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Original Paper

The effect of natural feed additive on productive performance of broiler chickens

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In this work we aimed to analyse the effect of different levels of Musculaton® with selected amino acids and herbal extracts on performance and carcass characteristics of broiler chickens. A total 240 one-day-old broiler chickens Ross 308 of mixed sex were divided into four experimental groups (n = 60): a control and three experimental groups with addition of Musculaton® in levels 0.75%, 1.00% and 1.25% in drinking water from 22 to 35 day of fattening. In nutrition, we used commercial feed mixtures, water and feed was provided ad libitum throughout the experimental period of 42 days. The body weights of all birds were recorded individually at weekly interval from 1 to 42 day. Total feed consumption and total mortality were determined to 42 day of fattening period. Carcass characteristics were detected at the end of the experiment. The addition of different levels of Musculaton® significantly increased (p <0.05) the live weight of broilers from 28 to 42 days of age compared with control. In the whole trial period, feed consumption and mortality were no affected by addition of Musculaton® to drinking water compared control group. As regards carcass parameters, the addition Musculaton® in drinking water significantly decreased (p <0.05) abdominal fat weight and significantly increased (p <0.05) breast proportion. Carcass yield and thigh proportion were not affected (p >0.05) by the application of Musculaton®. The liver, pancreas, kidney and small intestine proportions were significantly higher (p <0.05) in chickens supplemented by Musculaton®. In case of neck, crop, heart, proventriculus, gizzard, caecum and large intestine weights among control and experimental groups we observed no statistically significant differences (p >0.05).

Keywords: broiler chicken, amino acids, herbal extract, performance, carcass characteristics

1 Introduction

In the poultry industry, antibiotics are used to prevent pathogens and poultry diseases in order to improve meat and egg production. However, the use of dietary antibiotics has caused common problems, such as the development of resistant bacteria, medicine residues in poultry, and an imbalance in the normal microflora (Král et al., 2012; Hrnčár et al., 2017). In poultry nutrition, several alternatives to antibiotic growth promoters have been proposed such as for example organic acids (Kopecký et al., 2012; Capcarová et al., 2014; Kalafová et al., 2014), probiotics (Capcarová et al., 2010; Weis et al., 2010; Hrnčár et al., 2016), phytogenic feed additives (Hasheml and Davoodi, 2010; Suriya et al., 2012, Murugesan et al., 2015; Wang et al., 2015; Song et al., 2017), bee products (Attia et al., 2014; Daneshmand et al., 2015; Gheisari et al., 2017; Zafarnejad et al., 2017, Haščík et al., 2019, Haščík et al., 2020), enzymes (Al-Harthi, 2006) and other nature products (Hrnčár et al., 2015; Pistová et al., 2016; Hrnčár and Bujko, 2017; Hrnčár et al., 2018).

Addition of natural ingredients in poultry nutrition can have additional benefits for the health performance of broiler chickens (Brugalli, 2003; Hui et al., 2010). Essential amino acid methionine, lysine, and threonine are the three most limiting in nutrition of broiler chickens

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(Fernandez et al., 1994; Ojano-Dirain and Waldroup, 2002). The main metabolite of turmeric (*Curcuma longa* L.) is curcumin which with the potential used as substitute for antibiotics in poultry feed (Abou-Elkhair et al., 2014; Olukosi and Dono, 2014). The chemical composition of marjoram (*Origanum majorana* L.) extract as previously mentioned showed that it contains a variety of secondary metabolites and mainly carvacrol (Jamroz et al., 2003). These bioactive ingredients of the extract are reasons for improvement of gut health and nutrients absorption and utilization which ultimately enhance the health of broilers and increase their performance (Ali, 2014).

Musculaton® was developed as a natural growth promoter to ensure maximum growth of poultry at the end of fattening. This commercial preparation is also used to improve the appetite and compensate weight gain throughout the flock. Essential amino acids present in this formulation, methionine and lysine are responsible for muscular development, proper body building and the correct nitrogen balance. Lysine also activates tissue regeneration, thus enhances rapid growth of muscle proteins. Due to the presence of carvacrol and thymol originating from oregano extract, the poultry feed intake is improved and the absorption of nutrients in the body is accelerated. High content of turmeric extract improves the liver and pancreas function, thus more efficient metabolism of carbohydrates and fats, as well as better absorption of proteins. By stimulating appetite, the poultry gain muscular weight rather than fat and the taste of the meat is unaffected (Intermag, 2015).

The experiment was designed to examine the effect of inclusion of natural feed additive with selected amino acids and herbal extracts as a growth promoter on performance and carcass characteristics of broiler chickens.

2 Material and methods

Totally 240 one-day-old Ross 308 broiler chickens of mixed sex were weighed and randomly distributed into 4 treatments ($n = 60$) in independent pen with deep litter. Broiler chickens were kept up to 42 days (6 weeks) of age under uniform standard conditions in a temperature-controlled poultry house with a 23 h light and 1 h dark regime. The temperature was maintained at 32 °C during 1st week with a weekly decrease of 2 °C to a final temperature of 22 °C in 6th week.

Treatments s were prepared without additive in drinking water as control and with addition of 0.75%, 1.00% and 1.25% Musculaton® into drinking water from 22 to 35 day of fattening according to the producer's recommendations. Musculaton® (Intermag Ltd., Olkusz, Poland) was containing L-lysine (180,000 mg kg^{-1}), L-methionine (20,000 mg kg^{-1}), turmeric extract (10,000 mg kg^{-1}) and marjoram extract (25,000 mg kg^{-1}).

Broiler chickens were fed commercial feed mixtures (Biofeed a.s., Kolárovo, Slovak Republic): starter (12.01 MJ kg^{-1} metabolic energy, 210.76 g kg^{-1} crude protein) from 1 to 21 days, grower (12.03 MJ kg^{-1} metabolic energy, 190.42 g kg^{-1} crude protein) from 22 to 35 days and finisher (12.37 MJ kg^{-1} metabolic energy, 170.58 g kg^{-1} crude protein) from 36 to 42 days. All animals had free access to feed and water.

Broiler chickens were weighted individually at weekly interval from 1 to 42 day. The body weight gains were calculated as the difference between the final and initial chicken weight. Total feed consumption and total mortality were recorded at 42 days. At the end of fattening, 10 representative broiler chickens from each group were selected for slaughter and subjected to a 12-hours feed withdrawal. Abdominal fat, breast, thighs, drumsticks, back and wings were collected and weighed. The organs development was measured by taking weight of the broilers after slaughtering. Neck, crop, heart, proventriculus, gizzard (empty gizzard), liver (without gall bladder), pancreas, caecum, kidney, small intestine and large intestine weights were recorded individually and their percentages in relation to body weight were calculated. The results obtained were used to calculate carcass yield and the percentage of carcass components.

The data generated during the experiment were subjected to one-way analysis of variance per Duncan's Multiple Range Test (Duncan, 1955) and with the help of JASP 0.8.6 software (JASP, 2018).

3 Results and discussion

Growth performance of broiler chickens was recorded up to 42 days of age (Table 1).

There was significant (p <0.05) effect of Musculaton® supplementation on live weight from 28 to 42 day of age compared to control group. The best result we achieved in experimental group with the application of 1.00% Musculaton®. Our results suggested that the effect of marjoram plant extract supplementation was more pronounced at the later growth phase than broilers' growth in the first stage, which contradicts the findings of Ocak et al. (2008). The results of our study are in accordance with Osman et al. (2010) who noted that broiler chickens fed with marjoram at the level 1 g kg^{-1} at 28 and 42 days of age had a higher average live weight those received the lower level of 0.5 g kg^{-1}. Equally, Ali (2014) found that addition of 1.00% and 1.50% marjoram powder into broiler diets had significant effect on live

Table 1 Effects of different levels of Musculaton® on live weight and live weight gain of broiler chickens

Day of fattening	Control mean ± SD	Musculaton®		
		0.75% mean ± SD	1.00% mean ± SD	1.25% mean ± SD
Live weight (g)				
1.	46.37 ±2.98	46.11 ±2.75	46.53 ±3.06	45.98 ±2.63
7.	122.56 ±21.76	123.87 ±22.48	122.42 ±22.38	123.58 ±23.12
14.	331.86 ±49.23	333.28 ±50,65	332.48 ±50.54	331.95 ±49.66
21.	701.65 ±88.98	707.36 ±90.38	706.62 ±89.17	704.52 ±89.88
28.	1,193.82 ±139.03^{b}	1,224.23 ±141.22^{a}	1,237.73 ±143.51^{a}	1,223.16 ±143.11^{a}
35.	1,716.61 ±192.76^{b}	1,767.31 ±192.74^{a}	1,789.51 ±197.83^{a}	1,763.36 ±194.05^{a}
42.	2,172.89 ±207.11^{b}	2,241.64 ±213.52^{a}	2,268.13 ±211.87^{a}	2,236.14 ±212.39^{a}
Live weight gain (g)				
1.–7.	10.88 ±2.86	11.11 ±2.81	10.84 ±2.96	11.09 ±2.92
7.–14.	29.90 ±4.54	29.92 ±4.39	30.01 ±4.28	29.77 ±4.32
14.–21.	52.83 ±5.11	53.44 ±5.16	53.45 ±5.29	53.22 ±5.16
21.–28.	70.31 ±8.23^{b}	73.84 ±8.33^{a}	75.87 ±8.61^{a}	74.09 ±8.54^{a}
28.–35.	74.68 ±7.96^{b}	77.58 ±8.09^{a}	78.83 ±8.31^{a}	77.17 ±7.98^{a}
35.–42.	65.18 ±7.02^{b}	67.76 ±7.23^{a}	68.37 ±7.44^{a}	67.54 ±7.15^{a}

a, b mean values within a row with different superscript letters were significantly different (p <0.05)

weight at 21 and 42 days of age compared to control group. Roofchaee et al. (2011) state, that carvacrol and thymol may catalyse appetite; increase the efficiency of digestive enzymes and nutrient absorption. Durrani et al. (2006) recorded significantly higher live weight in chickens with 0.50% compared to control, 1.00% and 0.25% turmeric powder in diet. Al-Sultan (2003) achieved higher live weight gain in broiler chickens with supplementation of turmeric at 0.50% level than 0.00%, 0.25% and 1.00%. Doley et al. (2009) complemented that broiler feeds with 0.25% turmeric powder had daily live weight gains comparable to the control. Akbarian et al. (2012) using 0.50 g kg^{-1} level of turmeric rhizome powder (TRP) and observed that weekly live weight gain of broilers was not influenced significantly by TRP supplementation in feed in comparison with control. The mixture of thymol and carvacrol, fed at levels of 100 and 300 mg kg^{-1} persuaded the birds towards 24% improved live weight gain. This fact may have been due to the synergistic effect of thymol and carvacrol, which was previously described by Lambert et al. (2001) and Ultee et al. (2002).

In our experiment no significant difference (p >0.05) was found in feed consumption among control group (1.71 kg) and the addition of feed additive 1.00% (1.66 kg), 0,75% (1.68 kg) and 1.50% (1.69 kg) during fattening period. These results are in opposite with Osman et al. (2010) who detected that broiler chickens which received basal diet with 0.5 g kg^{-1} of marjoram supplementation consumed the lower (p <0.05) feed amounts than the control group. Accordance with Al-Sultan (2003), addition of turmeric with 1.00% diet caused comparable feed intake in comparison with 0.00%, 0.25% and 0.50% turmeric in the diet. However, Durrani et al. (2006) registered significant decrease in feed intake in broilers that supplemented by 0.50% turmeric powder compared to control. Finally, Al-Jaleel (2012) stated that addition of turmeric at the level of 0.50% significantly increased feed consumption compared to control to third week but there was no significant difference between groups at sixth week of age.

The results of our experiment revealed that application of natural stimulant has no positive effect or even increased the mortality of broiler chickens. The mortality in control and experimental groups with 0.75% and 1.00% levels of natural feed additive and control was identical (1.67%), highest mortality was recorded in experimental group with 1.25% of feed additive (3.33%) to 42 days. Durrani et al. (2006) observed no improvement in mortality by application of turmeric extract. Daneshyar et al. (2012) noted that addition of 2.5, 5.0 and 7.5 g kg^{-1} turmeric rhizome powder in the diet reduced the mortality of broilers due to ascites.

The results of our experiment revealed that application of natural stimulant with turmeric and marjoram extracts in drinking water nonsignificantly (p >0.05) influenced thigh, drumsticks, back and wings proportion (Table 2). Nevertheless, addition of natural growth stimulates to

drinking water significantly increased (p <0.05) breast proportion and decreased the abdominal fat weight. Also, Mehala and Moorthy (2008) recorded markedly effect of turmeric powder (10 g kg^{-1} of diet) on carcass percentage of broiler chickens in 42 days of age. Likewise, Durrani et al. (2006) observed improve carcass yield, breast weight and thigh weight of broiler chickens with addition 5 g kg^{-1} of turmeric powder in diets. The results obtained by us agree with the statement of Tesseraud et al. (1996) about the positive effect lysine on the muscle development of broiler chickens. We can state that the combination of amino acids and plant extracts in the natural stimulant Musculaton® had a positive effect on the breast muscle of broiler chickens.

The abdominal fat weight was significantly lower (p <0.05) in experimental groups (Table 2) in comparison with control. Equally, Nouzarian et al. (2011) observed that supplementation of turmeric extract in powder form (3.3, 6.6 and 10 g kg^{-1} of diet) reduced abdominal fat weight of broiler chickens. This reduction amount of abdominal fat may be caused by effect of curcumin on adipocyte apoptosis or glucose taken from the blood (Sugiharto, 2016).

The results in Table 3 showed significantly (p <0.05) increased liver, pancreas, kidney and small intestine proportions to body weight in broiler chickens in all experimental groups compared to the control group. The neck, crop, heart, proventriculus, gizzard, caecum and large intestine proportions to body weight between control and experimental group didn't show statistical differences (p >0.05). Various results have been acquired by Hernández et al. (2004). They did not recorded differences in gizzard, liver and pancreas weights of broiler chickens after addition of turmeric in feed. Al-Sultan (2003) stated that liver weight was higher for the birds receiving diet with addition 0.50% turmeric powder than control. Emadi and Kermanshahi (2006) observed that the supplementation of turmeric rhizome powder to diet significantly reduced heart weight at 0.75% but there was no significant increase or decrease

Table 2 Effects of different levels of Musculaton® on carcass characteristics of broiler chickens

Parameter	Control mean ± SD	Musculaton®		
		0.75% mean ± SD	1.00% mean ± SD	1.25% mean ± SD
Breast (%)	28.72 ±1.47[b]	30.22 ±1.63[a]	30.39 ±1.71[a]	30.19 ±1.61[a]
Thigh (%)	24.29 ±1.36	24.35 ±1.69	24.42 ±1.54	24.39 ±1.56
Drumsticks (%)	15.32 ±1.03	15.38 ±1.06	15.33 ±1.04	15.41 ±1.08
Back (%)	16.32 ±0.89	16.43 ±0.83	16.45 ±0.86	16.48 ±0.88
Wings (%)	13.76 ±0.62	13.82 ±0.65	13.81 ±0.63	13.79 ±0.61
Abdominal fat (%)	2.28 ±0.09[a]	2.12 ±0.08[b]	2.11 ±0,07[b]	2.14 ±0.08[b]
Carcass yield (%)	75.71 ±2.43	76.33 ±2.87	76.51 ±2.53	76.37 ±2.43

a, b mean values within a row with different superscript letters were significantly different (p <0.05)

Table 3 Effects of different levels of Musculaton® on proportion of internal organs

Intestinal organ	Control mean ± SD	Musculaton®		
		0.75% mean ± SD	1.00% mean ± SD	1.25% mean ± SD
Neck (%)	2.99 ±0.36	3.03 ±0.38	3.01 ±0.38	2.98 ±0.37
Crop (%)	0.27 ±0.07	0.26 ±0.06	0.26 ±0.06	0.28 ±0.07
Heart (%)	0.63 ±0.12	0.64 ±0.14	0.64 ±0.13	0.63 ±0.12
Liver (%)	1.91 ±0.27[b]	2.03 ±0.33[a]	2.06 ±0.34[a]	2.04 ±0.33[a]
Proventriculus (%)	0.36 ±0.08	0.37 ±0.07	0.37 ±0.08	0.38 ±0.09
Gizzard (%)	0.94 ±0.09	0.94 ±0.08	0.93 ±0.07	0.95 ±0.09
Pancreas (%)	0.16 ±0.04[b]	0.21 ±0.05[a]	0.22 ±0.05[a]	0.22 ±0.05[a]
Caecum (%)	0.51 ±0.12	0.49 ±0.09	0.55 ±0.14	0.55 ±0.14
Kidneys (%)	0.66 ±0.11[b]	0.76 ±0.14[a]	0.77 ±0.15[a]	0.77 ±0.14[a]
Small Intestine (%)	2.33 ±0.31[b]	2.41 ±0.33[a]	2.44 ±0.34[a]	2.43 ±0.33[a]
Large Intestine (%)	0.15 ±0.04	0.16 ±0.03	0.16 ±0.03	0.16 ±0.03

a, b mean values within a row with different superscript letters were significantly different (p <0.05)

in liver weight than other levels (0.00%, 0.25%, 0.50%). Hussein (2013) noted that turmeric powder addition at 7 g kg^{-1} of diet significantly increased liver and gizzard weight. However, Daneshyar et al. (2012) registered that addition of 2.5, 5.0 and 7.5 g kg^{-1} TRP in the diet had no effect on heart weight.

4 Conclusions

In conclusion, based on the available data it can be concluded that the natural growth additive Musculaton® can be used as natural nonantibiotic growth promoters in broiler chicken nutrition. The best results we were achieved in experimental group with the application 1.00% Musculaton®

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