

Effect of Fennel and Sage Essential Oil on Nutritive and Bioproductive Indices of Broiler Chickens

Alin Milcomete¹, Lavinia Ștef¹, Eliza Simiz¹, Ioan Pet¹, Adela Marcu¹, Ducu Ștef¹, Marioara Nicula¹, Adrian Grozea¹, Voichița Gherasim¹, Călin Julean¹

¹Banat University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timisoara, Timisoara - 300645, Calea Aradului, 119, Romania

Abstract

The purpose of this experiment was to determine the effect of fennel and sage essential oils administered in a dose of 125, respectively 250 mg/kg CF in the feeding of broiler chickens on the bioproductive indices. The biological material was represented by sexed (male) broiler chickens belonging to the ROSS 308 hybrid on which the phasial breeding (1-10d, 11-21d, 22-35d) was practiced, while observing the recommendations from the ROSS 308 Broiler Management Guide, 2014. The chickens were divided into 5 experimental variants (T0, T1, T2, T3, T4), with 3 replications and 10 chickens/replication. The chickens from T0 (control) have received only the basic diet, for T1 and T2 the basic diet+fennel essential oil (125 and 250 mg/kg CF) were administered, and for T3 and T4, the basic diet+sage essential oil (125 and 250 mg/kg CF). During the first breeding period (0-10d), the highest value for the body weight was recorded at T2 (258.93 g), which also had the lowest feed conversion ratio (1.03 kg CF/kg WG). In the period 11-21d, also in T2, the highest body weight (913.80 g) and the lowest feed conversion ratio (1.29 kg CF/kg WG) were recorded. In the finisher phase (22-35d), T2 maintained differences compared to T0, for body weight +8.01% and -10.56%, for FCR. During the entire breeding period 1-35d, the lowest FCR was recorded in T2 (1.45 kg CF/kg WG). The difference between T2 and T0 was statistically ensured, which highlighted the positive effect of the fennel essential oil (250 mg/kg CF) on the bioproductive performance of broiler chickens.

Keywords: broilers, phytoadditives, essential oils, fennel, sage, performances

1. Introduction

According to the EU legislation, starting with 2006, the use of antibiotics as growth promoters was forbidden. The researches performed in the field of animal nutrition were focused on finding some alternatives for replacing antibiotics with other nutritional supplements. The use of food additives extracted from plants (phytoadditives) is a viable alternative for replacing the antibiotics as growth promoters in different species of animals [1, 2]. During the last period, together with prebiotics and probiotics, essential oils extracted from various aromatic plants which are

successfully used in human and animal nutrition are also used [3, 4]. The performed researches have highlighted the beneficial role of phytoadditives on the feed consumption, digestibility, endocrine system, immune system etc. [5-7]. The studies of Williams and Losa, 2001 [8] have shown that the use of essential oils in the feed of broiler chickens, have determined the increase of body weight, reduction of losses due to mortality and have improved the carcass quality. Also, the researchers have shown that essential oils have stimulated the production of enzymes at the level of the digestive tract and have improved the digestive use of nutrients [8]. The use of fennel and sage essential oils as growth promoters was studied by Cengiz et al., 2016 [9] and Traesel Carolina Kist et al., 2011 [10].

* Corresponding author: Calin Julean
Tel. 0747996005, Email: calinjulean@animalsci-tm.ro

The fennel essential oil (*Foeniculum vulgare aetheroleum*) is a stimulative for the circulatory system, endocrine system, respiratory system and digestive system. The anethole 70.58% [9], the main active component from the fennel essential oil, has antimicrobial properties [9, 11].

The sage essential oil (*Salvia officinalis aetheroleum*) has multiple medicinal properties, with antiseptic, antimicrobial and astringent roles. It also contributes to the improvement of bioproductive indices of broiler chickens [12].

By means of this study, the effect of fennel (*Foeniculum vulgare*) and sage (*Salvia officinalis*) essential oils with a concentration of 125 mg/kg CF, respectively 250 mg/kg CF was followed on the nutritional and bioproductive indices of broiler chickens.

2. Materials and methods

The experiment performed to establish the effects of fennel (*Foeniculum vulgare*) and sage (*Salvia officinalis*) essential oils in a concentration of 125 mg/kg CF, respectively 250 mg/kg CF on the nutritional and bioproductive indices of broiler chickens, was carried out during a five weeks period. The used biological material was represented by sexed broiler chickens belonging to the commercial broiler hybrid ROSS 308. The 150 ROSS 308 males have been distributed into five experimental variants (T0-control group, T1, T2, T3 and T4 experimental groups), each with three replications/variant and 10 chickens/replication (Table 1).

Table 1. Experiment organizational desing

1-10 d (Starter)				
T0 (n=30)	T1 (n=30)	T2 (n=30)	T3 (n=30)	T4 (n=30)
-	Fennel essential oil 125 mg/kg CF	Fennel essential oil 250 mg/kg CF	Sage essential oil 125 mg/kg CF	Sage essential oil 250 mg/kg CF
11-21 d (Grower)				
-	Fennel essential oil 125 mg/kg CF	Fennel essential oil 250 mg/kg CF	Sage essential oil 125 mg/kg CF	Sage essential oil 250 mg/kg CF
21-35 d (Finisher)				
-	Fennel essential oil 125 mg/kg CF	Fennel essential oil 250 mg/kg CF	Sage essential oil 125 mg/kg CF	Sage essential oil 250 mg/kg CF

The breeding period was 35d and the phasial growth was practiced: starter 0-10d, grower 11-21d and finisher 22-35d. The chickens were raised on the deep litter of straw bedding. *Ad libitum* feeding was used, with combined feed (CF). The CF have had nutritional specifications specific to every breeding phase: starter ME 3007 kcal/kg and 23.01% CP; grower ME 3099 kcal/kg and 21.50% CP; finisher ME 3196 kcal/kg and 19.99% CP (Table 2). The chickens received water at discretion. The microclimate from experimental shed observed the recommendations from the ROSS 308 Broiler Management Guide of the Aviagen Company, 2014. The chickens from variant T0 (control group) were fed with the basic diet, for variants T1 and T2 the basic diet+fennel essential oil 125, respectively 250 mg/kg CF were administered, and for the experimental variants T3 and T4, the basic diet+sage essential oil (125 mg/kg CF, for T3, respectively 250 mg/kg CF, at T4), were administered. Fennel and sage essential

oils have been incorporated in the CF on a soybean oil support.

The chickens were weighted at 1, 10, 21 and 35 d. Knowing the values for the body weight at the beginning and end of every breeding period, the weight gain (WG) was calculated. Knowing the weight gain, the average daily gain (ADG/period) was calculated for every breeding period. The average daily gain represents the ratio between the total weight gain and the number of days from every breeding period.

Also, the administered CF quantities have been recorded daily, and at the end of each experimental phase, the consumed CF quantity was calculated for every experimental variant. By dividing this quantity to the number of chickens from every replication, the CF quantity consumed by every chicken was obtained.

Knowing the values for the weight gain and the quantity of consumed combined feed, the feed conversion ratio (FCR) was calculated, expressed

in kg CF/kg WG. FCR was calculated for each breeding period (starter, grower and finisher) and for the total breeding period 1-35d. For the followed indicators, the statistical

differences between the control group (T0) and those four experimental groups (T1, T2, T3 and T4) have been highlighted using the ANOVA test combined with the Tukey HSD test.

Table 2. The composition of combined feed

Ingredients	Starter: 1-10 d	Grower: 11-21 d	Finisher: 22-35 d
Corn yellow	31.94	34.92	37.01
Wheat	20.00	20.00	20.00
Soy bean meal	39.56	35.67	31.99
Soybean oil	3.65	5.11	6.86
MCP	1.30	1.10	1.00
Limestone	1.30	1.10	1.10
Premix	1.00	1.00	1.00
DL-Methionine	0.40	0.40	0.36
L-Lysine HCl	0.27	0.22	0.21
Sodium bicarbonate	0.25	0.20	0.20
Sodium chloride	0.18	0.20	0.20
L. Threonine	0.15	0.08	0.07
Total	100	100	100
Calculated levels			
ME kcal/kg	3007	3099	3196
CP %	23.01	21.50	19.99
Lys %	1.44	1.29	1.19
M+C %	0.99	0.95	0.87
Ca %	0.98	0.84	0.81
P %	0.66	0.61	0.57
CF %	2.56	2.46	2.35

3. Results and discussion

Dynamics of body weight

In view of establishing the dynamics of body weight, weighings have been performed at the age of one day, at 10 d, 21 d and at 35 d. The results obtained after weighing are shown in Table 3. From the data presented in Table 3, it is noticed that, upon population, the chickens from the five experimental variants had a good uniformity ($V=3.64-5.91$), and from a statistical point of view, no significant differences have been noticed. At the age of 10 d, in T2, the highest body weight was recorded, this being with 9.34% higher than in group T0, but not ensured statistically for $p>0.05$. At the end of the second breeding period (21 d), T2 recorded the highest body weight, this being with 10.27% higher than T0. Following the application of the variance analysis test, statistical differences have been noticed ($p\leq 0.05$) between T2 and T0. At the age of 35 d, the body weight is comparable for the five experimental groups, and the differences between them have not been ensured statistically ($p>0.05$).

Weight gain dynamics

Based on the evolution of the body weight, the weight gain recorded by the chicken on every breeding phase (Table 4), was determined. From the data presented in Table 4 and Figure 1, the following are ascertained:

- during the 1- 10 d period, the highest weight gain was recorded in the experimental group T2 (220.00 g returning to 22.00g/d), followed by T1 (211.5 g, respectively 21.15g/d), T3 (202.00 g and 20.20 g/d) and T4 (190.00 g, respectively 19.00 g/d);
- during the grower period (11-21d) and finisher period (22-35d), the same ascending trend was ascertained, regarding the weight gain and the percentage differences recorded in the broilers from the five experimental groups. The variance analysis test did not show statistically ensured differences for $p>0.05$.
- during the entire breeding period of the broiler chickens (1-35d), the daily average gain was comparable for the five groups, with the highest value in T2 (250 mg fennel essential oil/kg CF) of 60.57 g which was 8.17% higher than T0, closely followed by T1 (125 mg fennel essential oil/kg

CF) of 58.94 g with +5.26% compared to T0 in which the lowest average daily gain was recorded (55.99 g). From a statistical point of view, the

differences between T0 and experimental groups (T1, T2, T3, T4) were not statistically ensured ($p > 0.05$).

Table 3. Dynamics of body weight and the differences compared with T0

Specification	T0	T1	T2	T3	T4
Weight at one day (g) X±Sx	38.80±0.83	38.15±0.62	38.93±0.88	38.73±1.03	38.80±1.00
V (%)	4.83	3.64	5.04	5.91	5.79
Differences %		-1.68	+0.33	-0.18	0.00
ANOVA test			p=0.702		
Tukey test		NS	NS	NS	NS
Weight at 10 d (g) x±Sx	236.80±9.85	249.65±8.68	258.93±9.08	241.93±13.74	237.81±12.45
V (%)	14.06	19.27	17.13	10.98	20.47
Differences %		+5.43	+9.34	+2.17	+0.43
ANOVA test			p=0.119		
Tukey test		NS	NS	NS	NS
Weight at 21 d (g) x±Sx	828.63±38.00	867.25±23.93	913.80±25.52	848.26±38.11	835.73±35.52
V (%)	10.16	10.39	11.19	9.19	13.42
Differences %		+4.67	+10.27	+2.36	+0.86
ANOVA test			p=0.040		
Tukey test statistical meaning		NS	*	NS	NS
Weight at 35 d (g) x±Sx	1998.63±42.99	2100.97±80.54	2158.81±83.37	2075.33±79.93	2059.03±92.95
V (%)	11.09	10.66	11.93	12.01	12.91
Differences %		+5.12	+8.01	+3.84	+3.02
ANOVA test			p=0.245		
Tukey test		NS	NS	NS	NS

NS - $p > 0.05$; * $p < 0.05$

Table 4. Weight gain dynamics and the differences compared with T0

Specification	T0	T1	T2	T3	T4	
1 - 10 d	WG/chicken (g)	198.00±9.85	211.5±7.68	220.00±8.08	202.20±12.84	199.01±13.45
	ADG (g)	19.8	21.15	22.00	20.22	19.90
	Differences %		+6.81	+11.11	+2.12	+0.05
	ANOVA test			p=0.117		
	Tukey test		NS	NS	NS	NS
11-21 d	WG/chicken (g)	591.83±27.25	617.60±30.46	654.87±32.60	606.33±30.99	597.92±32.81
	ADG (g)	59.18	61.76	65.48	60.63	59.79
	Differences %		+4.35	+10.65	+2.45	+1.02
	ANOVA test			p=0.177		
	Tukey test		NS	NS	NS	NS
22-35 d	WG/chicken (g)	1170.00±54.67	1233.72±59.28	1245.01±73.65	1227.07±63.21	1223.30±93.15
	ADG (g)	83.57	88.12	88.93	87.65	87.38
	Differences %		+5.45	+6.41	+4.87	+4.56
	ANOVA test			p=0.727		
	Tukey test		NS	NS	NS	NS
1-35d	WG/chicken (g)	1959.83±40.99	2062.82±80.54	2119.88±82.37	2036.60±78.94	2020.23±104.95
	ADG (g)	55.99	58.94	60.57	58.19	57.72
	Differences %		+5.26	+8.17	+3.92	+3.08
	ANOVA test			p=0.245		
	Tukey test		NS	NS	NS	NS

NS - $p > 0.05$; * - $p < 0.05$

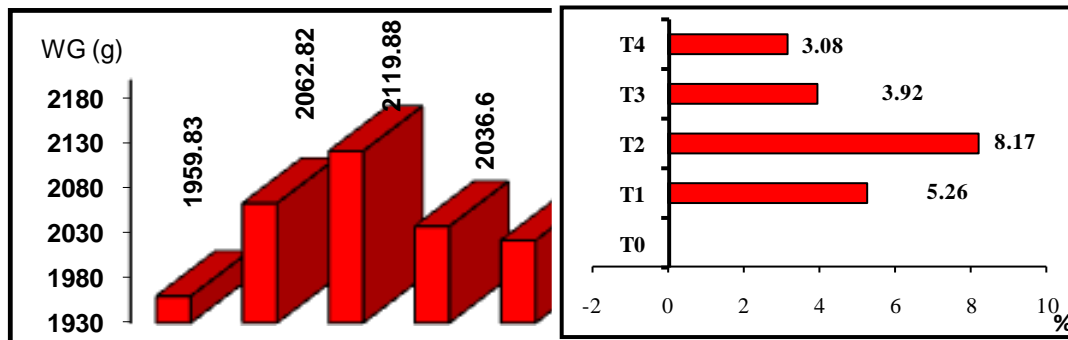


Figure 1. Dynamics of the weight gain and the differences

Dynamics of the feed conversion ratio (FCR)

FCR was obtained based on the ratio between the consumed combined feed quantity during every breeding period and the appropriate weight gain. FCR dynamics, as well as the statistical processing results are shown in Table 5 and Figure 2.

From the tabular data (Table 5) and Figure 2, it is ascertained that:

- during the breeding phase 1-10 d in experimental groups (T1, T2, T3, T4), FCR was lower as compared with group T0 (-6.37%, in T2; -2.73%, in the case of groups T1 and T3, and respectively -1.82%, for T4. During the following breeding periods (11-21d, respectively 22-35d), for FCR, the same dynamics was kept.
- during the entire breeding period (0-35d), the lowest feed conversion ratio was found in group

T2 (1.45 kg CF/kg WG) with -11.05% lower than group T0. Following the statistical processing by means of ANOVA test, significant differences were noticed, the significance coefficient having the value of 0.036. Following the application of Tukey HSD test, significant differences ($p \leq 0.05$) were noticed between T2 and T0 and no significant differences were found between the other variants ($p > 0.05$).

Similar results were obtained of Cengiz at al. [9] which revealed that diet supplementation with fennel essential oils significantly improves BWG and FCR.

Values obtained in this paper was in agreement with results of Fotea and Leonte [12] which supplemented diets of broiler chickens with sage essential oil at different levels. The authors reported positive effect on body weight, daily weight gain and feed conversion ratio.

Table 5. Dynamics of the feed conversion ratio (FCR) and the differences compared with T0

	Specification	T0	T1	T2	T3	T4
1-10 d	FCR (kg CF/kg gain)	1.10±0.03	1.07±0.01	1.03±0.001	1.07±0.11	1.08±0.11
	Differences %		-2.73	-6.37	-2.73	-1.82
	ANOVA test			p=0.864		
	Tukey test		NS	NS	NS	NS
11-21 d	FCR (kg CF/kg gain)	1.50±0.12	1.31±0.34	1.29±0.11	1.34±0.1	1.33±0.14
	Differences %		-12.67	-4.00	-10.67	-11.33
	ANOVA test			p=0.178		
	Tukey test		NS	NS	NS	NS
22-35 d	FCR (kg CF/kg gain)	1.80±0.15	1.63±0.15	1.61±0.04	1.63±0.04	1.63±0.07
	Differences %		-9.44	-10.56	-9.45	-9.45
	ANOVA test			p=0.199		
	Tukey test		NS	NS	NS	NS
1-35 d	FCR (kg CF/kg gain)	1.63±0.08	1.48±0.09	1.45±0.02	1.49±0.03	1.48±0.07
	Differences %		-9.21	-11.05	-8.59	-9.21
	ANOVA test			p=0.036		
	Tukey test		NS	*	NS	NS

NS - $p > 0.05$; * - $p < 0.05$

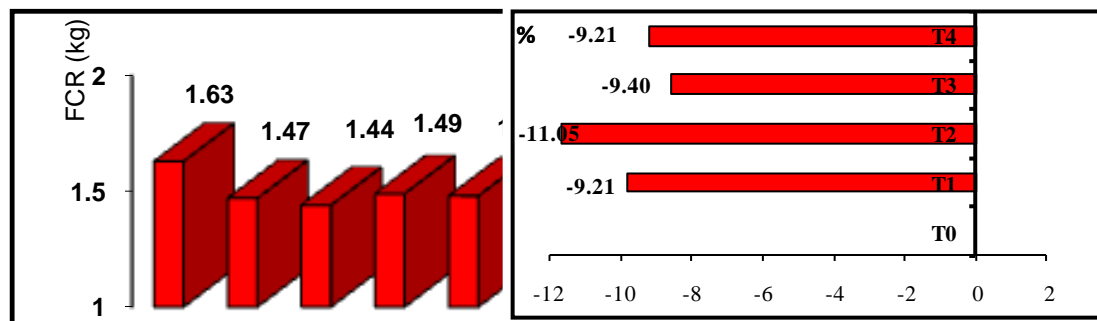


Figure 2. Dynamics of FCR and the differences

4. Conclusions

Introducing fennel and sage essential oils in diet at different levels aimed for broiler chickens had the following effects on the bio productive indices:

- The body weight at 35 d, for the experimental group T2, was higher as compared with the one recorded in group T0 with 8.01%, the differences were not statistically ensured ($p > 0.05$).
- The feed conversion ratio (FCR) has similar values, for the five groups. The lowest FCR was in T2, being 11.05% lower than in the control group T0, the difference being statistically ensured ($p < 0.05$).

Following the performed researches, the following recommendation can be made: in the case of broiler chickens, the supplementation of the diet with fennel essential oil at 250 mg/kg CF, ensures obtaining upper bio productive indices.

References

1. Bento, M., Ouwehand A., Tiihonen, K., Lahtinen, S., Nurminen, P., Saarinen, M., Schulze, H., Mygind, T., Fischer, J., Essential oils and their use in animal feeds for monogastric animals – Effects on feed quality, gut microbiota, growth performance and food safety: a review, *Veterinari Medicina*, 2013, 58, 449-458
2. Zhai, H., Liu, H., Wang, S., Wu, J., Klueber, A. M. Potential of essential oils for poultry and pigs, *Anim Nutr.*, 2018, 4(2), 179-186
3. Varel, V. H., Livestock manure odor abatement with plant derived oils and nitrogen conservation with urease inhibitors, *J. Anim. Sci.*, 2002, 80, 1–7
4. Toghyani, M., Toghyani, M., Gheisari, A., Ghalamkari, G., Mohammadrezaei, M., Growth performance, serum biochemistry and blood hematology of broiler chicks fed different levels of black seed (*Nigella sativa*) and peppermint (*Mentha piperita*, *Livest. Sci.*, 2010, 129, 173–178
5. Kirkpinar, F., Unlu, H. B., Ozdemir, G., Effects of oregano and garlic volatile oils on performance, carcass, organ and blood characteristics and intestinal microflora of broilers, *Livest. Sci.*, 2011, 137, 219-225.
6. Maenner, K., Vahjen, W., Simon, O., Studies on the effects of essential-oil-based feed additives on performance, ileal nutrient digestibility, and selected bacterial groups in the gastrointestinal tract of piglets, *J. Anim. Sci.*, 2011, 89, 2106–2112
7. Mountzouris, K. C., Paraskevas, V., Tsirtsikos, P., Palamidi, I., Steiner, T., Schatzmayr, G., Fegeros, K., Assessment of a phytogenic feed additive effect on broiler growth performance, nutrient digestibility and caecal microflora composition, *Anim. Feed Sci. Tech.*, 2011, 168, 223–231
8. Williams, P., Losa, R., The use of volatile oils and their compounds in poultry nutrition, *W. Poult.*, 2001, 17, 14–15
9. Cengiz, S. S., Yesilbag, D., Eren, M., Cetin, I., Meral, Y., Biricik, H., Effects of volatile oil additives on growth, carcass performances, and calcium and phosphorus concentrations in serum and bone of broilers, *Revue Méd. Vét.*, 2016, 167, 7-8, 230-239
10. Traesel, C. K., Lopes S. T. dos Anjos, Wolkmer P., Schmidt C., Santurio J. M., Alves S. H., Óleos essenciais como substituintes de antibióticos promotores de crescimento em frangos de corte: perfil de soroproteínas e peroxidação lipídica, *Ciência Rural*, 2011, 41(2), 278-284
11. Attia, G., El-Eraky, W., Hassanein, E., El-Gamal, M., Farahat, M. and Hernandez-Santan, A., Effect of Dietary Inclusion of a Plant Extract Blend on Broiler Growth Performance, Nutrient Digestibility, Caecal Microflora and Intestinal Histomorphology, *International Journal of Poultry Science*, 2017, 16, 344-353
12. Fotea, L., and Leonte, D., The effect of sage (*Salvia Officinalis*) essential oil on broiler performance, *Analele Universității din Oradea, Fascicula Ecotoxicologie, Zootehnie și Tehnologii de Industrie Alimentară*, 2011, X/B, 321-326