to their FC. It may be that the genotype S757 have benefited effectively from pasture feeding. Unfortunately, the pasture consumption was not measured in this study, but this parameter may need to be measured in future research to provide better understanding. Fanatico *et al.*[7] claimed that outdoor access has many factors, such as temperature, photoperiod, and light intensity, which are not controlled and are inherently variable. Furthermore, chickens raised outdoors have access to pasture and the forages, insects, and worms that may be available.

These results are consistent with those of Castellini *et al.*[32] suggesting that there are negative effects of the organic rearing system of chickens on BWG and FCR for Ross cockerels aged 56 and 81 days. A possible explanation for this might be that the high fiber content of pasture biomass may limit nutrient utilization and could reduce growth rates and feed efficiency [10]. Sirri *et al.*[33] claimed that FCR, calculated on FC with the exclusion of pasture intake resulted in 4.42 for slow growing genotype was higher than that of current finding. Grashorn and Closterman [34], while studying performance and slaughter characteristics of five slow and one fast growing genotypes for extensive production up to 84 days reported that genotypes differed significantly in BW's (Ross being heavier in this respect). On the other hand, Santos *et al.*[35] and Ponte *et al.*[10] showed significantly higher BW in broiler chickens that had free access to pasture. Similar results were obtained by Bassler and Ciszuk [36], Santos *et al.*[35] and Mikulski *et al.*[37], in FCR.

Breast is the most valuable portion of the chicken carcass in the market; even small differences in breast yield among genotypes could have a significant economic impact. In our experiment, while slow growing chickens showed differences in all carcass characteristics induced by genotype *(Table 4)*, but only cold carcass, legs, breast, and edible giblets yields were significant (P<0.05; P<0.01; *Table 5*).

The S757 genotype had higher cold carcass, edible giblets (P<0.05), legs and breast (P<0.05) yields compared to the GB-JA (P<0.01). Carcass yield was higher than that

(56.8%) of Sirri *et al.*[33] and lower than that (75.9%) of Şekeroğlu and Diktaş [38] in slow growing genotype, while it was similar to those reported by Castellini *et al.*[6], Fanatico *et al.*[7], Dou *et al.*[39], Poltowicz and Doktor [40]. Likewise, Castellini *et al.*[32] and Poltowicz and Doktor [40] showed that birds had access to free range achieved a higher percentage of breast muscle in the carcass. The present findings seem to be consistent with other research [39] which found the results of breast and legs yield (20.17% and 27.65%) of slow growing broiler in free-range system.

The abdominal fat yield of slow growing chickens was higher than those of reported by Castellini *et al.*[6] and Poltowicz and Doktor [40], while was similar than those of reported by Mikulski *et al.*[37] and Dou *et al.*[39]. Wang *et al.*[41] found that the abdominal fat yield of chickens in the free range system was significantly lower than chickens in the indoor treatment. Fat deposition is affected by many factors such as diet, age, genotype, environmental conditions, and sex [37]. On the other hand Narimani-Rad *et al.*[42] have reported that dietary supplementation of 1% oregano could improve broiler performance in conventional system and carcass quality via more weight gain, increase carcass yield and decrease abdominal fat deposition and might be a useful method to the production of organic broilers. It may be the case therefore that the dry lemon balm leaves also was the same effect just as dry oregano leaves on the decreasing abdominal fat of slow growing chickens in organic system.

The finding of genotype *X* sex and genotype *X* herb leaves *X* sex interactions had no significant influence on mass of major carcass parts yield as a percentage of BW.

### *Effect of Herb Leaves*

This study demonstrated that supplementing dietary oregano or lemon balm have no significant effects on all growth performance parameters measured until the age of 14 weeks. Such a case can firstly be explained by the fact that all chickens growing performance showed similar effects in term of both herb leaves treatment. For this reason, using one of two dry herb leaves in organic system may have a positive effect on growing performance of chickens. The second reason for the lack of effects of supplements may be related to the environmental conditions [15]. Recent studies [12,43-45] have engaged fast growing broilers fed supplemented products (leaf, oil or extract) of the oregano or lemon balm in conventional systems, including slow-growing chicken employed in the present study, but the design used in their trial did not conform to the standard of organic production in the EU. Therefore, the results from the present study cannot be compared with the results of Botsoglou *et al.*[23], Roofchaee *et al.*[12], Marcinčák *et al.*[44,45]. Previous observations have shown that herbs, plants extracts, essential oil and/or the main components of the essential oil did not affect BWG, FC or feed efficiency of chickens in indoor conventional systems [11,46-51]. A possible explanation for some of our results may be the lack of adequate research in organic systems. There is a large volume of published studies describing the role of dried leaves, flowers, extracts, essential oil of oregano which possesses substantial antioxidative, antimicrobial and antifungal activity [19,23,52,53]. They actually suppress pathogenic microflora in the gastrointestinal tract of animals and thus reduce mortality during the fattening period, especially in stress period [45]. In fact, they used anticoccidial medication in their diets while it does not actually contain any of the drug in current organic diets. Therefore, Giannenas *et al.*[54] and Aparecida da Silva *et al.*[55] have stated that oregano essential oil exerted an anticoccidial effect which was similar to the ionophorous antibiotic verified through the intestinal morphometric and excretion of oocysts. Mortality can have a large impact on profitability.

The mortality percentage of S757 slow growing chickens fed supplemented oregano or lemon balm leaves was 5% and 5% while those of GB-JA slow growing chickens fed supplemented oregano or lemon balm leaves was 0% and 3.3%, respectively (P>0.05) from 0-14 weeks (for the entire growing periods). It can thus be suggested that viability of genotypes fed with dry lemon balm and oregano leaves were higher due to antimicrobial properties during the experiment. Although previous work has shown higher mortality in fast growing birds compared with slow-growing birds [6,56], there was not difference in mortality in this study, and all treatments had less than 5% mortality.

### *Effect of Sex*

Contrary to expectations, this study did not find a significant difference in terms of BWG between sexes at 0 to 4 weeks. The result of this study indicates that BW in chickens was genotype and sex dependent, that is, birds' BW vary according to their sexes. In this study, males and females of S757 recorded significantly (P<0.01) higher mean values than the GB-JA' sexes in terms of BW and BWG at day old, 4, 8, 14 weeks and 4 to 8, 8 to 14, 0 to 14 weeks, respectively (*Table 2*; P<0.01) as expected.

It seems possible that these results are due to the fact that males consumed a higher level of diet than females for maximal BW and BWG [57]. This could be that generally male growing chickens gained weight faster than females due to higher daily FC in males [58] were also observed in this study. Males genetically have slow feathering growth than females which influence the different needs and use of dietary protein. In addition, it was shown by the study of Li and Nolan [59] that the daily protein synthesis and degradation rate for male broilers were higher than female broilers, suggesting that protein accumulation rate in males was also higher than females [60].

This present experiment showed that male chickens have significant differences on slaughter weight, hot and cold carcass weight, legs, breast, wings, back, neck and edible giblets weight (P<0.01), but no differences in abdominal fat weight in regard to effect of sex on carcass parameters.

With regard to dressing weight and all carcass parts except abdominal fat weight, males and females of S757 chickens had highest mean values than both sexes of GB-JA chickens. This also implies that this trait is genotype and sex dependent, and that S757 performed better, and superior to GB-JA genotype at the same age, and under uniform organic management conditions. Many authors [6,40,61,62] stressed that free-range production system positively affects the quality of bird carcasses by reducing their fat content genotypes due to great locomotory activity and pasture aptitude continued to show low fat deposition [63].

The legs of males were higher than those of female (P<0.01). In terms of overall parts yield, the females had higher percentages of breast (P<0.01) and edible giblets (P<0.05) meat yields than males. Males had greater leg yield (P<0.01). This finding agrees with the studies of Young *et al.*[64], Fanatico *et al.*[7] who also found that females have higher breast meat yields than males, whereas males have higher leg yields. Concerning the cut-up yields, the breast meat and thigh and drumstick yields were higher than those (8.0% vs. 21.6%) of Sirri *et al.*[33]. In another study, Suto *et al.*[65] applied prolonged fattening of one broiler genotype when they measured various carcass traits and reported sex differences. Several factors have been shown to affect CW and carcass yield. These factors include genotype, nutrition, age, BW and sex [64,66]. Genotype x sex interaction have significant differences on slaughter weight, hot and cold carcass, wings weights (P<0.05), while other carcass parts weight were similar to those of both genotype and sex. Male chickens fed dry oregano leaf had the highest neck weight, and female chickens fed dry lemon balm leaf had the lowest neck weight (P<0.05), while for the slaughter weight and other carcass parts were not any significant differences (P>0.05).

The choice of different chicken genotypes in organic farming plays a key role in determining growth performance and carcass traits. The results of the present study suggest that the performance and carcass traits of the slow growing chicken S757 genotype grown under the standards of organic production according to the relevant EU legislation could be better than that of GB-JA slow-growing chickens fed with both supplemented dry oregano or lemon balm leaves.

## REFERENCES

**1. Sarıca M, Yamak US:** Developing slow growing meat chickens and their properties. *Anadolu J Agric Sci,* 25 (1): 61-67, 2010.

**2. Hovi M, Sundrum A, Thamsborg SM:** Animal health and welfare in organic livestock production in Europe: Current state and future challenges. *Livest Prod Sci,* 80, 41-53, 2003.

**3. Bosco AD, Mugnai C, Ruggeri S, Mattioli S, Castellini C:** Processing, products, and food safety: Fatty acid composition of meat and estimated indices of lipid metabolism in different poultry genotypes reared under organic system. *Poult Sci,* 91, 2039-2045, 2012.

**4. Fanatico AC, Born HM:** Label Rouge: Pasture-Raised Poultry in France. ATTRA Publication. National Center for Appropriate Technology, Fayetteville, AR., 2001.

**5. EEC:** Subject: European Economic Community Council Regulation 2092/91 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs. 1991. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1991:198:0001:0015:EN:PDF, *Accessed:* Novembre 2012.

**6. Castellini C, Mugnai C, Dal Bosco A:** Meat quality of three chicken genotypes reared according to the organic system. *Ital J Food Sci,* 14, 401-412, 2002.

**7. Fanatico AC, Cavitt LC, Pillai PB, Emmert JL, Owens CM:** Evaluation of slower-growing broiler genotypes grown with and without outdoor access: Meat quality. *Poult Sci,* 84, 1785-1790, 2005.

**8. Mugnai C, Dal Bosco A, Castellini C:** Effect of rearing system and season on the performance and egg characteristics of Ancona laying hens. *Ital J Anim Sci,* 8, 175-188, 2009.

**9. Walker A, Gordon S:** Intake of nutrients from pasture by poultry. Proc Nutr Soc, 62, 253-256, 2003.

**10. Ponte PIP, Rosado CMC, Crepso JP, Crepso DG, Mourao JL, Chaveirosoares MA, Bras JLA, Mendes I, Gama LT, Prates JAM, Ferreira LMA, Fontes CMGA:** Pasture intake improves the performance and meat sensory attributes of free-range broilers. *Poult Sci,* 87, 71-79, 2008.

**11. Cross DE, McDevitt RM, Hillman K, Acamovic T:** The effect of herbs and their associated essential oils on performance, dietary digestibility and gut microflora in chickens from 7 to 28 days of age. *Br Poult Sci,* 48, 496-506, 2007.

**12. Roofchaee A, Irani M, Ebrahimzadeh MA, Akbari MR:** Effect of dietary oregano (*Origanum vulgare* L.) essential oil on growth performance, cecal microflora and serum antioxidant activity of broiler chickens. *African J Biotechnol,* 10 (32): 6177-6183, 2011.

**13. Rajaian H, Jalaee J, Aghajani A:** *Berberis vulgaris* as growth promoter in broiler chickens. *Int J Poult Sci,* 5 (4): 395-397, 2006.

**14. Sohn SH, Jang IS, Moon YS, Kim YJ, Lee SH, Ko YH, Kang SY, Kang HK:** Effect of dietary siberian ginseng and eucommia on broiler performance, serum biochemical profiles and telomere length. *Korean J Poult Sci,* 35 (3): 283-290, 2008.

**15. Ocak N, Erener G, Ak B, Sungu M, Altop A, Ozmen A:** Performance of broilers fed diets supplemented with dry peppermint (*Mentha piperita* L.) or thyme (*Thymus vulgaris* L.) leaves as growth promoter source. *Czech J Anim Sci,* 53 (4): 169-175, 2008.

**16. Rahimi S, Teymouri Zadeh Z, Karimi Torshizi MA, Omidbaigi R, Rokni H:** Effect of the three herbal extracts on growth performance, immune system, blood factors and Intestinal selected bacterial population in broiler chickens. *J Agr Sci Tech,* 13, 527-539, 2011.

**17. Wareth AAA:** Effect of thyme, oregano and their major active components on performance and intestinal microbial populations of broilers. Institute of Animal Science. Rheinische Friedrich-Wilhelms-Universität. http://hss.ulb.uni-bonn.de/diss_online elektronisch publiziert. Bonn, 2011.

**18. Vokou S, Kokkini S, Bessiere JM:** Geographic variation of greek oregano (*Origanum vulgare* subsp. *hirtum*) essential oils. *Biochem Syst Ecol,* 21, 287-295, 1993.

**19. Sivropoulou A, Paranikolaou E, Nikolaou C, Kokkini S, Lanaras T, Arsenakis M:** Antimicrobial and cytotoxic activities of *Origanum essential* oils. *J Agric Food Chem*, 44, 1202-1205, 1996.

**20. Thompson DP:** Fungitoxic activity of essential oil components on food storage fungi. *Mycologia,* 81, 151-153, 1989.

**21. Daouk RK, Dagher SM, Sattout EJ:** Antifungal activity of the essential oil of *Origanum syriacum* L. *J Food Prot,* 58, 1147-1149, 1995.

**22. Karpouhtsis I, Pardali E, Feggou E, Kokkini S, Scouras ZG,

**Mavragani Tsipidou P:** Insecticidal and genotoxic activities of oregano essential oils. *J Agric Food Chem,* 46, 1111-1115, 1998.

**23. Botsoglou NA, Florou-Paneri, P, Christaki E, Fletouris DJ, Spais AB:** Effect of dietary oregano essential oil on performance of chickens and on iron-induced lipid oxidation of breast, thigh and abdominal fat tissues. *Br Poult Sci,* 43, 223-230, 2002.

**24. Dastmalchi K, Dorman H, Oinonen P, Darwis Y, Laakso I, Hiltunen R:** Chemical composition and *in vitro* antioxidative activity of a lemon balm (*Melissa officinalis* L.) extract. *Food Sci Technol,* 41, 391-400, 2008.

**25. Mahady GB, Pendland SL, Stoia A, Hamill FA, Fabricant D, Dietz BM, Chadwick LR:** *In vitro* susceptibility of *Helicobacter pylori* to botanical extracts used traditionally for the treatment of gastrointestinal disorders. *Phytotherapy Res,* 19, 988-991, 2005.

**26. Lahucky R, Nuernberg K, Kovac L, Bucko O, Nuernberg G:** Assesment of the antioxidant potential of selected plant extracts - *In vitro* and *in vivo* experiments on pork. *Meat Sci,* 85, 779-784, 2010.

**27. OFL:** Organic Farming Legislation. published by the Republic of Turkey Ministry of Food, Agriculture and Livestock. *Turkey Official Gazette.* 27676, 2010.

**28. NRC:** Nutrient Requirements of Poultry. 9th rev. ed., Natl. Acad. Press, Washington, DC., 1994.

**29. Türkoğlu M, Arda, M, Yetişir R, Sarıca M, Erensayın C:** Tavukçuluk Bilmi. 167-185, Otak Form-Ofset, Samsun -Turkey, 1997.

**30. TSE:** Turkish Standards Institute. The rules of chicken carcass cutting up, TS April 5890, Ankara, Turkey, 1997.

**31. Eleroğlu H, Yıldırım A, Işıklı ND, Şekeroğlu A, Duman M:** Comparison of meat quality and fatty acid profile in slow-growing chicken genotypes fed diets supplemented with *Origanum vulgare* or *Melissa officinalis* leaves under the organic system. *Ital J Anim Sci,* 12, e64, 2013.

**32. Castellini C, Mugnai C, Dal Bosco A:** Effect of organic production system on broiler carcas and meat quality. *Meat Sci,* 60, 219-225, 2002.

**33. Sirri F, Castellini C, Bianchi M, Petracci, M, Meluzzi A, Franchini A:** Effect of fast-, medium- and slow-growing strains on meat quality of chickens reared under the organic farming method. *Animal,* 5, 312-319, 2011.

**34. Grashorn MA, Clostermann G:** Mast-und Schlachtleistung von Broilerherkunften fur die Extensivmast. *Arch Geflugelk,* 66, 173-181, 2002.

**35. Santos AL, Sakomura NK, Freittas ER, Fortes CMS, Carrilho ENVM:** Comparison of free range broiler chicken strains raised in confined or semi-confined systems. *Brazilian J Poult Sci,* 7, 85-92, 2005.

**36. Bassler A, Ciszuk PP:** Pilot Studies In Organic Broiler Production-Management And Cross-Breeds. Ekologiskt lantbruk-34, Centre for Sustainable Agriculture Swedish University of Agricultural Sciences, Uppsala, 2002.

**37. Mikulski D, Celej J, Jankowski J, Majewska T, Mikulska M:** Growth performance, carcass traits and meat quality of slower-growing and fast-growing chickens raised with and without outdoor access. *Asian-Aust J Anim Sci,* 24 (10): 1407-1416, 2011.

**38. Şekeroğlu A, Diktaş M:** Yavaş gelişen etlik piliçlerin karkas özelliklerine ve et kalitesine serbest yetiştirme sisteminin etkisi. *Kafkas Univ Vet Fak Derg,* 18 (6): 1007-1013, 2012.

**39. Dou TC, Shi SR, Sun HJ, Wang KH:** Growth rate, carcass traits and meat quality of slow-growing chicken grown according to three raising systems. *Anim Sci P,* 27 (4): 361-369, 2009.

**40. Poltowicz K, Doktor J:** Effect of free-range raising on performance, carcass attributes and meat quality of broiler chickens. *Anim Sci P,* 29 (2): 139-149, 2011.

**41. Wang KH, Shi SR, Dou TC, Sun HJ:** Effect of a free-range raising system on growth performance, carcass yield, and meat quality of slow-growing chicken. *Poult Sci,* 88, 2219-2223, 2009.

**42. Narimani-Rad M, Nobakht A, Shahryar HA, Kamani J, Lotfi A:** Influence of dietary supplemented medicinal plants mixture (Ziziphora, Oregano and Peppermint) on performance and carcass characterization of broiler chickens. *J Med Plants Res*, 5 (23): 5626-5629, 2011.

**43. Giannenas A, Florou-Paneri P, Papazahariadou M, Botsoglou NA, Christaki E, Spais AB:** Effect of diet supplementation with ground oregano on performance of broiler chickens challenged with *Eimeria tenella. Arch Geflugelk,* 68 (6): 247-252, 2004.

**44. Marcinčáková D, Čertík M, Marcinčák S, Popelka P, Šimková J, Klempová T, Petrovič V, Tučková M, Bača M:** Effect of dietary supplementation of *Melissa officinalis* and combination of *Achillea millefolium* and *Crataegus oxyacantha* on broiler growth performance, fatty acid composition and lipid oxidation of chicken meat. *Ital J Anim Sci,* 10 (e43): 165-170, 2011.

**45. Marcinčák S, Popelka P, Zdolec N, Mártonová M, Šimková J, Marcinčáková D:** Effect of supplementation of phytogenic feed additives on performance parameters and meat quality of broiler chickens. *Slov Vet Res,* 48 (1): 27-34, 2011.

**46. Cross DE, Acamovic T, Deans SG, Cdevitt RM:** The effects of dietary inclusion of herbs and their volatile oils on the performance of growing chickens. Br Poult Sci, 43, S33-S35, 2002.

**47. Botsoglou NA, Christaki E, Florou-Paneri P, Giannenas I, Papageorgiou G, Spais AB:** The effect of a mixture of herbal essential oils or α-tocopheryl acetate on performance parameters and oxidation of body lipid in broilers. *S Afr J Anim Sci,* 34, 52-61, 2004.

**48. Hernandez F, Madrid J, Garcia V, Orengo J, Megias MD:** Influence of two plant extracts on broiler performance, digestibility and digestive organ size. *Poult Sci,* 83, 169-174, 2004.

**49. Bampidis VA, Christodoulou V, Florou-Paneri P, Christaki E, Chatzopoulou PS, Tsiligianni T, Spais AB:** Effect of dietary dried oregano leaves on growth performance, carcass characteristics and serum cholesterol of female early maturing turkeys. *Br Poult Sci,* 46, 595-601, 2005.

**50. Barreto MSR, Menten JFM, Racanici AMC, Pereira PWZ, Rizzo PV:** Plant extracts used as growth promoters in broilers. *Braz J Poultry Sci,* 10, 109-115, 2008.

**51. Brenes A, Roura E:** Essential oils in poultry nutrition: Main effects and modes of action. *Anim Feed Sci Tech,* 158, 1-14, 2010.

**52. Tsimidou M, Papavergou E, Boskou D:** Evaluation of oregano antioxidant activity in mackerel oil. *Food Res Internat,* 28, 431-433, 1995.

**53. Ozcan M, Boyraz N:** Antifungal properties of some herb decoctions. *Eur Food Res Technol,* 212, 86-88, 2000.

**54. Giannenas I, Florou-Paneri P, Papazahariadou M, Christaki E, Botsoglou NA, Spais AB:** Effect of dietary supplementation with oregano essential oil on performance of broilers after experimental infection with *Eimeria tenella. Archiv für Tierernährung*, 57 (2): 99-106, 2003.

**55. Aparecida da Silva M, Mirelly de Sousa Pessotti B, Freitas Zanini S, Luiz Colnago G, Alves Rodrigues MR, de Carvalho Nunes L, Santos Zanini M, Freire Martins IV:** Intestinal mucosa structure of broiler chickens infected experimentally with *Eimeria tenella* and treated with essential oil of oregano. *Ciência Rural Santa Maria,* 39 (5): 1471-1477, 2009.

**56. Lewis PD, Perry GC, Farmer LJ, Patterson RLS:** Responses of two genotypes of chicken to the diets and stocking densities typical of UK and "Label Rouge" systems: I. Performance, behaviour and carcass composition. *Meat Sci,* 45, 501-516, 1997.

**57. Sogut B, Inci H, Sengul T:** Growth performance and carcass traits of broiler reared in conventional and organic conditions. *Asian J Anim Vet Adv*, 6, 992-1000, 2011.

**58. Zaghari M, Shivazad M, Kamyab, A, Nikkhah A:** Digestible lysine requirement of arian male and female broiler chicks during six to twenty-one days of age. *J Agric Sci Technol,* 4, 111-117, 2002.

**59. Li L, Nolan JV:** Efficiency of protein utilization in male and female broiler chickens. *Proc Aust Poult Sci Sym,*14, 175-178, 2002.

**60. Indarsih B, Tamsil MH:** Response of different genotypes of broilers to lysine supplementation raised under practical condition. *J Indonesian Trop Anim Agric,* 37 (2): 139-148, 2012.

**61. Muriel A, Pascual MR:** Carcass and meat characteristics from free range chickens. *Proceedings of XII European Symposium on Quality of Poultry Meat,199, Zaragoza,* 219-222, 1995.

**62. Baeza E, Lessire M, Berri, C, Juin H:** Compared carcass and meat characteristics of label and standard guinea fowl. *Proceedings of XV European Symposium on the Quality of Poultry Meat,2001, Kusadasi, Turkey,* 73-78, 2001.

**63. Castellini C, Dal Bosco A, Mugnai C, Pedrazzoli M:** Comparison of two chicken genotypes organically reared: Oxidative stability and other qualitative traits. *Ital J Anim Sci*, 5, 29-42, 2006.

**64. Young LL, Northcutt JK, Buhr RJ, Lyon CE, Ware GO:** Effects of age, sex, and duration of postmortem aging on percentage yield of parts from broiler chicken carcasses. Poult Sci, 80, 376-379, 2001.

**65. Suto Z, Horn P, Jensen JF, Sorensen P, Csapo J:** Carcass traits, abdominal fat deposition and chemical composition of commercial meat type chicken during a twenty-week growing period. *Arch Geflugelk,* 62, 21-25, 1998.

**66. Abdullah AY, Muwalla MM, Maharmeh HO, Matarneh SK, Abu Ishmais MA:** Effects of strain on performance, and age at slaughter and duration of post-chilling aging on meat quality traits of broiler. *Asian-Aust J Anim Sci,* 23 (12): 1645-1656, 2010.