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Original Scientific Article

EFFECT OF SUPPLEMENTATION OF PHYTOGENIC FEED ADDITIVES ON PERFORMANCE PARAMETERS AND MEAT QUALITY OF BROILER CHICKENS

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Summary: The aim of the experiment was to study the effects of clove powder *(Syzygium aromaticum* L*)*, extracts of agrimony (*Agrimonia eupatoria* L.) and lemon balm (*Melissa officinalis* L.) on broiler chicken performance, carcass and meat quality. Three treatment combinations were prepared: C – control group without any feed or water additive; AC – feed supplemented with clove powder and drinking water supplemented with agrimony extract; LC – feed supplemented with clove and drinking water supplemented with lemon balm extract. AC group chickens had significantly higher body weight ($P < 0.05$) compared to the control group within 14 days of fattening. On the 42nd day higher body weight, better feed conversion, higher carcass yield and higher breast and thigh weight were determined in broiler chickens from groups AC and LC. However, significant differences ($P > 0.05$) in selected parameters were not recorded in experimental groups AC and LC compared to control. Dry matter of thigh muscles derived from AC and LC broiler chickens were significantly higher ($P < 0.05$) compared to controls. In groups AC and LC lower total fat content was recorded in thigh muscles ($P > 0.05$) when compared with control and significantly higher ($P < 0.05$) proportion of total protein was found in AC group. In the sensory evaluation of meat experimental groups AC and LC were rated better, despite no significant differences ($P > 0.05$) in comparison with control group.

Keywords: agrimony; clove; growth of broilers; lemon balm; meat quality

Introduction

A ban on the use of antibiotics as growth promoters in the European Union in 2006 due to increase bacterial resistance in human population encouraged the search for replacement alternatives, which would be useful to improve the production parameters of fattening pigs and poultry (1). A new group of potential feed additives are herbs, their extracts or essential oils (2).

Phytogenic feed additives are usually defined as products derived from plants and added to animal feed for fattening to increase productivity, improving the quality of feed and animal hygiene conditions and not least to improve the quality of produced food. Feed additives produced from plants have often a significant antibacterial effect, thereby suppressing pathogenic microflora in the gastrointestinal tract of animals and thus reducing mortality during the fattening period, especially in stress period (3). Plant additives are often added into feedstuff as they improve the taste and smell of feed and thus improve intake and growth of animals (1). Several herbal additives contain substances which increase the production of digestive juices (saliva, gastric juices, pancreatic and intestinal secretion) and thereby enhance appetite and digestion (4).

Several plants or their essential oils, especially those with aromatic character such as cloves, rosemary, cinnamon (1), anise (5), but also oregano (6) and sage (7) have been used in fattening. Plant ar-

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omatic oils as well as probiotics and organic acids can be used to support growth in order to achieve improvements in breeding broilers in organic farming system (8). Supplementation of feed or drinking water with plant aromatic oils increases body weight of chickens and favourably has an effect on feed conversion (9).

For a wider range of action the most suitable combination of extracts is researched. The role of research is to find the most effective concentrations and combinations of plants and essential oils. According to Ertas et al. (10), the combination of some plants extracts has a better effect on the growth performance in poultry than their individual supplementation. Synergism between some herbal constituents was highlighted in the studies of Hernandez et al. (7) and Burt (11).

Clove (*Syzygium aromaticum* L.) is considered as one of the most versatile herbs due to its analgesic and anti-inflammatory, anaesthetic, antimicrobial and antifungal effect (12), antiseptic, appetite and digestion stimulation (13), anti-inflammatory, anticarcinogenic, antiparasitic as well as antioxidant properties (6, 14, 15). The major constituent of clove is an essential oil (up to 20 %), which is characterized by presence of up to 85.5 % of eugenol (16). Lemon balm (*Mellisa officinalis* L.) and agrimony (*Agrimonia eupatoria* L.) are the most common herbs used in our traditional folk herbal medicine (17). However, little is known about the antioxidant properties of their extracts and essential oils in poultry. The alcohol extracts of both herbs are a potent source of polyphenols (6, 17, 18). In *in vitro* experiments, it was found that active substances extracted from agrimony possess a significant radical scavenging activity as well as potential antioxidant capacity (18, 19).

The aim of our work was to study the effect of combination of cloves added to the feed and agrimony or lemon balm extracts administered into water on growth of broiler chickens and quality parameters of produced meat.

Materials and methods

Plant material

Pulverized extracts of agrimony (*Agrimonia eupatoria* L.) and lemon balm (*Mellisa officinalis* L.) were prepared by Calendula (Nova Bana, Slovak Republic) and both herbs were collected in East Slovakia. The plant material consisted of leaves, flowered tops and stalks that was dried at 30 - 35 °C, ground, extracted with 50 % ethanol and evaporated to obtain a powder (prescription and protocol of Calendula, Slovak Republic). Clove (*Syzygium aromaticum* L.) powder was purchased from Mäspoma (Zvolen, Slovak Republic).

Experimental animals, diets and treatments

The experiment was carried out on 120 one-day-old unsexed hybrid broiler chickens Ross 308 which were randomly allotted to 3 groups (40 birds per group). Broilers were kept in large pens with wood shavings. On the day of hatching, the initial room temperature was 32 °C. It was gradually decreased by 3 °C weekly to a final temperature of 23 °C on the 21st day and then kept constant. During the entire fattening period, the lighting regimen was 24 h of continuous light per day. Broilers were reared in the air environment with 70 % humidity. The experiment was approved by the Ethics Committee of the University of Veterinary Medicine and Pharmacy in Kosice, Slovak Republic.

All birds were fed with commercial basal diets (BD) for broilers “Starter” for days 1 to 14, “Grower” for days 15 to 29 and “Finisher” for days 30 to 42. The composition of all BDs is presented in Table 1. The control group of chickens received the basal diet (BD) only. The second (LC) group was fed with the same BD enriched with 1 % clove buds powder combined with 0.2 % lemon balm extract diluted in drinking water for 42 days. Third group (AC) was also fed with BD enriched with 1 % clove buds powder combined with 0.2 % agrimony extract diluted in drinking water. The broilers had a free access to the feed and water.

Data collection and analysis

Body weights were recorded weekly. Feed intake per group was measured throughout the experiment and the feed conversion ratio was calculated at the end of experiment. Broiler chickens were slaughtered on the 42nd day of fattening. After the carcass processing, chickens in each group were weighed, boned and chilled at 4 °C. The yield of carcasses was calculated by dividing the body weight of the animal before slaughter and carcass weight after evisceration. The proportion of breast and thigh muscle was calculated from a weight of individual parts and body weight after evisceration.

Chemical composition of meat samples

Determination of water content, dry matter content and fat content in % was performed according to Veterinary laboratory methods (20).

Sensory evaluation

For sensory analysis of meat samples thigh and breast muscle were packed into containers and evaluated 24 hours after slaughtering. Professional evaluation committee was represented by a panel of 7 assessors who worked according to Methods intended for meat sensory evaluation (21). The samples were boiled and 5-point scheme was used while the maximum number of evaluation points was 20 (22).

Table 1: Composition of basal diets given to the broilers during the entire experiment

Ingredients (%)	Starter (1 to 14 day)	Grower (15 to 29 day)	Finisher (30 to 42 day)
Maize	51.3	49.0	52.8
Wheat	8.0	10.0	20.0
Wheat meal	7.0	4.00	-
Soybean meal (46.5 % CP, 1.5 % fat)	29.9	31.6	23.5
Wheat bran	-	2.25	-
Limestone	1.90	1.25	1.75
Monocalcium phosphate	0.89	1.00	0.90
Vitamin-mineral premix [a]	0.30	0.3	0.30
NaCl	0.36	0.30	0.35
L-lysine	0.25	0.15	0.15
DL-methionine	0.10	0.15	0.25
Nutrient level (%)			
Linoleic acid	1.0	1.0	1.0
Metabolizable energy (MJ/kg)	11.5	12.0	12.0
Crude protein	17.5	19.0	17.0
Crude fibre	5.0	4.0	4.0
Ash	80.0	70.0	70.0
L-lysine	0.80	0.95	0.95
DL-methionine	0.35	0.40	0.40
Methionine + cysteine	0.70	0.75	0.70
Calcium	0.80	0.70	0.70
Phosphorus	0.50	0.50	0.50

[a] supplied per kg of basal diet: vitamin A 8,000,000 IU; vitamin D_3 1,200,000 IU; vitamin E 15,000 mg; vitamin K_3 3,000 mg; vitamin B_1 1,500 mg; vitamin B_6 8,000 mg; niacin 15,000 mg; choline chloride 50,000 mg; pantothenic acid 50 mg; pyridoxine 5 mg; folic acid 2 mg; cyanocobalamine 30 μg; biotin 0.2 mg; I 2 mg; Co 1 mg, K 8.6 g; Cl^- 2 g; Cu 6.0 mg; Fe 60 mg; Zn 50 mg; Mn 50 mg

Statistical analysis

Statistical treatment of results was performed using statistical program GraphPad Prism, version 4.00 (23). Results are expressed as arithmetic mean (x) and standard deviation (sd). Results in each group were compared with each other by one-way ANOVA test. To compare the statistical differences between values Tukey's comparison test was used and $P < 0.05$ was regarded as statistically significant.

Results

Average weights of chickens during the whole fattening period are shown in Table 2. The addition of clove (1%) in the feed and agrimony extract (0.2%) into water had the greatest impact on weight of broiler chickens at the beginning of fattening period. At the age of 14 days, the weight of chickens was significantly higher compared with control ($P < 0.05$). On the 28th and 42nd day, the weights of both

experimental groups were higher but no significant differences were recorded when compared with control (P > 0.05). However, chickens in experimental groups were balanced and were seen less fluctuation in weight than control. The total feed consumption in all three groups was approximately the same (Table 2, P > 0.05). Feed conversion, i.e. conversion of feed to gain 1 g, was lower in both experimental groups in comparison with control. The best values were seen in group AC (1.83).

Carcass weight in all groups was correlated with weight of living animals before slaughter (Table 3). The average weights of carcasses from experimental groups were higher compared to controls (P > 0.05). The highest average weight of carcasses and also carcass yield percentage was recorded in experimental group AC supplemented with 1% clove in feed and 0.2% extract of agrimony in water. Highest average weights of thigh and breast muscles were recorded in experimental group AC (P > 0.05) again.

Table 2: Effect of supplementation of combination of clove (*Syzygium aromaticum* L) and agrimony (*Agrimonia eupatoria* L) or lemon balm (*Melissa officinalis* L) on broiler performance

Parameters	Treatments		
	C	LC	AC
LBW 0, g	41 ± 4	42 ± 3	41± 4
LBW14, g	253 ± 13a	260 ± 16ab	270 ± 18b
LBW 28, g	1025 ± 133	1046 ± 104	1118 ± 129
LBW 42, g	2112 ± 262	2156 ± 222	2232 ± 172
ADWG, g	49.30	50.33	52.16
FC 1 – 42, g (g)	4108	4137	4086
FCR (0 – 42)	1.94	1.91	1.83

C – control, LC – Clove (1 %) + Lemon balm (0.2 %), AC – Clove (1 %) + Agrimony (0.2%), LBW– live body weight, ADWG – average daily weight gain, FC – feed consumption, FCR – Feed conversion ratio.
[a,b] – values with different labelling in row are statistically different.

Table 3: Effect of suplementation of combination of clove (*Syzygium aromaticum* L) and agrimony (*Agrimonia eupatoria* L) or lemon balm (*Melissa officinalis* L) on slaughter characteristics and meat cat-ups

	C	LC	AC
Final body weight (g)	2112 ± 262	2156 ± 222	2232 ± 172
Carcass yield (g)	1449 ± 231	1473 ± 109	1558 ± 149
Carcass yield (%)	68.60	68.32	69.80
Breast (g)	294 ± 52	303 ± 31	342 ± 33
Breast yield (%)	20.29	20.57	21.95
Thighs (g)	364 ± 44	370 ± 35	410 ± 27
Thighs (%)	25.55	25.52	26.31

C – control, LC – Clove (1 %) + Lemon balm (0.2%), AC – Clove (1 %) + Agrimony (0.2%)

Results of chemical composition and sensory analysis of breast and thigh muscles are shown in Table 4. Added extracts had no effect on the chemical composition of breast muscle and experimental groups were comparable with control. Only a smaller proportion of crude protein (P > 0.05) was recorded in the breast muscles of experimental groups. Dry matter content of thigh muscle was significantly lower in the experimental groups (AC, LC) compared with control (P < 0.05). In the experimental group AC a significantly higher proportion of crude protein was recorded compared to other groups (P < 0.05). Lower proportion of fat in thigh muscles was analyzed in experimental groups (AC, LC) compared with control (P > 0.05). Adding plant additives to feed had also a positive impact on the sensory evaluation of breast and thigh muscle (Table 4). Breast and thigh muscles of experimental groups were scored better in comparison with control (P > 0.05). Breast muscle samples were evaluated as the best after feeding cloves and lemon balm extract (LC). As for thigh muscle the best evaluation of a sample was seen after feeding the cloves and agrimony extract (AC).

Table 4: Chemical composition and sensory evaluation of meat

Treatments		Dry matter	Crude fat	Crude protein	Sensory evaluation
C	Breast	25.76 ± 054	1.60 ± 0.45	23.11 ± 0.14	15.40 ± 1.63
	Thigh	28.37 ±0.27[a]	9.34 ± 0.20	17.59 ± 0.02[a]	16.80 ± 1.90
LC	Breast	25.65 ± 0.28	1.75 ± 0.31	22.91 ± 0.14	16.60 ± 2.01
	Thigh	27.51 ± 0.11[b]	8.80 ± 0.13	17.70 ± 0.07[a]	16.82 ± 1.70
AC	Breast	25.89 ± 0.23	1.65 ± 0.35	22.88 ± 0.17	15.87 ± 1.68
	Thigh	27.12 ± 0.25[b]	8.75 ±0.70	17.90 ± 0.09[b]	17.60 ± 1.63

C – control, LC – Clove (1 %) + Lemon balm (0.2%), AC – Clove (1 %) + Agrimony (0.2%)
[a,b] – values with different labelling in column are statistically different.

Discussion

In recent years, an interest in plant feed additives as alternative growth a promoter has increased because of the prohibition of the use of antibiotic feed additives. Plant (phytogenic) growth promoters act primarily as regulators of intestinal flora suppressing the growth of potential pathogens in the intestinal tract, especially in critical period of stress (1, 2). In poultry critical period is mainly at the beginning of feeding, which can result in reduced growth and mortality of animals (24). Even in our experiment, the most significant increase in weight was achieved for 14 days of fattening. On the 28th and the 42nd day, the weight of both experimental groups was higher but no significant differences were observed when compared with control ($P > 0.05$). The effect of plants and their essential oils on the final weight of chickens has been described in several works (1, 2, 4, 5, 7, 10). However, their effect on increasing total weight of chickens is inconsistent (1). The resulting effect depends on plant extracts used in feeding and on their proper concentrations. Adding only one plant extract to the feed or water does not favourably influence the growth parameters of poultry (4). This problem could be overcome by a combined supplementation of different herb constituents with the synergistic effect (2, 8, 25). Hernandez et al. (7) indicate higher weight gains of chickens after feeding a combination of sage, thyme and rosemary extracts in a dose of 5 g per kilogram of feeding mixture. After feeding a combination of these extracts feed conversion was also decreased by 4%.

Equal or lower consumption of feed during fattening after addition of plants essential oils is mentioned by several authors (2, 26). Although even in these indicators are not uniform scientific results, generally there is a perception that plant additives have neutral or positive impact on consumption and feed conversion (1, 2, 24).

Higher carcass yield was also recorded after the addition of extracts of coneflower, thyme (27) in feed, and in a combination of *Nigella sativa* extract in feed and coneflower extract administered in water (28). Even in our experiment, higher carcass weight and higher weight of breast and thigh muscles were recorded in experimental groups (AC, LC). Although differences in weight are not statistically significantly higher when compared with control, weight of carcass, breast and thigh muscles of poultry fed with cloves in feedstuff and agrimony extract in water may be interesting for poultry producers.

Plumbless importance of plant feeding additives is also in terms of quality of produced meat. Most of the plants and their extracts have strong antioxidant properties, significantly resulting in lower fat oxidation during storage of meat (29). Added plant additives often have a positive effect on the sensory evaluation of produced meat (2). Our results showed that feeding a combination of cloves in the feed and agrimony or lemon balm extracts in water to broiler chickens had a slightly positive effect on the sensory evaluation of produced meat. Several authors mention better sensory characteristics of poultry meat after adding plants with antioxidant activity (25, 30). Positively improved taste and smell were evaluated in meat from chickens supplemented with rosemary powder (31).

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UČINEK FITOGENIH PREHRAMBENIH DODATKOV NA PROIZVODNE PARAMETRE IN KAKOVOSTI MESA PRI BROJLERSKIH PIŠČANCIH

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Povzetek: Cilj poskusa je bil proučiti vplive prahu nageljnovih žbic (*Syzygium aromaticum* L) ter izvlečkov repika (*Agrimonia eupatoria* L) in navadne melise (*Melissa officinalis* L) na proizvodne parameter brojlerskih piščancev, njihove klavne lastnosti in kvaliteto mesa. Pripravljene so bile tri kombinacije dodatkov k prehrani: C – kontrolna skupina brez prehrambenega dodatka in dodatka v prehrani; AC – prehrambeni dodatek s prahom nageljnovih žbic in dodatkom izvlečka repika v pitni vodi; LC – hrana z dodatkom prahu nageljnovih žbic in pitna voda z dodatkom izvlečka melise. Skupina AC brojlerskih piščancev je imela po 14 dneh krmljenja statistično značilno povečano težo ($P < 0.05$) v primerjavi s kontrolno skupino. 42. dan krmljenja je bil pri skupinah brojlerskih piščancev AC in LC opažen boljši izkoristek krme, večji izplen pri klanju ter večja teža prsi in stegen. Statistično značilnih razlik ($P < 0.05$) v izbranih parametrih v poskusnih skupinah AC in LC v primerjavi s kontrolno skupino ni bilo. Suha snov v stegenskih mišicah brojlerskih piščancev skupin AC in LC je bila statistično značilno višja ($P < 0.05$) v primerjavi s kontrolno skupino. V skupinah AC in LC je bila v stegenskih mišicah ugotovljena manjša količina maščobe ($P > 0.05$) kot v kontrolni skupini in statistično značilno ($P < 0.05$) višje razmerje celotnih proteinov v skupini AC. Pri senzoričnem ocenjevanju mesa sta bili skupini AC in LC ocenjeni bolje, čeprav ni bilo opaznih statistično značilnih razlik ($P > 0.05$) v primerjavi s kontrolno skupino.

Ključne besede: repik; nageljnove žbice; rast brojlerskih piščancev; navadna melisa; kakovost mesa