Effect of oregano essential oil as a diet supplement on the productive performance and meat quality of broiler chickens

Simona Pașcalău, Camelia Răducu, Andrada Ihuț, Gergő Páll, Mirela Cadar, Cristina Hegedüs

Faculty of Animal Science and Biotechnologies, University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Cluj-Napoca, Romania. Corresponding author: C. Hegedüs, cristina.hegedus@usamvcluj.ro

Abstract. This research was conducted to determine the effect of oregano essential oil added to the diet of broilers on body weight gain, feed consumption, feed conversion ratio (FCR) and on the chemical composition of meat and liver. For this purpose, two groups of one-day old broiler chickens Ross 308, a control group (CG) and an experimental group (EG) were raised for 42 days. In the experimental group, 1% of oregano essential oil was added to the standard diet, dissolved in vegetable oil and mixed with the administered diet. The live body weight (LBW) of the chickens at 42 days was higher in the control group (2099.69±29.56 g) compared to that of the experimental group (1972.23±42.20 g). The total feed consumption of the control group was 4393.62 g per bird, higher in comparison with the experimental group, which registered 4067.45 g per bird. The feed conversion indices of 2.14 (CG) and 2.11 (EG), favouring the experimental group. With regards to the chemical composition of meat and liver, a higher proportion of dry matter was recorded in the samples collected from breast and thighs musculature and liver of experimental group of chickens.
Key Words: growth performance, meat chemical composition, nutrition.

Introduction. Due to its superior taste properties and special nutritional value, poultry meat is highly appreciated by consumers. The poultry industry must respond to the challenges posed by the market in regards to nutritional, sanitary and organoleptic quality criteria. Consumers are increasingly concerned and informed about their diet, which influences their quality of life. Poultry meat consumption could presents some advantages compared to other human foods, and might be a good option in the diet.

For a long time, the oxidative stability of meat was controlled using synthetic antioxidants. The concern of the consumers about the possibility of consuming synthetic supplements led to the identification of some natural antioxidants and antimicrobial agents as alternatives to the synthetic ones (Aziza et al 2010; Davies & Wales 2019). Algae represent an important source of unconventional proteins, oils, vitamins, minerals, antioxidants and colorants. Supplementation of *Spirulina pratensis* in broiler diets may replace the incorporation of vitamin-mineral premix and antibiotics (Alshelmani et al 2021). Red grape pomace is rich in flavonoids and can be used in broiler diets, having a positive effect on live weight and breast weight (Haščík et al 2020).

Oregano essential oil is known for its antioxidant, antimicrobial, antifungal and insecticidal properties given by carvacrol and thymol, two phenols that are found in its composition in proportion of 78-82% (Marcinčák et al 2008). Its administration as a supplement in the diet of broilers may constitute a natural alternative to antibiotics and medication, due to the absence of side effects and residues (Alagawany et al 2018; Silva-Vázquez et al 2018). In the context of the European Union's Regulation 1831/2003, which banned the use of antibiotics as growth promoters in animal production, the identification of supplemental natural feed additives that can also ensure productive efficiency is in the attention of specialists. Oregano essential oil can be used in broiler diets as a phytogenic additive (Eler et al 2019).

Essential oils favour digestion and absorption and increase immunity (Yang et al 2019). In general, the use of natural compounds as an alternative source to antibiotics in broiler diets can delay the oxidation of fats and improve the quality of meat and meat products (Marcincák et al 2008). However, the effects of many products used as alternative sources can be cancelled by the interaction with different ingredients of the basic diet. In addition, these antioxidants have different effects caused by the composition of oil or fats from the broiler diet, which can alter their activity or effect (Yanishlieva et al 1999). There are some studies which showed that the use of oregano powder as a supplement in the broiler diet could improve the growth performance and antioxidant status of broiler chicken (Ri et al 2017). The chemical composition of oregano oil may vary depending on weather, season, harvest cycle, extraction process and crop location (Ortega-Nieblas et al 2011).

This study aims to determine the effect of administering oregano essential oil in the diet of broiler chickens on body weight gain, feed consumption, feed conversion ratio (FCR) and the chemical composition of meat and liver.

Material and Method. The biological material was represented by Ross 308 broiler chickens, which were divided into two groups of 20 chickens each, one control group (CG) and one experimental group (EG). The chickens were bred from the age of 1 day to 42 days. The rearing of chickens was done in a family farm from Gheorgheni, Romania. The chickens were reared in two pens of 3 m^2 each, on a floor surface, on permanent bedding consisting of chopped straw. In the first 14 days, a light program of 23 hours per day was provided, and from that moment until the end of growing period, the chicks benefited only of natural light for 13-14 hours per day. The ambient temperature gradually decreased, from 32-30^{o}C in the first three days to 20^{o}C on day 25, after which it remained constant until the end of the growth period.

The feeding of the chickens had several phases, with commercial starter feed mixture in the period of 1-14 days, growth feed in the period of 15-35 days and finishing feed in the period of 36-42 days (Table 1).

Table 1

Nutritional characteristics of the administered combined fodder

Specification	*Starter (1-14 days)*	*Growth (15-35 days)*	*Finishing (36-42 days)*
Crude protein (%)	20.39	17.0	15.01
Crude fats and oils (%)	2.88	3.33	2.65
Crude fiber (%)	3.85	4.20	5.43
Ash (%)	6.00	5.75	5.07
Calcium (%)	0.70	0.9	0.81
Phosphorus (%)	0.57	0.55	0.59
Sodium (%)	0.14	0.16	0.20
Lysine (%)	1.23	0.98	0.56
Methionine (%)	0.47	0.38	0.30

The starter fodder had the following ingredients: corn, wheat, fodder sorghum, corn cob, soybean meal, calcium carbonate, monocalcium phosphate, vegetable oil and salt. The growth fodder contained corn, wheat, soybean meal, wheat fodder flour, sunflower grist, wheat bran, calcium carbonate, rapeseed grist, monocalcium phosphate and sodium chloride. The finishing fodder presented the following ingredients: corn, wheat, sunflower grist, barley, wheat bran, rapeseed seed flour, soybean grist, calcium carbonate, salt and monocalcium phosphate.

In the experimental group, 1% of oregano essential oil dissolved in sunflower oil was added to the feed mixtures during the entire growth period. Fodder and water were administered *ad libitum*. The used oregano essential oil is produced by the Solaris Plant S.R.L. It was obtained by water steam distillation processes from the leaves and stems of the plant *Origanum vulgare* (https://solarisplant.ro).

The body weight of the chickens was determined by individual weightings at the age of 1 day and subsequently at every seven days until the end of the growing period. Average daily gain was established for each seven days interval. The feed consumption for each group was recorded daily, and the feed conversion ratio (FCR) was calculated by dividing the total amount of consumed diet to the total gain in body weight.

At the end of the growth period, the chickens were slaughtered and meat samples were collected randomly from five chickens per each group, from the breast, thighs and liver, for chemical analysis. The assessment of water and dry matter (DM) content from the collected samples was established by the drying method in oven, the mineral substances (MS) were determined by the calcination method, the determination of fat content (F) was made using the Soxhlet method, and the Kjeldahl method was used for protein content determination (CP) according to Iurcă & Răducu (2005) and AOAC (2005). For statistical analysis, ANOVA Single Factor was used.

Results and Discussion. In order to establish the effect of oregano essential oil administered as a supplement in the diet of broilers, the measurements were focused on the growth performances of chickens, feed consumption, conversion index and the chemical composition of meat and liver. At 42 days, the average body weight of chickens in the experimental group was 1972.23±42.20 g per bird, with 127.46 g lower than the average body weight recorded in the control group (2099.69±29.56 g). The average body weights of the groups are presented in Table 2.

Table 2

Dynamics of body weight

Age (days)	*Average body weight (g/bird)*		
	CG (x±sx)	*EG (x±sx)*	*p-value*
1	50.31±1.66	51.77±1.01	0.2707
7	165.54±2.00	150.15±6.60	0.0017
14	519.31±16.03	481.54±20.59	0.0310
21	858.92±24.06	843.46±10.80	0.3750
28	1488.62±11.26	1323.76±25.25	0.0001
35	1857.85±23.76	1789.69±42.70	0.0380
42	2099.69±29.56	1972.23±42.20	0.0011

Note: x – mean; sx – standard error of mean; CG – control group; EG – experimental group; $p>0.05$ – not significant; $p<0.05$ - * significant; $p<0.01$ - ** distinctly significant; $p<0.001$ - *** very significant; $p<0.0001$ - **** extremely significant.

The differences between the average body weight of groups are statistically distinctly significant at the age of 42 days ($p<0.01$). A similar situation was also found in the average daily gain, which was 45.74 g per bird per day in the experimental group and 48.79 g per bird perday in the control group during the entire growth period (Table 3).

The results obtained by different authors regarding the effect of oregano essential oil administration as a growth promoter in broiler chickens are different. Some authors pointed out an improvement in growth performance (Fotea et al 2010), while others have not found significant effects (Barreto et al 2008; Marcinčák et al 2008; Symeon et al 2009; Ri et al 2017).

Table 3

Dynamics of body weight gain

Period (days)	Body weight gain			
	CG		EG	
	Total (g per bird per period)	Daily average (g per bird per day)	Total (g per bird per period)	Daily average (g per bird per day)
1 – 7	115.23	16.46	98.38	14.05
8 – 14	353.77	50.54	331.39	47.34
15 – 21	339.61	48.52	361.92	51.70
22 – 28	629.70	89.96	480.30	68.61
29 – 35	369.23	52.75	465.93	66.56
36 – 42	241.84	34.55	182.54	26.08
1 – 42	2049.38	48.79	1920.46	45.74

Note: CG – control group; EG – experimental group.

Positive effects of the oregano essential oil administration were observed in the analysis of the data recorded for the feed consumption (Table 4). During the research period, in the experimental group, the total feed consumption was of 4067.45 g per bird, and the average daily feed consumption was of 96.84 g per bird. In the control group, the total feed consumption value was higher with 326.17 g per bird, and the average daily feed consumption was higher with 7.77 g per bird. Alp et al (2012) also found a decrease in feed consumption and a better conversion rate in chickens with additional oregano oil compared to the control group.

Table 4

Consumption of combined feed

Period (days)	Feed consumption				p-value for daily average
	Total (g per bird per period)		Daily average (g per bird per day)		
	CG	EG	CG	EG	
1 – 7	149.66	139.02	21.38	19.86	0.6578
8 – 14	352.87	343.28	50.41	49.04	0.7573
15 – 21	622.23	594.23	88.89	84.89	0.3031
22 – 28	901.95	858.01	128.85	122.57	0.2021
29 – 35	1115.66	1029.66	159.38	147.09	0.0120
36 – 42	1251.25	1103.25	178.75	157.61	0.0001
1 – 42	4393.62	4067.45	104.61	96.84	0.5079

Note: CG – control group; EG – experimental group; $p>0.05$ – not significant; $p<0.05$ - * significant; $p<0.01$ - ** distinctly significant; $p<0.001$ - *** very significant; $p<0.0001$ - **** extremely significant.

The p-value calculated for daily average feed consumption (Table 4) for the entire period of growth (1-42 days) shows that there are statistically insignificant differences between the two groups ($p>0.05$). During the entire growth period, the feed conversion index recorded a value of 2.11 kg of feed kg^{-1} of weight gain for the experimental group and slightly superior for the control group, with 2.14 kg of feed kg^{-1} of weight gain. Alagawany et al (2018) mentioned that the use of 1% oregano oil led to a better conversion ratio of the feed.

The quality of meat and liver was assessed in terms of the chemical composition from the samples collected from breast and thighs musculature and from the liver. The obtained results showed a reduction in water content in all samples collected from chickens of the experimental group (Table 5).

Table 5

The chemical composition of meat and liver

Specification		Breast			Thighs			Liver		
		x±sx	V%	p-value	x±sx	V%	p-value	x±sx	V%	p-value
Water (%)	CG	74.12±0.27	0.36	0.14	71.36±0.30	0.85	0.02	75.80±0.27	0.74	0.001
	EG	73.83±0.20	0.27		70.10±0.31	0.89		73.58±0.28	0.77	
DM(%)	CG	25.88±0.27	1.05	0.14	28.64±0.30	2.14	0.02	24.20±0.27	2.34	0.001
	EG	26.17±0.20	0.78		29.90±0.31	2.09		26.42±0.28	2.15	
F(%)	CG	1.29±0.09	7.31	0.97	3.06±0.09	6.22	0.0001	0.94±0.03	7.28	0.0001
	EG	1.29±0.13	10.44		4.48±0.14	6.47		1.54±0.06	8.28	
CP(%)	CG	23.78±0.25	1.07	0.09	24.57±0.18	1.52	0.68	21.97±0.27	2.47	0.005
	EG	24.07±0.14	0.58		24.45±0.22	1.80		23.57±0.26	2.23	
MS(%)	CG	0.81±0.09	3.49	0.96	1.00±0.04	9.49	0.68	1.28±0.02	4.14	0.36
	EG	0.80±0.02	3.69		0.97±0.05	10.74		1.31±0.01	2.27	

Note: CG – control group; EG – experimental group; x – mean; sx – standard error of mean; V% - variability; DM – dry matter; F – fat content; CP – crude protein content; MS – mineral substances; p>0.05 – not significant; p<0.05 - * significant; p<0.01 - ** distinctly significant; p<0.001 - *** very significant; p<0.0001 - **** extremely significant.

The chemical analysis of the samples collected from the breast musculature revealed a dry matter content of 26.17±0.2% in the experimental group and 25.88±0.27% in the control group. The studied indicator was homogeneous, the values of the variation coefficient being between 0.78% and 1.05%. The crude protein levels were 24.07±0.14% in the experimental group and 23.78±0.25% in the control group. The fat content had close values, 1.29±0.13% in the experimental group and 1.29±0.09% in the control group, while the mineral substances contents were 0.80±0.02% in the experimental group and 0.81±0.09% in the control group.

The dry matter content determined in the samples collected from thigh musculature was 29.9±0.31% in the experimental group and 28.64±0.3% in the control group. As regards to the fat content, larger differences were found between the groups, the average value being 4.48±0.14% in the experimental group and 3.06±0.09% in the control group. The content in protein and mineral substances had close values in both studied groups.

The analysis of the liver samples revealed dry matter content values of 26.42±0.28% in the experimental group and 24.20±0.27% in the control group. The protein content, fat content, and the mineral substances content were higher in the experimental group compared to the control group.

Conclusions. The results obtained in this study revealed that the administration of 1% oregano essential oil as a supplement in the diet of Ross 308 broiler chickens resulted in a reduction in feed consumption, a decrease in feed conversion index and a decrease in water content in the breast and thigh muscles and liver, but the differences were not sustained statistically.

Conflict of Interest. The authors declare that there is no conflict of interest.

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Authors:
Simona Pașcalău, Department of Technological Sciences, Faculty of Animal Science and Biotechnologies, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 3-5 Mănăstur St., RO-400372 Cluj-Napoca, Romania, e-mail: simona.pascalau@usamvcluj.ro
Camelia Răducu, Department of Technological Sciences, Faculty of Animal Science and Biotechnologies, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 3-5 Mănăstur St., RO-400372 Cluj-Napoca, Romania, e-mail: camelia.raducu@usamvcluj.ro
Andrada Ihuț, Department of Technological Sciences, Faculty of Animal Science and Biotechnologies, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 3-5 Mănăstur St., RO-400372 Cluj-Napoca, Romania, e-mail: andrada.ihut@usamvcluj.ro
Gergő Páll, Department of Technological Sciences, Faculty of Animal Science and Biotechnologies, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 3-5 Mănăstur St., RO-400372 Cluj-Napoca, Romania, e-mail: gergo.pall@student.usamvcluj.ro
Mirela Cadar, Department of Fundamental Sciences, Faculty of Animal Science and Biotechnologies, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 3-5 Mănăstur St., RO-400372 Cluj-Napoca, Romania, e-mail: mirela.cadar@usamvcluj.ro
Cristina Hegedüs, Department of Fundamental Sciences, Faculty of Animal Science and Biotechnologies, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 3-5 Mănăstur St., RO-400372 Cluj-Napoca, Romania, e-mail: cristina.hegedus@usamvcluj.ro

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