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Effects of the Summer Savory (*Satureja hortensis* L.) Powder and Extract on the Performance of Male Broiler Chicken

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A B S T A R A C T

Background: Savory herbs and their active essential oils have been extensively investigated as feed additives and an alternative to the use of antimicrobial agents. The present study aimed to assess their effects on broiler chicken performance.
Methods: Dried savory powder (SP) (1.0% or 2.0%) or savory extract (SE) (50 or 100 ppm) was added to the basal starter (until day 22) and grower diets/drinking water, respectively. In total, 308 male Ross broilers aged 225 days were assigned to four treatment groups and the non-supplemented control group.
Results: On day 42, the feed conversion ratio (FCR), improved in the treatment groups (FCR =1.63 on 1.0% SP) compared to the control group (FCR =1.81±0.04; $P < 0.005$), while no such change was observed in the feed intake or daily weight gain. The FCR was similar between the SP and SE at different levels.
Conclusion: According to the results, 1% or 2% savory powder and 50 or 100 ppm of the savory extract as food and drinking water additives could improve the FCR in the 42-day broiler production cycle and could be a proper alternative to commercial essential oils.

1. Introduction

Summer savory (*Satureja hortensis* L.) is an aromatic medicinal plant native to southern Europe, and one of the 12 Satureja species has been classified in Iran [1]. Carvacrol and thymol (isomer) are the major active compounds in this plant, which has numerous health benefits for humans and animals [2]. Several primary references on this plant are available. For instance, Funke (1943) examined the effects of Satureja hortensis on *Allium cepa* [3], while Suchar (1955) assessed the ethereal oil and properties of *Satureja hortensis* L. cultivated at various levels [4]. In addition, Felklova (1958) elaborated on the contents of the ethereal oil of *Satureja hortensis* during vegetation [5], and Thieme (1972) investigated the accumulation and composition of the volatile oils in *Satureja hortensis*, *Satureja montana*, and *Artemisia dracunculus* during ontogenesis [6]. Some studies have also been focused on the essential oil composition of *Satureja hortensis* in various regions [7].

Summer savory and its active essential oils have recently been experimented as food additives and in alternative to antimicrobial agents in order to determine their effects on broiler performance. For instance, Hashemipour et al. (2014) [8] reported the improvement of body weight gain (BWG) and feed conversion ratio (FCR), while the feed intake had no increase in the female broilers receiving 100 and 200 mg/kg of carvacrol with thymol from a commercial feed additive product. However, the feed intake linearly decreased when the concentration of thymol and carvacrol increased to zero, 60, 100, and 200 mg/kg in the basal diet. In the mentioned study (Hashemipour et al. 2013) [9], it was also suggested that the improvement palatability was dose-dependent.

In another research, Lee et al. (2003) [10] observed that 200 ppm of carvacrol (Fluka Chemie, Sigma-Aldrich Chemie BV, Zwijndrecht, The Netherlands) decreased the feed

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intake and improved the FCR on day 28, while no such effects were denoted with 200 ppm of thymol (Acros Organics, Geel, Belgium). The aforementioned studies demonstrated that broiler FCR could be improved, and the commercial products based on summer savory essential oils could be economically advantageous as a feed additive. The proximate composition for *Satureja hortensis* as a dry plant is 0.86% lipids, 7% moisture, 7.85% mineral substances, and 11.83% proteins [11].

Despite the potential quantitative variability of the active compounds, we used the natural dried summer savory herb, which was preliminary tested without significant performance improvement. On day 42, BWG and FCR performances remained statically unaltered after the addition of 0.15%, 0.3%, and 0.45% [12] or 5 and 10 g/kg [13] of the summer savory aerial parts to the diet of male broilers. In a recent study, Nobakht et al. (2012) reported the increased feed intake despite the lack of BWG or FCR improvement when the broilers were supplemented with 2% of the dried aerial parts of summer savory in their diet, suggesting the palatability improvement [14].

The present study aimed to test the hypothesis that low levels of natural savory extract (SE) or natural savory powder (SP) could improve FCR within a 42-day broiler production cycle, limiting the potential adverse effects on feed palatability.

2. Materials and Methods

A 42-day experiment was conducted on 308 male Ross broilers aged 225 days, which were weighed individually and assigned to five treatment groups. Each treatment consisted of three replicate pens (15 chickens per pen, 45 chickens in each treatment). The pen dimensions were 200×100 centimeters, and the temperature inside the experimental room was maintained at 30-32 ºC during days 1-14 of age and at 23-28ºC during days 15-42 of age. In addition, the birds were vaccinated against bronchitis (day one), Newcastle disease (days six and 15), and Gumboro disease (days 11 and 20).

A two-phase feeding program was used in this investigation, which involved the provision of starter feed during days 1-21 and grower feed during days 22-42. The composition of the basal starter and grower feeds is shown in Table 1. The prescribed diets met or exceeded the recommendations of the Ross catalogue (Aviagen, 2007) [15] .

Dried savory was obtained from the Agricultural Jihad Organization in Hamadan, Iran, and the extracts were prepared as described by Bombik et al. (2012) [1]: To do so, 200 grams of the dried herb per liter of water was daily infused for 10 minutes, cooled to the temperature of 40°C, and strained. Following that, The dried SP (1.0% or 2.0%) or SE (50 or 100 ppm) was added to the diet and drinking water [16], respectively during days 1-42 to evaluate their effects on performance.

The study groups were as follows: 1) control group, receiving standard basal diets only (starter and grower); 2) SP1 group, receiving basal starter and grower diets supplemented with 1.0% SP; 3) SP2 group, receiving diets supplemented with 2.0% SP; 4) SE50 group, receiving basal starter and grower diets and drinking water supplemented with 50 ppm of SE; and 5) SE100 group, receiving drinking water supplemented with 100 ppm of SE. The chickens had ad libitum access to food and water.

Feed intake (g) and BWG (g/day) were recorded weekly, and FCR was calculated based on the following formula: Total Feed Intake / Total BWG [17].

The use and care of the birds in the present study was approved by the Ethics Committee of the authors' institution, and the experimental procedures were also approved by this committee. Moreover, we attempted to minimize the number of the birds for the experiments.

2.1. Statistical Analysis

Data analysis was performed in SAS statistical software (2000) [18], and the mean values were compared using the Tukey's test. The following statistical model was used to demonstrate the number of each control in the experiments:

$$X_{ij} = \mu + T_j + e_{ij}$$

where X_{ij} and μ show the total average of the population considered zero based on the samples, T_j is the effects of each experimental diet group, and e_{ij} represents the effect of the error.

The total value of the observed treatment effects and mean test error were resulted from the entire population. Before the statistical analysis of the data, all the data were assessed using normality tests.

3. Results and Discussion

According to the obtained results, the feed intake did not improve significantly in the treatment groups supplemented with the savory plant during the starter (days 1-21), grower (days 22-42), and total periods (42-day production cycle) (Figure 1). Similarly, the daily weight gain did not improve significantly in these groups during the grower (days 22-42) and total periods (42-day production cycle), while a significant improvement in this regard was observed in the starter period (days 1-21; $P < 0.05$) (Figure 2).

According to the findings of the current research, the FCR improved in all the groups supplemented with the savory plant during the grower (days 22-42) and total periods (42-day production cycle; $P < 0.05$), while no such improvement was denoted in the starter period (days 1-21; $P < 0.05$) (Figure 3).

The results of the present study indicated that the bot natural SP and SE that were added to feed or drinking water, respectively could improve the FCR at the end of the 42-day production cycle without adverse effects on the feed intake and daily weight gain. This is consistent with the study by Hashemipour et al. (2014) [8], in which a commercial product was used. Contrarily, SP was reported to have no significant effects on the feed intake, daily weight, and FCR in the studies by Zamanimoghaddam et al. (2007) [12] and Ghalamkari et al. (2011) [13]. It is notable that low levels of SP were used in the mentioned studies (0.5% and 1%, respectively).

In a research in this regard, Nobakht et al. (2012) [14] only observed an increment in the feed intake in the broilers supplemented with 2% SP, while such increase was not denoted in the broilers supplemented with 0.0%, 0.5%, 1.0% or 1.5% SP, suggesting the palatability of the feed improvement at the highest level. Furthermore Ghalamkari et al. (2011) [13] reported no significant difference in terms of performance between the SP groups and an additional broiler group treated with flavophospholipol (4.5 mg/kg), which is an antimicrobial substance. In the mentioned study, it was emphasized that other than feed features, health and immune status factors could largely influence broiler performance. In fact, Pirgozliev et al. (2014) [19] observed that broiler rearing/hygienic conditions are influenced by nutrient availability with the use of an essential oil blend (XT 6930; Pancosma S.A., Geneva, Switzerland), which was composed of 5% carvacrol, suggesting that the rearing conditions should be considered for the proper interpretation of the findings regarding the use of essential oils.

Recently, some studies have confirmed the health benefits of medicinal plants. For instance, Movahhedkhah et al. (2019) reported that summer savory extract (*Satureja hortensis* L.) could be used as a natural feed additive in broilers, thereby positively affecting growth, plasma constituents, immune response, and ileal microflora [20]. Moreover, Vase-Khavari et al. (2019) confirmed the positive effects of three tropical medicinal plants on the growth performance, carcass features, blood constitutes, immune response, and gut microflora of broilers [21].

In another research, Qorbanpour et al. (2018) reported the positive effects of dietary ginger (*Zingiber officinale* Roscoe) on the growth, carcass features, blood biochemistry, immune responses, and intestinal microflora of broiler chicken [22].

Table 1: Feed Ingredients and Nutrient Analysis of Used Diets during Starter and Grower/Finished Periods (manufactured by authors)

Feed Ingredients (%)	Starter Period (from 1st to 21st day of age)	Grower/Finished period (from 22nd to 42nd day of age)
Corn	57.75	59.00
Soybean Meal	34.75	32.00
Corn Oil	3.50	3.50
Ca%22P%18	2.00	1.50
CaCO3	0.0	1.30
Anzymite[1]	0.0	1.20
NaCl	0.20	0.20
DL-Methionine	0.15	0.15
Lysine-Hydro-Chloride	0.15	0.15
Mineral Mixture[2]	0.5	0.50
Vitamin Mixture[3]	0.5	0.50
Nutrient analysis		
Energy (kcal/kg)	3019.80	2995
Protein (%)	20.48	19.39
Calcium (%)	1.00	0.85
Available Phosphorus (%)	0.50	0.42
DCAB (mEq/kg)	236	202
Lysine SID[3] (%)	1.15	0.96
Methionine SID (%)	0.50	0.48
Methionine+ Cysteine SID (%)	0.83	0.78
Threonine (SID) (%)	0.79	0.71

[1] $[(K_2,Na_2,Ca,Mg)_3.Al_6Si_30.O_{72}.24H_2O]$
[2] Cu: 3 mg/g; Zn: 15 mg/g; Mn: 20 mg/g; Fe: 10 mg/g; K: 0.3 mg/g
[3] Vitamin A: 5000 IU/g; Vitamin D_3: 500 IU/g; Vitamin E: 3 mg/g; Vitamin K_3: 1.5 mg/g; Vitamin B_2: 1 mg/g; Calcium Pantothenate: 4 mg/g; Niacin: 15 mg/g; Vitamin B_6: 13 mg/g
3SID (Standardized Ileal Digestible).

Figure 1: Feed intake of Ross 308 broilers at starter (±26.6), grower (± 60.2), and total (± 62.8) periods (gr/chick/period)

Control group: standard diets ;
SP1: diets supplemented with 1.0% savory powder;
SP2: diets supplemented with 2.0% savory powder;
SE50: drinking water supplemented with 50 ppm savory extract;
SE100: drinking water supplemented with 100 ppm savory extract.

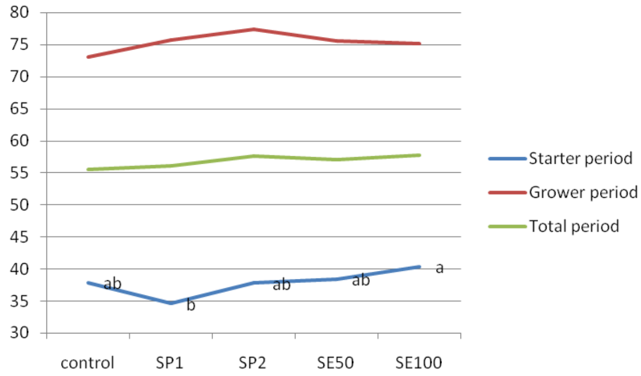

Figure 2: Daily weight gain of Ross 308 broilers at starter (± 0.8), grower (± 1.9), and total (± 1.0) periods (gr/chick/day)

a,b: Different letters within the same column indicate significant differences among treatment groups (P< 0.05).
Control group: standard diets;
SP1: diets supplemented with 1.0% savory powder;
SP2: diets supplemented with 2.0% savory powder;
SE50: drinking water supplemented with 50 ppm savory extract;
SE100: drinking water supplemented with 100 ppm savory extract.

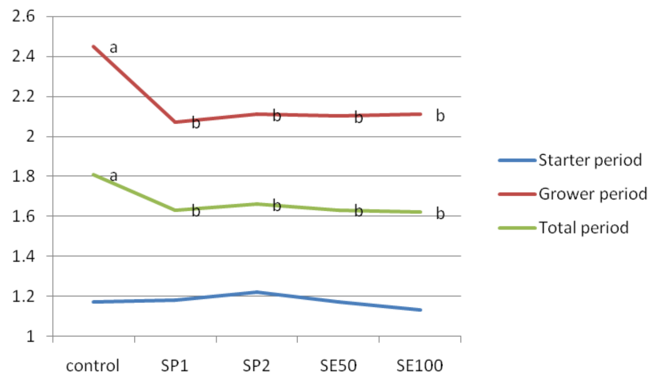

Figure 3: Feed conversion ratio of Ross 308 broilers at starter (± 0.01), grower (± 0.04), and total (± 0.04) periods (gr/gr)

a,b: Different letters within the same column indicate significant differences among treatment groups (P< 0.05).
Control group: standard diets ;
SP1: diets supplemented with 1.0% savory powder ;
SP2: diets supplemented with 2.0% savory powder ;
SE50: drinking water supplemented with 50 ppm savory extract;
SE100: drinking water supplemented with 100 ppm savory extract.

Similarly, Ebrahimi et al. (2013) confiemed the positive effects of various concentrations of summer savory (*Satureja hortensis* L.) on the blood parameters and gastrointestinal microbial population of broiler chicken [23].

On the other hand, Hassanzadazar et al. (2019) reported the antimicrobial effects of the nanoemulsion of rosemary essential oil against important foodborne pathogens [24].

In another study, Hosseini et al. (2019) confirmed the antibacterial and antioxidant effects of clove (*Syzygium aromaticum*) and lemon verbena (*Aloysia citriodora*) essential oils [25], while Khanzadi et al. (2019) determined the chemical composition and antibacterial activity of the emulsion and nanoemulsion of *Ziziphora clinopodioides* essential oil against *Escherichia coli* O_{157}:H_7 [26]. Finally, Raji et al. (2019) investigated the positive effects of the chitosan coating nanoemulsion containing *Zataria multiflora* and *Bunium persicum* essential oils on *E. coli* O_{157}:H_7 in vacuum-packed rainbow trout fillet [27]. Further investigations are required in order to accurately determine the effects of these medicinal plants on various biological systems.

In the current research, the FCR improvement in the total production period was due to the FCR differences between the control and treatment groups, which were observed during the grower period, in which the daily weigh gain and subsequent meat protein deposition were intense in the broiler chickens. Therefore, it is recommended that other studies also evaluate the effects of the summer savory herb on broiler performance only with the supplementation of a grower diet with SP and SE.

4. Conclusion

According to the results, 1% and 2% summer savory powder and 50 and 100 ppm of the summer savory extract added to feed or drinking water, respectively could improve the FCR on day 42 of the broiler production cycle, which renders them proper alternatives to commercial essential oils.

Authors' Contributions

A.S., and S.G., designed the experiment. S.S.M., the performed field experiment and collected the data. A.S., S.G., and J.S., prepared, reviewed and revised the manuscript.

Conflict of Interest

None declared.

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