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ORIGINAL ARTICLE

Influence of Supplementation of *Satureja khuzestanica* Essential oils in Drinking water on Digestive organ size and Carcass Characteristics broiler Chickens reared under Heat stress

Reza Parvar[1]*., Heshmatollah Khosravinia[1]., Arash Azarfar[1]
Dept. of Animal Sciences, Agriculture Faculty, Lorestan University, Khoramabad, Lorestan, Iran
*Corresponding author: parvar.90@gmail.com

ABSTRACT
720 one-day-old Arian broiler chicks were used to examine the effect of Satureja khuzistanica essential oils (SkEO) on digestive organ size and carcass characteristics broiler chickens reared under heat stress. Experimental treatments were addition of 0 (control-), 200, 300, 400 and 500 ppm SkEO or 500 ppm Polysorbate-80 (control+) in drinking water from 1 to 42 days of age. The birds were exposed to extreme ambient temperature during 22 to 42 days of age. Incorporation of SkEO into drinking water at levels greater than 200 ppm caused significant decrease in daily weight gain in 28 to 35 days of age (P<0.05). The mean abdominal fat percentage was significantly reduced in the male birds received 400 ppm SkEO compared to the other male birds. The relative weights of duodenum and pancreas and gall bladder were significantly increased with SkEO-added water (P<0.05). In conclusion, the present study reveal that administration of SkEO at 400 ppm through drinking water to heat stressed broiler chickens bring about appreciated economic consequences.
Key words: *Broiler chicken, heat stress, carcass characteristics, Satureja khuzistanica.*

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INTRODUCTION

The banning of the use of antibiotics as feed additives has accelerated and led to investigations of alternative feed additives in animal production. As one of the alternatives, herbal extracs are already being used as feed supplements to improve growth performance under intensive management systems [1]. A number of feed additives including antibiotics have been widely employed in the poultry industry for several decades. A manipulation of gut function and microbial habitat of domestic animal with feed additives has been recognized as an important tool for improving growth performance and feed efficiency [2]. Herbs that are rich in such flavonoids as thyme (*Thymus vulgaris*) extend the activity of vitamin C, act as antioxidants and may therefore enhance the immune function [3].

Satureja khuzistanica Jamzad (SkEO), is a medical plant well-known for its remedial properties in traditional medicine [4]. The aerial parts of *Satureja khuzistanica* collectively contain up to 3 percent of essential oils which it spectacularly riches in carvacrol (up to 94 percent) [5]. Carvacrol is described as a phenolic, caustic and bitter tasting compound with good stability [6]which demonstrate significant antioxidant [7] antimicrobial [8] effects. Accordingly, it has been reported that SkEO has antioxidant [9], and antibacterial [10] effects mainly in experiments conducted under standard managerial practices and normal environmental conditions.

Considering the scarce experimental results available on administration of phytogenic extracts to heat stressed avian species, this study, was undertaken to examine the effect of *Satureja khuzistanica* essential oils (SkEO) on productive performance of broiler chickens where it constantly supplemented into drinking water during 1 to 42 days.

MATERIALS AND METHODS

A total of 720 day-old mixed sex broiler chicks (Arian) were weighed and based on completely randomized design assigned to 6 treatment groups with 6 replicate and 20 bird (5 male and 5 female) per each. Chopped barley stalks top dressed with 2 cm wood shavings were used as bedding material. Corn and soybean meal based super starter (24.28% CP and 2962 Kcal ME/kg, 1 to 7 day), starter (21.15% CP and 2880 Kcal ME/kg, 7 to 21 d), grower (18.82% CP and 2952 Kcal ME/kg, 22 to 35 d) and finisher (17.63% CP and 2993 Kcal ME/kg, 36 to 42 d) diets and water were provided for ad libitum consumption throughout the experimental period. The shed was equipped with wet pad-and-fan cooling system to decline the ambient temperature. Nonetheless, average temperature during day and night hours were ranged from 32 to 35 and 28 to 30 °C during 21 to 42 days. Therefore, from 21 days of age the birds were exposed to seasonal extreme ambient tempratures.The effect of six experimental treatments consisted of supplementation of drinking water with 0 (control-), 200, 300, 400 and 500 ppm SkEO or 500 ppm Polysorbate- 80 (control+) were examined in 6 replicates of 20 birds each. Polysorbate-80 is an emulsifier which it was used to disperse SkEO in water at 1: 1 ratio (*v/v*). All treatments (drinking water) were prepared daily. Newcastle vaccination against Newcastle virus was done on the 15th and 28th days (as eye drop), day of the experimental period**.** At 21 days of age, one male bird and at 42 days of age eight birds (4 males and 4 females) per pen were killed to evaluate carcass, abdominal fat and organ weights.

Statistical Analysis

The statistical model used to analyze the collected data was

$Y_{ijk} = \mu + SkEO_i + Sj + B_k + \varepsilon_{ijk}$

Where Y_{ijk} is the dependent variable, μ is the general mean, $SkEO_i$ is the fixed effect of SkEO (i =6; control+ and 0, 200, 300, 400, 500 ppm SkEO), S_j is the fixed effect of sex (j= 2), B_k is the random effect of block (j =6; 1, 2, 3, 4, 5 and 6) and ε_{ijk} is the residual error. The data were analyzed using PROC MIXED of SAS 9.1 (24). The LSD test was used for multiple treatment comparisons using the LSMEANS statement of SAS 9.1 [11]. with letter grouping obtained using the SAS pdmix800 macro [12]. For the different statistical tests, significance was declared at $P \leq 0.05$. The REG procedure of SAS 9.1 [11] was used to provide regression models for assessment of relation between SkEO and water consumption.

RESULTS AND DISCUSSION

In this study, *Satureja khuzistanica* Essential Oils (SkEO) exhibit no considerable favorable effects on Daily Weight Gain (DWG) of the treated birds in 1 to 28 days when birds maintained under normal production practices. During 29 to 35 days, when the birds suffered from extreme heat stress, SkEO-added water decreased the DWG of the treated birds (P<0.05; Table 1).

Table 1. Effect of essential oils of *Satureja khuzistanica* on average daily weight gain (g) in broiler chicken up to 42 days of age.

			Essential oils of *Satureja k.* (ppm)					
Days (d)	Cont+[1]	Cont-[1]	200	300	400	500	SEM[2]	P-value
1-7	16.61[a]	16.90[a]	16.78[a]	16.91[a]	16.92[a]	16.98[a]	0.09	0.7981
8-14	26.29[a]	26.41[a]	26.26[a]	26.21[a]	27.17[a]	25.31[a]	0.29	0.5547
15-21	41.31[ab]	41.72[a]	40.19[ab]	41.52[a]	39.40[b]	40.90[ab]	0.32	0.1484
22-28	72.62[b]	74.72[ab]	76.05[a]	73.48[ab]	74.91[ab]	74.48[ab]	0.46	0.3590
29-35	81.36[b]	87.72[a]	87.48[a]	80.00[b]	85.00[ab]	80.29[b]	0.87	0.0076
36-42	82.43[a]	81.43[a]	79.60[a]	85.62[a]	86.07[a]	83.00[a]	1.25	0.6865
1-42	53.43[a]	54.81[a]	54.39[a]	53.96[a]	54.91[a]	53.49[a]	0.23	0.2456

[1]Control+; The birds received drinking water supplemented with 500 ppm polysorbate-80 throughout the trial, and Control-; The birds received drinking water with no additive.

[2] Standard error for overall mean.

[a-g] Means within a raw without a common superscript differ significantly (P<0.05).

The results of this experiments showed that the mean abdominal fat percentage was affected by treatments and it was lower for the male birds received 400 ppm SkEO compared to the other birds of the same sex. In females, abdominal fat was increased by SkEO-treated water but it was lower for the females received 500 ppm compared with other SkEO-received birds (Table 2). The relative weight of duodenum was affected by SkEO treated water at 21 and 42 days of age in different approaches (Basmacioglu et al., 2004). The mean duodenum weight was generally lower for all treated birds compared to control groups at 21 d (Table 3). However, all the birds received SkEO at 200 to 400 ppm showed greater duodenum weight compared to control birds at 42 days of age. Pancreas weight was influenced by SkEO treatments and it was specially increased for the birds received 200 ppm SkEO at 21 days of age. At 42 days of age,

the pancreas weight was also greater for all treated birds but the differences were not significant compared with the control groups (P>0.05; Table 3). Liver weight percentage (% of carcass weight) was not significantly differ for treated and control birds but it was greater for the birds received 200 ppm SkEO. The relative weight of gall bladder was influenced by SkEO-treated water and it was 17.56, 40.50, 12.16 and 38.73 percent greater for the birds received 200, 300, 400 and 500 ppm SkEO, respectively, compared with control- birds at 42 days of age (Table 3).

The disability of the treated birds in sufficient growth could be attributed to decreased water consumption which it imposed a great conflict to the birds as they needed more water intake to overcome their disturbed homeothermic state. The from *Satureja khuzistanica* Essential Oils (SkEO) was described as a natural product very rich in carvacrol so that almost all properties of these oils could be credited by carvacrol features. It has been shown that supplementation of drinking water with high doses of SkEO (ranging from 500 to 2500 ppm) adversely affected production parameters in broilers during 1 to 28 days of age [13]. these results are to some extent in discord with the findings of Lee et al. [14] and Basmacioglu et al. [15]who found decreased FCR for the carvacrol-received birds. Such difference may be reasoned by differences in managerial practices applied, physiological state of the birds.

In the present study, SkEO brought about a pronounced decrease in water consumption in all the treated birds. The bitter- and pungent tasting carvacrol and possibly other principles in SkEO caused significant drop in water consumption. Water is involved in every aspect of broiler metabolism. It plays important roles in regulating body temperature and digesting food.

In the current study Carcass Weight (CW) was not positively influenced by treatments in either male or female birds but carcass yield increased in all male and female birds which received treated water compared to control- birds at 42 days of age. These results are expected as carcass weight is mainly associated with preslaughter weight but carcass yield is correlated with body composition among many other factors. It seems that SkEO exert considerable impact on carcass composition as it is also demonstrated in abdominal fat weight. It has been reported that dietary carvacrol affect fat metabolism in chicken [2]. In broiler chicken, lipids and triglycerides in particular are stored in abdominal cavity [3]. There is an apparently general postulation that almost all the fat build up in broiler adipose tissue including abdominal fat is synthesized in the liver or derived from the diet [16, 17]. In this study abdominal fat percent was affected by SkEO-treated water in dissimilar ways for male and female birds. In general, SkEO caused reduced abdominal fat in males but it increased the same trait in females.

Table 2. Effect of essential oils of *Satureja khuzistanica* on carcass weight (CW; g), carcass yield (CY; %), abdominal fat- to-carcass weight ratio (AF: CW) in broiler chicks at 42 days of age.

	CW	CY	AF: CW
Males			
Control+	1662.6^{a}	40.54^{a}	2.442^{a}
Control-	1594.2^{a}	31.69^{b}	1.969^{b}
200	1651.0^{a}	38.00^{ab}	2.294^{ab}
300	1661.3^{a}	35.50^{ab}	2.131^{ab}
400	1652.2^{a}	32.00^{b}	1.940^{b}
500	1683.6^{a}	38.75^{ab}	2.300^{ab}
SEM[2]	14.449	1.202	0.067
P<F	0.1581	0.1859	0.2125
Females			
Control+	1408.0^{ab}	41.77^{ab}	2.970^{b}
Control-	1454.2^{a}	36.58^{ab}	2.500^{a}
200	1413.6^{ab}	45.00^{a}	3.127^{a}
300	1328.4^{b}	38.08^{ab}	2.866^{ab}
400	1398.2^{ab}	37.92^{ab}	2.722^{ab}
500	1409.6^{ab}	36.25^{b}	2.557^{b}
SEM[2]	15.238	1.203	0.077
P<F	0.2936	0.2910	0.1581

[1]Control+; The birds received drinking water supplemented with 500 ppm polysorbate-80 throughout the trial, and Control-; The birds received drinking water with no additive.

[2] Standard error for overall mean.

[a-e] Means within a column without a common superscript differ significantly (P<0.05).

These results disagreed with the findings of Khosravinia [13] who reported that SkEO significantly reduce abdominal fat in both male and female birds. It has to be mentioned that in that study birds were maintained under normal conditions and they were received high doses of SkEO (500 to 2500 ppm) through drinking water. These are suggestions that dietary administration of phytogenic products may improve digestion process in avian species [18]. In a number of experiments the positive effect of essential oils on feed digestion have been attributed to increased bile salt secretion [19] and stimulation of digestive enzymes activity of intestinal mucosa and of pancreas [20]. The later effect mainly has been reasoned by pungent principles in essential oils.

Table 3. Effect of essential oils of *Satureja khuzistanica* on relative weight of duodenum and pancreas (at 21 and 42 day), and relative weight of liver and bile bladder (at 42 day) in broiler chickens.

			Essential oils of *Satureja k.* (ppm)					
	Cont+[1]	Cont-[1]	200	300	400	500	SEM[2]	P-value
	g per 100 g body weight at 21 day							
Duodenum	1.412[b]	1.689[a]	1.628[ab]	1.625[ab]	1.483[ab]	1.507[ab]	0.045	0.3120
Pancreas	0.549[ab]	0.492[b]	0.579[a]	0.547[ab]	0.528[ab]	0.545[ab]	0.012	0.2192
	g per 100 g body weight at 42 day							
Duodenum	1.180[b]	1.218[ab]	1.269[ab]	1.356[a]	1.223[ab]	1.178[b]	0.023	0.1927
Pancreas	0.332[a]	0.302[a]	0.332[a]	0.329[a]	0.332[a]	0.340[a]	0.006	0.5121
Liver	3.783[a]	3.639[a]	3.831[a]	3.566[a]	3.583[a]	3.500[a]	0.065	0.6670
Gall bladder	0.094[ab]	0.074[b]	0.087[ab]	0.104[a]	0.083[ab]	0.102[a]	0.004	0.2146

[1]Control+; The birds received drinking water supplemented with 500 ppm polysorbate-80 throughout the trial, and Control-; The birds received drinking water with no additive.
[2] Standard error for overall mean.
[a-e] Means within a column without a common superscript differ significantly (P<0.05).

In the current study, increased pancreas as well as gall bladder weight at 21 and 42 days of age verified that SkEO stimulate pancreatic enzymes activities and bile salts secretion. It is necessary to further investigate the effect of elevated enzyme and bile secretion on apparent digestibility of diet ingredients especially on fats.

In conclusion, the present study revealed that despite of fluctuating results for different age periods, administration of SkEO at 400 ppm through drinking water to heat stressed broiler chickens bring about appreciated economic consequences. Such beneficial effects are due to accumulation of minute advantages in DWG. Our examination indicates that the reduced water consumption due to pungent and caustic flavor of SkEO-treated water is the main obstacle for a pronounced improvement in production performance of the heat stressed broiler chicken.

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