Effect of fennel and savory essential oils on performance, carcass characteristics and blood parameters of broilers

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Abstract

In order to investigate the effect of fennel (*Foeniculum vulgare*) and savory (*Satureja hHortensis*) essential oils and their mixture on performance, some characteristics of carcass, organs and blood parameters of broiler chickens in a factorial arrangement of 3 × 3 based on a completely randomized design with 9 treatments and 4 replicates and 15 pieces Broiler chickens were taken from 0 to 42 days in each replicate. The experimental diets included the control diet (without essential oil) and the levels of 0.15 and 0.25 g/kg essential oil of fennel and savory. At the end of the experiment period, from each replication three birds were selected and killed in order to examination of different parts of the carcass. The results of the experiment showed that the use of mixture of essential oils of fennel and savory in the level of 0.25 g/kg was effective in increasing feed intake. This difference was significant between treatment containing the mixture of essential oils of fennel and savory in the level of 0.25 g/kg with control treatment and other experimental treatments ($p \leq 0.05$). The highest kidney and heart weights were in treatments 3 and 4 respectively. The highest weight of pancreas and proventiculus were related to treatment 9. The relative weight of these organs was not affected by experimental diets ($p \geq 0.05$). Adding the essential oils of fennel, savory and their mixture increased the cholesterol to HDL ratio compared to the control treatment, so that the highest amount was in the treatment containing fennel 0.25, but this difference was not significant ($p \geq 0.05$). Therefore, the use of mixture of essential oils of fennel and savory had a more beneficial effect on growth performance than separate consumption of fennel and savory.

Keywords: essential oils, fennel, savory, organs weight, performance

Introduction

Following the EU ban on the use of growth-promoting antibiotics in 2006, in recent years much attention has been devoted to plant-based food additives. There are many commercial products currently on the market and it is expected that the use of these additives will increase in the future. The phytogenic term refers to plant-derived compounds and phytobiotic compounds, which are added to the animal's diet in order to alter the nutritional properties and improve performance. Phytogenes have a wide range of plant materials, many of which have a long history in human nutrition and have been used as a seasoning, preservative, and medication since ancient times. These plant materials are usually composed of various types of active ingredients (Eugenol, Cinnamaldehyde, Caracrol and Thymol), which together create a special flavor and aroma. In fact, plant-based compounds are commonly known as flavoring properties; therefore, they affect the palatability of livestock and poultry diets On the other hand, herbs have active biologically active substances that can have a positive effect on the health of the digestive system and their function (Mohiti-Asli et al, 2010).

Herbs have different combinations. These compounds include essential oils and plant extracts and their active compounds, which are known to the consumer as natural and harmful compounds, and have found a special place in the treatment of human, animal and bird diseases in recent years. The valuable therapeutic aspects of this genus are often related to the presence of essential oils, *flavonoids*, and *triterpenoid* (Pittenger et al, 1999). There are some reports about effects of medical plants/herbs on broilers (Butani and Parnerkar, 2015; Hosseini et al., 2016a; Hosseini et al., 2016b; Salehifar et al., 2017).

The savory (*Satureja hortensis*) plant belongs to the family of mint. It is distributed throughout Southern Europe, Southwest Asia, especially in Iran. The use of savory in the diet of broiler chicks raises the palatability of the diet and, as a result, increases feed intake, body weight, and antibody levels (Zamanimoghaddam et al, 2007). Essential oils of medicinal plants increase the feed conversion ratio of meaty poultry (Garcia et al, 2006).

The fennel (*Foeniculum vulgare*) is a herbaceous plant in the family Apiaceae. It probably originated from southern Europe and the Mediterranean region, it also is located in northern Iran (Samsamshariat, 2003). The fennel essence has an essential oil called anthoole, which has antibiotic effects.

Some researchers have reported that fennel consumption increases weight and improves the nutritional efficiency of broiler chickens (Eldeek et al, 2003). Indisch et al (2008) reported that plant additives could increase performance and reproduction in animals.

However, nutrition and feeding play a crucial role in improving the profitability and profitability of animal products. Essential oil and extract of herbs are natural and healthy alternatives to achieve this goal. Medicinal plants are not just a simple alternative to artificial additives, but because of the Synergistic effect of the presence of essential oils and other active ingredients in them, they are effective in improving the production efficiency and quality of meat and increasing the shelf life, and the natural ingredients are environmentally friendly (Mohiti-Asli et al, 2010).

Fennel and savory are cultivated in Iran and may possibly be the appropriate alternative for artificial growth stimulants. On the other hand, there is no comprehensive research on the use of essential oils of these herbs in poultry nutrition. Therefore, this study was conducted to determine the effects of fennel and savory essential oils in broiler chicks separately and in combination.

Materials and Methods

The experiment was conducted for 42 days in a commercial poultry house, Rasht, Iran. Totally, 540 male one-day-old Ross 308 (Aviagen, Newbridge, Scotland, UK 35805) chicks were housed in group cages (15 birds per cage), and provided 23 h of light per day. Heat was generated by a heater programmed according to the Ross 308 manual (Aviagen, Newbridge, Scotland, UK 35805; infoworldwide@aviagen.com). Feed and water were supplied *ad libitum* throughout the experimental periods.

Treatments and diet composition

Nine treatments with four replicates of 15 birds, with similar body weight, were applied. All birds were fed according to the producer's feeding instructions. The mean composition of basal diets and their nutrient composition for the starter (1-10 days of age) , grower (11-24) and finisher (25-42 days of age) periods are given in Table 1.

Fennel and savory essential oils was included at levels of 0.15 g/kg and 0.25 g/kg in the basal diet, according to each treatment: control group or treatment 1 (savory 0- fennel 0), treatment 2 (savory 0- fennel 0.15), treatment 3 (savory 0- fennel 0.25), treatment 4 (savory 0.15- fennel 0), treatment 5 (savory 0.15- fennel 0.15), treatment 6 (savory 0.15- fennel 0.25), treatment 7 (savory 0.25- fennel 0), treatment 8 (savory 0.25- fennel 0.15), and treatment 9 (savory 0.25- fennel 0.25). From the first day of breeding, the essential oils of fennel and savory

were added to the diet after being mixed with calcium carbonate as carriers. Feed remaining in feeders was weighed and removed at the end of each week. This feed was not taken in account for intake calculation.

Table 1- Ingredients and chemical composition of the broiler diets

Ingredients (%)	Starter (1-10d)	Grower (11-24d)	Finisher (25-42d)
Corn	54.789	60.044	63.765
Soybean Meal	38.733	33.951	30.510
Oil-Vegetables	1.313	1.594	1.649
DL-Methionine	0.260	0.227	0.204
L-Lysine. HCl	0.152	0.158	0.160
L-Threonine	0.037	0.033	0.028
Choline Chloride	0.074	0	0
Di Ca- Phosphate	2.247	1.878	1.662
CaCO3	1.267	0.992	0.904
Na-Bicarbonate	0.244	0.222	0.222
NaCl	0.183	0.201	0.196
Vit.& Mineral Mixture	0.600	0.600	0.600
Filler	0.100	0.100	0.100
Nutrient Analysis			
Dry Matter (%)	89.212	89.064	88.964
Energy-ME (kcal/kg)	2800.0	2887.0	2935.0
Crude Protein (%)	21.809	19.410	18.194
Calcium (%)	1.050	0.861	0.776
Available. Phosphorus (%)	0.500	0.430	0.338
Na (%)	0.156	0.157	0.155
Lysine-TFD (%)	1.150	1.050	0.976
Methionine-TFD (%)	0.541	0.490	0.455
Methionine+Cysteine-TFD (%)	0.826	0.758	0.710
Threonine-TFD (%)	0.748	0.683	0.635
Tryptophane-TFD (%)	0.223	0.201	0.185
Arginine-TFD (%)	1.294	1.173	1.087

Vitamin A: 3,600,000 IU/kg; Vitamin D3: : 800,000 IU/kg; Vitamin E: 7,200IU/kg; Vitamin K3: 800 mg/kg; Vitamin B1: 720 mg/kg; Vitamin B2: 2,640 mg/kg; Vitamin B3 (Calcium Pantothenate): 4,000 mg/kg; Vitamin B5 (Niacin): 12,000 mg/kg; Vitamin B6: 1,200 mg/kg; Vitamin B9 (Folic acid): 400 mg/kg; Vitamin B12: 6 mg/kg; Vitamin H2 (Biotin): 40 mg/kg; Choline: 100,000 mg/kg; Antioxidant: 40,000 mg/kg and 1mg/kg Excipient; Mn: 39,680 mg/kg; Fe: 20,000 mg/kg; Zn: 33,880 mg/kg; Cu: 4,000 mg/kg; I: 400 mg/kg; Se: 80 mg/kg; Choline: 100,000 mg/kg and 1 mg/kg Excipient.

Performance, hematology and carcass

Feed intake (g) and weight gain (g) were recorded weekly. Feed conversion ratio (FCR = total feed intake / total body weight gain) and production index [PI = total body weight x livability (%) / (age days x feed conversion ratio)] were calculated.

Before blood collection, feed was removed from feeders for a period of four hours in an attempt to allow stabilization of the various plasma components. At 42 days of age, a 4 mL volume of venous blood was collected from the wing vein of three birds per replicate. The whole blood sample was transferred from the syringe into a tube coated with 10 mg of the anticoagulantethylenediaminetetra acetic acid (EDTA). Blood samples were centrifuged at 3000 rpm for 20 min to ensure the separation of blood cells from plasma. Plasma was collected and stored at -20°C until further analyses. Plasma component analyses were based on standard protocols, using the Roche Cobas Integra 400 Plus autoanalyzer (Roche Diagnostics, GmbH, Mannheim, Germany). Ratio of total cholesterol to high density lipoprotein (HDL), and ratio of low density lipoproteins (LDL) to high density lipoprotein (HDL) were assayed using commercial kits (TeifAzmoon Pars, Co., Tehran, Iran).

In order to study the carcass traits at the end of the experiment, three broiler chicks per replicate were selected based on the average weight. Carcass parts were dissected and separately weighed. Parts included the heart,

kidneys, pancreas and proventiculus were carefully weighed precisely after extraction, and weighed accurately with a digital scale of 0.01 g. Total weight of all dissected parts and the weights of various segments of the digestive tract were calculated relative to eviscerated carcass weight according to the following formula: [(weight of component/eviscerated carcass weight) x 100].

Statistical analysis

Data were submitted to two-way analysis of variance, according to a 3×3 factorial arrangement, with two fennel and savory essential oils inclusion levels (0.0, 0.15, and 0.25 g/kg in diet). Data were analyzed using the GLM procedure of SAS statistical package version 9.3 (SAS, 2010). The means (± SEM) were compared by Duncan test. The results were considered different at 5% significance level.

Results

Performance

The effects of fennel and savory essential oils on the performance of broiler chickens in the first week are reported in Table 2. The results showed that feed intake in treatment 6 was higher than other treatments and control, but this difference was not significant between treatments($p\geq0.05$). Results from this experiment indicated that daily gain in treatment 9 was higher than control and other treatments. This difference was significant between experimental treatments and control ($p\leq0.05$). Also, the treatments that consumed fennel and savory essential oil had a better feed conversion ratio than control treatment during the breeding period, but this difference was not significant($p\geq0.05$).

According to the Table 2, the use of different amounts of fennel and savory essential oils and their mixture increased the feed intake during the breeding period compared to the control treatment. The difference between treatments 6, 7 and 9 with control was significant ($p\leq0.05$). Daily weight gain in broiler chickens was higher than the control treatment when the essential oils were received. The difference between treatments 2, 5 and control with other treatments was significant ($p\leq0.05$). The best feed conversion ratio was related to treatment 9. This difference between treatment 6 and other treatments was not significant ($p\geq0.05$).

The effects of different amounts of fennel and savory essential oils and their mixtures on the performance of broiler chickens in the third week are given in Table 2. Results from this experiment indicate that the use of different amounts of essential oils increased feed intake during the breeding period compared to the control treatment ($p\leq0.05$). Daily weight gain in broiler chickens was higher than the control treatment when the essential oils were received. The difference between treatment 9 and control with other treatments was significant ($p\leq0.05$). The best feed conversion ratio was related to treatment 9. This difference between treatment 6 and other treatments was significant ($p\leq0.05$).

According to the Table 2, the study of feed intake of broiler chickens showed that there was a significant difference between treatments 9 and 5 with control in the fourth week($p\leq0.05$). Daily weight gain in broiler chickens was higher than the control treatment when the essential oils were received. The difference between treatment 9 with control and treatment 5 was significant ($p\leq0.05$).

Results indicated that the difference between treatments 7, 8 and 9 with control was significant in the fifth week ($p\leq0.05$). The difference between treatment 9 and control was significant($p\leq0.05$). The results of daily weight gain in broiler chickens that consumed essential oils showed that the difference between control with other treatments was significant($p\leq0.05$). Treatments that were received essential oil had a lower feed conversion ratio than control treatments ($p\leq0.05$).

Results from this experiment indicate that the use of different amounts of essential oils increased feed intake during the breeding period compared to the control treatment. The difference between treatment 9 with control was significant in the sixth week ($p\leq0.05$). The results of daily weight gain in broiler chickens that consumed essential oils showed that the difference between treatment 9 with control and other treatments was significant ($p\leq0.05$). Treatments that were received essential oil had a lower feed conversion ratio than control treatments ($p\leq0.05$).

Hematological parameters

According to the Table 3, the use of different levels of fennel and savory essential oils and their mixture in broiler chickens diet did not have a significant effect on total cholesterol /HDL ratio and LDL/HDL ratio compared to control treatment ($p\geq0.05$).

Table 2- Performance of broilers fed the experimental diets at 1st to 6th week

Duration→		1-7 days of age			8-14 days of age			15-21 days of age			22-28 days of age			29-35 days of age			36-42 days of age		
Treatment↓		FI	WG	FCR	FI	WG	FCR	FI	WG	FCR	FI	WG	FCR	FI	WG	FCR	FI	WG	FCR
Savory	0 g/kg	22.64 a	16.67 a	1.38 a	54.53 a	40.68 b	1.37 a	91.29 a	75.54 b	1.21 a	147.66 a	71.10 b	2.09 a	187.07 a	99.86 b	1.88 a	183.86 a	69.09 b	2.69 a
	0.15 g/kg	22.99 a	16.79 a	1.37 a	55.29 a	41.63 b	1.36 a	91.30 a	77.13 b	1.18 a	148.80 a	74.90 b	1.99 a	187.06 a	106.73 b	1.76 a	184.68 a	73.27 b	2.53 a
	0.25 g/kg	22.98 a	16.99a	1.37 a	56.31a	44.22 a	1.29 a	92.80 b	80.49 a	1.16 a	149.19 a	80.62 a	1.86 a	193.50 a	108.60 a	1.79 a	187.73 a	77.44 a	2.45 a
SEM		0.18	0.12	0.01	0.59	0.51	0.014	0.48	0.80	0.01	1.27	1.21	0.03	1.23	1.44	0.02	1.16	1.47	0.05
P		0.33	0.17	0.78	0.13	0.0001	0.001	0.058	0.001	0.001	0.682	<0.0001	0.0002	0.005	0.0005	0.001	0.063	0.002	0.01
Fennel	0 g/kg	22.65 a	16.48 b	1.38 a	54.71 a	41.21 b	1.35 a	90.19 a	75.15 b	1.20 a	145.79 a	72.06 b	2.05 a	184.25 a	70.29 b	2.65 a	184.25 a	70.29 b	2.65 a
	0.15 g/kg	22.96 a	16.89 a	1.37 a	55.07 a	42.18 ab	1.36 a	91.81 b	77.86 a	1.18 a	150.71 b	75.01 a	2.01 a	183.21 b	71.44 a	2.57 a	183.21 b	71.44 a	2.57 a
	0.25 g/kg	23.01 a	17.08 a	1.36 a	56.30a	43.20 a	1.31 a	93.30 b	80.15 a	1.17 a	149.15 b	79.56 a	1.88 a	188.81 b	78.07 a	2.44 a	188.81 b	78.07 a	2.44 a
SEM		0.18	0.12	0.01	0.59	0.51	0.014	0.48	0.80	0.01	1.27	1.21	0.03	1.23	1.44	0.02	1.16	1.47	0.05
P		0.33	0.004	0.18	0.14	0.03	0.47	0.0005	0.001	0.116	0.033	0.0007	0.005	0.089	0.038	0.44	0.05	0.002	0.020
T1		22.25 a	15.91 b	1.41 b	52.65 a	37.84 c	1.39 b	88.06 a	71.68 c	1.24 c	146.17 ab	63.08 c	2.32 d	183.98 ab	92.93 c	1.98 b	179.26 a	59.65 c	3.02 c
T2		22.93 a	16.97 a	1.37 ab	54.98 ab	40.87 b	1.41 b	90.98 b	76.45 b	1.19 bc	151.51 bcd	76.17 b	1.99 bc	188.13 abc	102.45 b	1.84 a	183.38 ab	74.92 b	2.45 ab
T3		22.75 a	17.05 a	1.35 a	55.97 ab	43.33 ab	1.30 a	94.84 c	78.50 b	1.21 bc	145.21 ab	74.06 b	1.96 abc	189.11 abc	104.19 b	1.82 a	188.96 bc	72.71 b	2.60 b
T4		22.98 a	16.59 a	1.38 ab	55.20 ab	42.25 ab	1.38 b	90.81 b	77.86 b	1.17 b	143.71 a	73.57 b	1.96 abc	182.53 a	107.47 ab	1.70 a	185.15 ab	76.05 b	2.44 ab
T5		22.69 a	16.77 a	1.35 ab	54.35 ab	40.91 b	1.38 b	91.15 b	76.45 b	1.19 bc	154.69 d	73.31 b	2.12 c	188.97 abc	106.86 ab	1.77 a	183.09 ab	70.24 b	2.62 b
T6		23.21 a	17.01 a	1.37 ab	56.32 b	41.72 ab	1.34 ab	91.93 b	77.08 b	1.11 bc	148.01 abcd	77.82 b	1.90 ab	189.68 bcd	105.85 ab	1.71 a	185.79 abc	73.53 b	2.54 b
T7		22.71 a	16.86 a	1.36 ab	56.28 b	43.54 ab	1.29 a	91.71 b	75.902 bc	1.21 bc	147.50 abc	79.53 b	1.86 ab	191.43 cd	106.00 ab	1.81 a	188.35 bc	75.17 b	2.52 b
T8		23.26 a	16.93 a	1.37 ab	55.89 ab	44.56 a	1.28 a	93.56 bc	80.69 ab	1.16 b	145.83 ab	75.54 b	1.93 abc	192.79 cd	106.95 ab	1.81 a	183.16 ab	69.17 b	2.66 b
T9		22.97 a	17.20 a	1.36 ab	56.75 b	44.56 a	1.29 a	93.13 bc	84.88 a	1.09 a	154.22 cd	86.79 a	1.78 a	196.28 d	112.86 a	1.74 a	191.68 c	87.98 a	2.18 a
SEM		0.31	0.21	0.02	1.04	0.88	0.02	0.85	1.47	0.02	2.21	2.10	0.06	2.13	2.49	0.04	2.02	2.54	0.09
P		0.43	0.02	0.37	0.20	0.0002	0.003	0.0005	0.0002	0.007	0.001	<0.0001	<0.0001	0.004	0.001	0.01	0.007	<0.0001	0.0001

Means within each column with no common superscripts differ significantly at $p \leq 0.05$.

FI- Feed Intake (g.chick/day); WG- Weight gain(g/chick/day) FCR- Feed Conversion ratio (g/kg), T1- Treatment1:(Savory 0- Fennel 0); T2- Treatment 2:(Savory 0- Fennel 0.15); T3- Treatment 3:(Savory 0- Fennel 0.25); T4- Treatment 4:(Savory 0.15- Fennel 0); T5- Treatment 5:(Savory 0.15- Fennel 0.15); T6- Treatment 6:(Savory 0.15- Fennel 0.25); T7- Treatment 7:(Savory 0.25- Fennel 0); T8- Treatment 8:(Savory 0.25- Fennel 0.15); T9- Treatment 9:(Savory 0.25- Fennel 0.25)

Carcass/organ characteristics

Weight and relative weight percentages of some carcass parts are shown in the Table 4. The highest weight and relative weight of pancreas were observed in treatment 9. Weight of pancreas was significantly affected by additives ($p \leq 0.05$), but relative weight of pancreas was significant ($p \geq 0.05$).

No significant difference was observed in the relative weight of the heart, kidney and proventiculus in the experimental treatments ($p \geq 0.05$). The highest heart weight was related to treatment 9, which showed a significant difference with control treatment ($p \leq 0.05$). The highest kidney and proventiculus weight was related to treatment 3 and 9, which showed significant difference with control treatment ($p \leq 0.05$).

Table 3 - Blood parameters of broiler diets differing in dietary different levels of fennel, savory essential oils and their combination

Treatments↓		LDL/HDL (mg/dl)	Cholesterol/HDL (mg/dl)
Savory	0 g/kg	2.04a	0.79 a
	0.15 g/kg	1.97 a	0.82 a
	0.25 g/kg	1.97 a	0.83 a
SEM		0.11	0.08
P		0.88	0.93
Fennel	0 g/kg	2.04 a	0.87 a
	0.15 g/kg	1.90 a	0.75 a
	0.25 g/kg	2.05 a	0.83 a
SEM		0.11	0.08
P		0.55	0.57
T1		1.80 a	0.65 a
T2		1.97 a	0.80 a
T3		2.35 a	0.92 a
T4		2.27 a	1.05 a
T5		1.72 a	0.62 a
T6		1.92 a	0.80 a
T7		2.05 a	0.90 a
T8		2.00 a	0.82 a
T9		1.87 a	0.77 a
SEM		0.19	0.14
P		0.33	0.51

Means within each column with no common superscripts differ significantly at $p \leq 0.05$

T1- Treatment1:(Savory 0- Fennel 0); T2- Treatment 2:(Savory 0- Fennel 0.15); T3- Treatment 3:(Savory 0- Fennel 0.25); T4- Treatment 4:(Savory 0.15- Fennel 0); T5- Treatment 5:(Savory 0.15- Fennel 0.15); T6- Treatment 6:(Savory 0.15- Fennel 0.25); T7- Treatment 7:(Savory 0.25- Fennel 0); T8- Treatment 8:(Savory 0.25- Fennel 0.15); T9- Treatment 9:(Savory 0.25- Fennel 0.25)

Table 4– Organ weights & relative weights (%) of broilers fed different levels of fennel, savory essential oils and their combination

Treatments↓		Pancreas (g)	RW of Pancreas (%)	Heart (g)	RW of Heart (%)	Kidney (g)	RW of Kidney (%)	Proventiculus (g)	RW of Proventiculus (%)
Savory	0 g/kg	6.07 b	0.27 a	11.85 a	0.53 a	10.64 b	0.47 a	9.15 b	0.41 b
	0.15 g/kg	6.18 ab	0.27a	11.97 a	0.53 a	10.48 b	0.46 a	10.52 a	0.46 a
	0.25 g/kg	6.54 a	0.27 a	12.10 a	0.50 a	11.57 a	0.48 a	10.64 a	0.44 ab
SEM		0.15	0.01	0.26	0.01	0.29	0.01	0.35	0.02
P		0.43	0.04	0.82	0.12	0.317	0.67	0.65	0.32
Fennel	0 g/kg	5.93 b	0.26 a	11.73 a	0.52 a	10.37 b	0.46 a	9.50 a	0.42 a
	0.15 g/kg	6.41 a	0.28 a	11.75 a	0.51 a	10.72 b	0.47 a	10.42 a	0.45 a
	0.25 g/kg	6.46 a	0.27 a	12.43 a	0.52 a	11.60 a	0.49 a	10.39 a	0.44 a
SEM		0.15	0.01	0.26	0.01	0.29	0.01	0.35	0.02
P		0.25	0.05	0.81	0.13	0.18	0.56	0.51	0.55
T1		5.60 b	0.26 a	10.90 c	0.50 b	9.39 c	0.43 b	7.96 b	0.37 b
T2		6.53 ab	0.29 a	11.98 abc	0.53 ab	10.21 bc	0.45 b	9.80 ab	0.44 ab
T3		6.09 bc	0.26 a	12.66 a	0.55 ab	12.31 a	0.53 a	9.68 ab	0.42 ab
T4		6.00 bc	0.27 a	12.75 a	0.57 a	10.32 bc	0.46 b	10.45 a	0.47 a
T5		6.38 abc	0.29 a	11.14 bc	0.50 b	10.77 abc	0.48 ab	10.87 a	0.49 a
T6		6.17 bc	0.26 a	12.03 abc	0.51 ab	10.36 bc	0.44 b	10.24 a	0.44 ab
T7		6.18 bc	0.27 a	11.54 abc	0.50 b	11.41 ab	0.50 ab	10.11 a	0.44 ab
T8		6.33 abc	0.26 a	12.15 abc	0.51 b	11.19 ab	0.46 ab	10.58 a	0.44 ab
T9		7.11 a	0.28 a	12.60 ab	0.50 b	12.11 a	0.48 ab	11.24 a	0.45 ab
SEM		0.26	0.01	0.45	0.02	0.50	0.02	0.61	0.029
P		0.908	0.50	0.37	0.254	0.424	0.897	0.526	

Discussion

Performance

Generally, it is believed that herbal compounds improve the growth of domestic animals, which is partly because of increased feed intake due to the palatability improvement in diet (Mohiti-Asli et al, 2010).

Daily weight gain, feed intake and feed conversion ratio were studied as growth parameters. Adding the mixture of fennel and savory essential oils at a level of 0.25 g/kg to broiler chickens diet was effective in increasing feed intake. This difference was significant between treatments containing mixture of essential oils of fennel and savory in the level of 0.25 g/kg with control treatment and other treatments ($p \leq 0.05$). Also, the lowest feed conversion ratio among experimental treatments was related to the treatment containing mixture of essential oils of fennel and savory in the level of 0.25 g/kg, which showed a significant difference with control treatment ($p \leq 0.05$).Taki et al. (2014) studied different levels of fennel essential oils on feed consumption, which showed that different levels of fennel essential oil did not have a significant effect on daily feed intake during different weeks. Vakili (2011) added 40 mg/kg of fennel extract to laying hens diet and observed an increase in feed intake which was not significant. Nasiroleslami and Torki (2010) did not observe any significant effect on feed intake by adding 350 mg/kg fennel essential oils to laying hens diet. Some researchers have reported that fennel consumption can increase weight and improve the nutritional efficiency of broiler chickens (Eldeek et al, 2003). Some herbs and essential oils affect the digestion and secretion of digestive enzymes and, by increasing these enzymes, increase digestibility of nutrients and improve the growth of animal (Eldeek et al, 2003).

Increasing performance is due to the use of medicinal plants because of the presence of various chemical compounds in them. These compounds have beneficial effects on digestive activity and improve the productivity of feedstuffs and play a role in eliminating harmful microorganisms in the digestive system and feedstuffs (Hashemi and Davoodi, 2011).

It seems that the synergistic effect of the active ingredients of the fennel and savory essential oils such as anethole and carvacrol have a positive effect on the digestion and absorption of nutrients in the mixed treatment, thus improving the feed efficiency in the bird.

In general, herbal supplements, through their effect on the microflora of the digestive system and the control of pathogens, have their role in improving growth. As a result, these compounds contribute to the immune system during critical production conditions and increase the availability of some nutrients to absorb the intestines. Ultimately, they create the right conditions for genetic potential growth (Indisch et al, 2008).

Hematological parameters

The results of the effect of essential oils of fennel, savory and their mixture on some blood parameters in broiler chickens are shown in Table 8. The addition of essential oil increased the cholesterol to HDL ratio compared to the control treatment, with the highest amount related to the treatment containing essential oil of the fennel 0.25g/kg, but this difference was not significant($p \geq 0.05$). The LDL / HDL ratio also increased with the addition of essential oil, but this difference was not significant.

In a study on broiler chickens, the use of 2% black cumin in the diet reduced the level of triglyceride and total cholesterol (Khajeali et al, 2012). Also, adding 0.5 and 2**%** cumin powder to the Japanese quail diet reduced total cholesterol and triglyceride. Reducing the level of triglyceride in fennel and cumin plants can be associated with a decrease in the absorption of fat in the intestines by their active components, the main cause of which is the presence of thymol, thymocaine, anethole, and carvone in the building of these medicinal plants that reduce cholesterol and its biosynthesis (Sedlakova et al, 2003). It was found that the addition of thymol and carvacrol to broiler chickens diet reduced serum cholesterol concentrations, which is attributed to the inhibition of 8-hydroxy-8-methylglutaryl-quanzime reductase enzyme in the synthesis of cholesterol (Lee et al, 2003). Another reason may be the high fiber content of fennel and cumin because it has been reported that increasing the dietary fiber content increases bile excretion and reduces blood cholesterol and triglyceride levels (Sarikhan et al, 2009).

Carcass characteristics

The weight of pancreas, heart, kidneys and proventiculus, also their relative weight in different experimental groups at 42 days of age, is presented in Table 9. The relative weight of these organs was not affected by experimental diets ($p \geq 0.05$). The highest kidney and heart weights were in treatments 3 and 4, respectively. The highest weight of pancreas and proventiculus were related to treatment 9. The results of this experiment on carcass characteristics are in agreement with the results of studies of Toghyani et al. (2010). They reported that the use of black seed and peppermint had no significant effect on carcass characteristics and relative weight of internal organs such as liver, heart and gizzard despite beneficial effects on growth performance. In a study, Zadehamiri et al (2014), Showed that the use of different levels of savory did not have a significant effect on performance and carcass characteristics in broiler chickens, but its different levels had improved immune response. According to the

results of this experiment, it can be stated that although the weight of each component was added in the treatments, their weight / body weight ratio did not show any significant difference with other treatments.

Conclusion

The results of this study showed that the use of mixture of essential oils of fennel and savory, compared to fennel and savory consumption separately, had more beneficial effect on growth performance. Adding the different levels of essential oils of fennel, savory and their mixture to broiler chickens have improved the LDL/HDL ratio. However, more research is recommended in order to have more stable results and also to determine the exact level of use of these plant additives in broiler diets.

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