Paper received: 26.08.2019. Journal of Agronomy, Technology and Engineering Management
Paper accepted: 11.12.2019. ISSN: 2620-1755 Popović et al., 2019. Vol. 2(6): 335-343

Original research paper

THE USEFULNESS OF DIETARY ESSENTIAL OILS MIXTURE SUPPLEMENTATION ON QUALITY ASPECT OF POULTRY MEAT

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ABSTRACT: The main objective of this research was to determine the effects of dietary essential oils mixture of thyme (*Thymus vulgaris*), oregano (*Origanum vulgare*) and rosemary (*Rosmarinus officinalis*), on breast and thigh with drumstick composition, technological and sensory quality of poultry meat. In order to realize the tasks set, biological trial was carried out with 840 Ross 308 strain broiler chickens equally distributed into three dietary treatments. The diets were supplemented with no essential oils mixture (T1), essential oils mixture at 0.05% (T2) and essential oils mixture at 0.10% (T3). On the basis of gained results, it can be concluded that in breast and thigh with drumstick of experimental treatments protein content was statistically significantly ($p<0.05$) higher compared to control treatment. Additionally, in thigh with drumstick fat content was significantly lower in treatments T2 and T3 relative to those reared on control (without supplementation) diet, while in breast this difference was only numerically different. Ca content, hydroxyproline and collagen contents, as well as relative content of connective tissue proteins were also improved in treatments with addition of essential oils mixture. Based on the technological property parameters of meat such as pH, colour, water holding capacity and cook loss it is proved that essential oils mixture improved breast and thigh with drumstick quality. Moreover, regarding the sensory quality attributes a higher overall score for the breast and thigh with drumstick supplemented with essential oils mixture than for those of the control group was recorded. The findings obtained in this study highlight the potential of phytogenic feed additives as a tool to improve poultry meat quality and meet consumer expectations.

Key words: *phytobiotics, essential oil, broiler, poultry meat, meat quality*

INTRODUCTION

Poultry meat is considered as an easily available source of high-quality and easily digestible protein and other nutrients that are necessary for proper body functioning, and it is characterized by low saturated fat content (Kralik et al., 2017). Additionally, relatively low sales prices of poultry meat, in comparison to other types of meat, speak in favor of the increased poultry meat consumption. In order to meet the consumers' greater quality demands for high-quality meat, but keeping also in mind animal welfare

and environmental pollution, last two decades much attention has been drawn to phytobiotics. After the ban of antibiotic growth promoters (AGP) in the EU, phytobiotics have been recognised as a promising alternative due to their high content of pharmacologically active compounds (Hassan et al., 2018). It should be also emphasized that nowadays broiler chickens are fattened in an intensive way, so the stress is an unavoidable factor, and many scientist point out that this fast growth of broiler chickens resulted in modifications of muscle tissue, which has direct impact on meat quality (Adzitey and Nurul, 2011; Petracci and Cavani, 2012). Therefore, a huge number of *in vivo* studies have confirmed a positive effects of phytobiotics in broiler chicken nutrition on final quality of the meat (Ghazalah and Ali, 2008; Jamroz et al., 2003; Kirkpinar et al., 2014; Marcinčák et al., 2011; Puvača et al., 2014; Puvača et al., 2016; Symeon et al., 2009; Yesilbag et al., 2011).

Since world poultry meat consumption is constantly growing, it is very important to ensure constant improvement of poultry meat production and to offer product of improved quality. Therefore, it is valuable to examine impact of phytobiotics supplemented to broiler chicken feed on meat quality parameters.

MATERIAL AND METHODS

Experimental trial with broiler chickens was carried out under production conditions on a total of 840 one-day-old Ross 308 strain broilers, of both sexes, which were equally distributed into three dietary treatments, with eight replicates each. Dietary treatments in the experiment were as follows: T1 (Basal diet), T2 (Basal diet + essential oils mixture at 0.05%), T3 (Basal diet + essential oils mixture at 0.10%). The essential oils mixture consists of thyme (*Thymus vulgaris*), oregano (*Origanum vulgare*) and rosemary (*Rosmarinus officinalis*) essentials oils present in concentrations of 4, 3 and 3 g/100 g of mixture, while calcium carbonate was used as a carrier. The feeding program included a three-phase diet as starter, grower and finisher according to the experimental design given in Table 1. The experiment lasted for 42 days. Structural and chemical composition of used mixtures are given in Table 2. During the whole trial, feed and water were provided *ad libitum*. Rearing and housing conditions were in accordance with specific strain requirements, while the microclimatic condition was regularly monitored with SKOV climate system (Denmark) for poultry houses.

Table 1. Experimental design

Experimental treatments	Concentration of essential oils mixture in broiler chicken diets			
	Additive	**Starter, %** 1 – 21 days	**Grower, %** 22 – 35 days	**Finisher, %** 36 – 42 days
T1	-	-	-	-
T2	Essential oils mixture	0.05	0.05	0.05
T3	Essential oils mixture	0.10	0.10	0.10

At the end of 42nd day of biological trial, 36 broiler chickens (12 broiler chickens per treatment) of an average bodyweight were selected for meat-quality evaluations. Before slaughtering, broiler chickens were starved for 12 h. On slaughter, dressed cold carcasses were dissected into primal cuts such as breast, thighs with drumsticks, wings, back, head, neck and legs, following the method prescribed by the Regulation on Poultry

Meat Quality (1988). After 24 h *post-mortem*, samples of breast (*Musculus pectoralis*) and thigh with drumstick (*Tibialis anterior* and *Biceps femoris*) were used for further analyses.

Table 2. Structural and chemical composition of chicken diets excluding the additives (essential oils mixture was added on top of the basal diet)

Ingredients, %	**Diet mixtures**		
	Starter	**Grower**	**Finisher**
Maize	30.20	38.50	42.40
Wheat	25.00	25.00	25.00
Vegetable oil	0.95	1.25	1.85
Soybean cake	21.60	16.10	13.50
Soybean meal	18.00	15.00	9.00
Sunflower meal	-	-	4.00
Monocalcium phosphate	0.10	0.10	0.20
Limestone	0.02	0.03	-
Methionine DL	0.06	0.04	-
Ronazyme WX	0.01	0.01	0.01
Premix	4.00	4.00	4.00
Nutrients, % of as-fed basis			
Dry matter	89.60	89.20	88.90
Moisture	10.40	10.80	11.10
Crude protein	22.00	19.00	17.00
Crude fat	5.10	5.10	5.60
Crude fibre	3.50	3.20	3.60
Crude ash	6.30	6.00	5.50
Ca	1.00	1.00	0.90
P	0.80	0.80	0.70
Metabolizable Energy, MJ/kg	12.50	12.80	13.00

Proximate composition of breast and thigh with drumstick were determined according to the ISO recommended standards for moisture (ISO 1442 1998), protein (ISO 937 1992), fat (ISO 1443 1998) and ash (ISO 936 1999) contents. The preparation of samples for the determination of Ca content was carried out by method of Gorsuch (1970), whereupon Ca content was determined on a Varian SpectrAA 10 atomic absorption spectrophotometer. The content of total phosphorus (P) in the breast and and thigh with drumstick was determined by SRPS ISO 13730 method (1999), while hydroxyproline content was determined according to SRPS ISO 3496 method (2002). Collagen content was calculated by multiplication of hydroxyproline content by a factor of 8. Collagen was expressed as the percent of collagen in the total protein content. Relative content of connective tissue proteins was determined by dividing collagen content by protein content.

Technological quality of meat samples was evaluated by determinations of pH_k, colour, WHC and cooking loss in breast and thigh with drumstick. The pH values of meat

samples were measured 24-hour p.m. according to the SRPS ISO 2917 method (2004) using the portable pH meter Testo 205 (Testo AG, USA). Breast and thigh with drumstick colour were determined on the fresh cross section 24-hour p.m. using Minolta Chroma Meter CR - 400 (Minolta Co., Ltd., Osaka, Japan) and colour characteristics were presented in CIE L*a*b* system (lightness L*, redness a*, yellowness b*) (CIE, 1976). Water holding capacity (WHC) was determined by compression method and expressed as % of bound water (Grau and Hamm, 1953; Van Oeckel et al., 1999). The samples of breast and thigh with drumstick were roasted in the convection air oven at 175°C for 50 min, cooled at room temperature for 1 h and then analyzed for sensory characteristics. Cooking loss was evaluated by comparing the weight before and after roasting of meat samples. Six trained panelists, experienced in the sensory evaluation of various meat products were employed in order to determine sensory quality of meat samples. Sensory evaluation was carried out according to point system of analytical descriptive test using a scale from 0 to 5 (0-unacceptable, 5-optimal).
Statistical analyses were conducted using statistical software program Statistica 13.2 for Windows (StatSoft, Inc., Tulsa, OK, USA; 2016). Significant effects were explored using Analysis of variance (ANOVA) and Fisher's LSD (*least significant difference*) post hoc significance test. Differences were considered significant at $P<0.05$.

RESULTS AND DISCUSSION

Table 3 shows the results obtained by determining the nutritional quality of breast and thigh with drumstick.

The results given in Table 3 indicate that there were no significant ($P>0.05$) differences in moisture content between treatments, in both breast and thigh with drumstick. The highest concentration of protein in breast meat was observed in treatment T2 (23.84 g/100 g), followed by treatment T3 (23.56 g/100 g), and obtained values were significantly ($P<0.05$) higher from treatment T1 (22.50 g/100 g). In thigh with drumstick the highest protein content was recorded in treatment T3 (20.64 g/100 g). Negligible lower protein content was observed in treatment T2 (20.22 g/100 g), while in control treatment this value was significantly ($P<0.05$) lower (18.51 g/100 g). Perić (1982) points out that the amount of protein in meat is relatively constant, averaging 23.05 g/100 g in breast meat and 20.09 g/100 g in thigh with drumstick, which is consistent with results obtained in this paper. The free fat content in both, breast and thigh with drumstick, was significantly lower in treatments T2 and T3 compared to control treatment. Puvača et al. (2014) state that the addition of 2.0 g/100 g of garlic powder to the diet of broiler chickens contributes to a significant increase in the protein content of breast meat (by 5.05 g/100 g) compared to the control treatment, wherein it was recorded reduction of the free fat content in meat samples. From the results showed in Table 3 could be also noticed that Ca and P contents were significantly improved in treatments where essential oils mixture was used as a dietary supplement. Chicken meat contains low collagen levels, which is another positive characteristic of this foodstuff. The addition of a natural supplement in concentrations of 0.05 and 0.10% also improved meat quality in terms of collagen content. Collagen is a structural protein that reduces meat digestibility, so chicken meat is easier to digest than other types of meat. The results of this study confirm the well-known fact that poultry meat contains more protein, the least connective tissue protein compared to other types of meat (beef and pork) and less fat (1-5%), so that can be considered as dietetic food (Barroeta, 2007).

Therefore, the poultry meat of broiler chickens fed with a mixture of essential oils of thyme, oregano and rosemary can be recommended as a valued high-nutritional low-fat, or low-calorie dietary product.

Table 3. Basic chemical composition of breast and thigh with drumstick of broiler chickens fed diets supplemented with essential oils mixture

Parameter	Treatments		
	T1	T2	T3
Breast			
Moisture (g/100 g)	74.14^{a}±0,39	74.84^{a}±0.92	74.88^{a}±0.63
Proteins (g/100 g)	22.50^{b}±0.68	23.84^{a}±1.39	23.56^{a}±1.01
Fat (g/100 g)	0.46^{a}±0.16	0.29^{a}±0.15	0.37^{a}±0.14
Ash (g/100 g)	1.06^{a}±0.07	1.10^{a}±0.05	1.14^{a}±0.15
Ca (mg/100 g)	4.69^{b}±0.54	30.36^{a}±4.11	33.99^{a}±4.04
P (g/100 g)	0.47^{b}±0.07	0.60^{a}±0.06	0.60^{a}±0.03
Hydroxyproline (%)	0.14^{a}±0.02	0.10^{b}±0.01	0.09^{b}±0.01
Collagen (%)	1.13^{a}±0.12	0.78^{b}±0.06	0.76^{b}±0.004
Relative content of connective tissue proteins (%)	5.02^{a}±0.41	3.27^{b}±0.22	3.22^{b}±0.18
Thigh with drumstick			
Moisture (g/100 g)	73.55^{a}±1.43	74.08^{a}±1.13	73.70^{a}±0.59
Proteins (g/100 g)	18.51^{b}±0.85	20.22^{a}±1.93	20.64^{a}±2.12
Fat (g/100 g)	5.08^{a}±1.71	3.62^{b}±0.57	3.21^{b}±0.65
Ash (g/100 g)	1.01^{a}±0.04	1.05^{a}±0.05	1.02^{a}±0.07
Ca (mg/100 g)	12.93^{b}±1.36	34.48^{a}±2.01	35.54^{a}±3.14
P (g/100 g)	0.46^{a}±0.09	0.50^{a}±0.08	0.49^{a}±0.03
Hydroxyproline (%)	0.16^{a}±0.03	0.11^{b}±0.02	0.13^{a}±0.03
Collagen (%)	1.30^{a}±0.21	0.86^{b}±0.08	1.07^{a}±0.10
Relative content of connective tissue proteins (%)	7.00^{a}±0.78	4.27^{b}±0.46	5.19^{b}±0.37

Treatments T1 = control diet; T2 = diet + 0.05% of essential oils mixture; T3 = diet + 0.10% of essential oils mixture. $^{a-b}$ Means in rows followed by different superscripts are significantly different (P<0.05)

Results of technological properties of breast and thigh with drumstick of broiler chicken fed diets supplemented with essential oils mixture are presented in Table 4. Obtained results revealed that breast meat samples of treatments T2 and T3 have higher pH_k values, compared to control treatment, but this differences between treatments were not significant (P>0.05). The same trend was noticed in thigh with drumstick samples. On the basis of average pH_k value of meat samples it could be indicated meat quality. According to pH_k values as parameters and criteria for determining the breast meat quality, PSE (pale, soft, exudative) quality is when pH_k<5.8, "normal" quality when the pH_k is in the range of 5.9 to 6.2, while DFD meat is characterized by pH_k≥6.3 (Ristić and Dame, 2010). If compare the average pH_k values of breast meat obtained in this paper with the proposed criteria, it could be noticed that the breast meat of broiler chickens

fed with essential oils mixture in concentrations of 0.05 and 0.10% could be classified as normal quality meat. Statistical data processing revealed that the difference in the pH_k values of breast meat, but of thigh with drumstick also, was not significant between the tested treatments ($P>0.05$).

Regarding the breast meat, the lightest muscles were for experimental treatment T1 with the lightness (L*) value of 57.43, while the darkest were muscles of the experimental treatment T3 (51.05). The breast meat lightness (L*) value in treatments T2 and T3 were significantly ($P<0.05$) improved compared to control treatment.

Table 4. Technological characteristic of breast and thigh with drumstick of broilers supplemented with essential oils mixture

	Treatments		
	T1	**T2**	**T3**
Breast			
pH_k	$5.83^{a}\pm0.12$	$5.92^{a}\pm0.08$	$5.92^{a}\pm0.03$
*L**	$57.43^{a}\pm1.33$	$51.45^{b}\pm1.09$	$51.05^{b}\pm0.59$
*a**	$2.31^{a}\pm0.34$	$2.56^{a}\pm0.95$	$3.25^{a}\pm1.04$
*b**	$4.88^{a}\pm0.95$	$4.58^{a}\pm0.91$	$4.17^{a}\pm1.05$
WHC	$55.63^{b}\pm1.04$	$63.25^{a}\pm3.83$	$63.79^{a}\pm5.91$
cooking loss	$25.86^{b}\pm3.74$	$20.99^{a}\pm6.48$	$18.57^{a}\pm3.89$
Thigh with drumstick			
pH_k	$6.20^{a}\pm0.07$	$6.08^{a}\pm0.02$	$6.06^{a}\pm0.22$
*L**	$47.19^{a}\pm2.20$	$49.12^{a}\pm3.10$	$50.38^{a}\pm3.80$
*a**	$7.14^{a}\pm2.43$	$6.98^{a}\pm2.48$	$7.48^{a}\pm2.25$
*b**	$5.05^{a}\pm1.80$	$6.46^{a}\pm2.71$	$6.00^{a}\pm1.87$
cooking loss	$22.67^{b}\pm2.04$	$16.68^{a}\pm3.01$	$18.41^{a}\pm3.82$

Treatments T1 = control diet; T2 = diet + 0.05% of essential oils mixture; T3 = diet + 0.10% of essential oils mixture. $^{a-b}$ Means in rows followed by different superscripts are significantly different ($P<0.05$)

Qiao et al. (2001) distinguish three qualities of chicken breast meat based on lightness (L*) value: meat brighter than normal when L*> 53; meat of normal quality when the lightness (L*) value ranges from 48 to 53; and meat darker than normal when the lightness (L*) value is L <46. If we compare the average lightness (L*) value of breast meat measured in this paper with the proposed criteria for determining the quality of breast meat, it can be concluded that the breast meat of broiler chickens fed diets supplemented with a mixture of essential oils of thyme, oregano and rosemary at concentrations of 0.05 and 0.10% is meat of normal quality, while the breast meat of control treatment was PSE meat. Regarding the thigh with drumstick, it was not recorded statistically significant differences in lightness (L*) value.

Regarding the WHC values, in Table 4 could be seen that this values in breast meat ranged from 55.63% (T1) to 63.79% (T3). Based on the results obtained by Fisher's LSD post-hoc test, it was found that the average WHC of breast meat, found in control broiler chickens, was statistically significantly ($P<0.05$) lower compared to the values of this indicator established in treatments E5 and E10. In a study conducted by Shirzadegan and Falahpour (2014), the addition of phytobiotics to the diet of broiler chickens

contributed to a reduction of WHC of meat from 62.9%, found in control treatment, to 57.37% in treatment with addition of a 0.5% phytobiotic mixture in broiler chicken diets. On the other hand, Yang et al. (2008) and Petracci et al. (2004) found in their studies that phytobiotics added to the diet of broiler chickens did not affect the value of this indicator, which is not consistent with the findings obtained in this paper.

Cooking loss was significantly (P<0.05) decreased in the breast meat from chickens that were consumed essential oils mixture, compared to control treatment. The same trend was in thigh with drumstick samples. In a study conducted by Garcia et al. (2010) it was found that PSE meat lost 14.61% more water during heat treatment compared to normal quality meat, which the authors explain by reduction of WHC in meat due to protein denaturation at lower pH values.

Table 5. Sensory quality of breast and thigh with drumstick of broilers supplemented with essential oils mixture

	Treatments		
	T1	**T2**	**T3**
Breast			
Colour	4.45^{b}±0.32	4.75^{a}±0.26	4.85^{a}±0.23
Smell	4.75^{a}±0.30	4.77^{a}±0.34	4.77^{a}±0.34
Taste	4.50^{a}±0.56	4.62^{a}±0.42	4.70^{a}±0.41
Tenderness	4.27^{b}±0.62	4.30^{ab}±0.33	4.57^{a}±0.37
Chewiness	4.10^{a}±0.70	4.32^{a}±0.41	4.37^{a}±0.39
Juiciness	4.12^{a}±0.67	4.60^{b}±0.38	4.57^{b}±0.47
Overall impression	4.40^{a}±0.47	4.70^{b}±0.30	4.77^{b}±0.26
Thigh with drumstick			
Appearance - colour	4.70^{a}±0.38	4.97^{b}±0.11	4.97^{b}±0.11
Taste and smell	4.55^{a}±0.53	4.65^{a}±0.33	4.75^{a}±0.38

Treatments T1 = control diet; T2 = diet + 0.05% of essential oils mixture; T3 = diet + 0.10% of essential oils mixture. $^{a-b}$ Means in rows followed by different superscripts are significantly different (P<0.05)

Based on the obtained results of evaluation of sensory quality of breast meat (Table 5) it could be noticed that significantly higher scores for colour, tenderness, juiciness and overall impression were recorded in the treatments T2 and T3 compared to control samples, demonstrating that the addition of essential oils mixture in broiler chickens diet did not have any adverse effect on meat quality. The same trend was noticed in thigh with drumstick samples regarding the appearance-colour of meat. Garcia et al. (2010) point out that the sensory characteristics of meat, such as color, texture and juiciness, are partly dependent on WHC. Since significantly higher WHC values were observed in the breast meat of broiler chickens fed with diets with the addition of essential oils mixture at concentrations of 0.05 and 0.10%, higher sensory ratings of certain breast meat properties in these treatments (tenderness, juiciness), compared to control samples, are more than expected. The positive influence of phytobiotics on the sensory properties of poultry meat has been demonstrated in many other studies (Jamroz et al., 2003; Ghazalah and Ali, 2008; Marcinčák et al., 2011; Yesilbag et al., 2011; Kirkpinar et al., 2014).Phytobiotics, such as thyme, oregano and rosemary, did not have

any residual or adverse effects on sensory quality of poultry meat, and therefore it could be successfully used in broiler chicken nutrition aiming to improve poultry meat quality.

CONCLUSION

Based on the obtained results, it can be concluded that with well-balanced feed, which contains optimal composition and content of naturally dietary supplement, can produce meat of improved nutritive, technological and sensory quality. This study investigation promotes use of dietary thyme, oregano and rosemary essential oils mixture in broiler chicken's nutrition in order to improve final quality of the poultry meat.

ACKNOWLEDGMENTS

This research is a result of the project III 46012 financed by the Ministry of Education, Science and Technological Development, Republic of Serbia.

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