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EFFECT OF PLANT-SUPPLEMENTED FEEDING ON FRESH AND FROZEN STORAGE QUALITY OF BROILER CHICKEN MEAT

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ABSTRACT

Single plant supplements were added to the ration fed to Ross 308 broiler cockerels. The chickens were held in four feeding groups until their 42 days of age. The birds of all the groups were fed on the same standard mixes. Group I represented the control group which received mixes without the supplement. The birds of group II received a feed supplement of 1% dried fine echinacea herb (*Echinacea purpurea*), group III received 0.3% of crushed raw garlic (*Allium sativum*). The chickens in group IV were twice a week provided with raw ginger (*Zingiber officinale*) water extract (5.5 g·cm^{-3}) to drink. Chemical composition and physicochemical properties of breast muscle were analysed while fresh as well as on 4-month storage at –18°C

Supplementation with echinacea or ginger did not influence significantly dry matter, crude protein, or raw fat content in the breast muscle. Supplementation with ginger resulted in brighter meat colour, significantly higher acidity, and lower level of cholesterol. Herbal supplementation did not affect the meat quality properties during its frozen storage.

Key words: chickens, feeding, echinacea, garlic, ginger, meat, quality, storage

INTRODUCTION

In pursuit of improved chicken healthiness and in order to fulfil consumer expectations in relation to food quality, poultry producers more and more commonly apply natural feeding supplements, mainly herbs. Previous studies have demonstrated positive effects of herbal supplements on production performance, carcass quality, and quality traits of meat [6, 8, 9, 11, 17, 19]. Today, with a large overproduction of poultry meat, physicochemical and sensory properties of meat as well as its storage life is becoming more and more important.

In poultry feeding, mixtures of many herds are most often used, since it has been reported that this is more efficient than applying just a single plant species or a preparation [8, 13]. As the results of such studies remain unconvincing, a need persists for in-depth studies on what could result from application of a particular plant supplement (quantity and form) in poultry feeding in terms of their growth performance, slaughter value, and meat quality. In this experiment, broiler chicken ration was supplemented with echinacea herb, garlic, and ginger. These supplements have been widely recognised for their strong stimulating effect on the immune system in both humans and animals. Moreover, garlic and ginger are very rich in aromatic oils, which enhance digestion and positively influence respiratory system being inhaled into air sacks and lungs of birds. Strong antioxidative effect of garlic and ginger seems especially important these days when poultry feeds are supplemented with fat. The strong smell of aromatic oils may penetrate into muscles and organs, which would improve their flavour as well as storage and processing values.

The aim of these studies was to evaluate the effect of broiler chicken feeding supplementation with individual plants, echinacea (*Echinacea purpurea*), garlic (*Allium sativum*), and ginger (*Zingiber officinale*), on the quality of fresh meat and meat after a period frozen storage.

MATERIALS AND METHODS

The analyses covered breast muscles of Ross 308 broiler cockerels. The chicken had been raised on the poultry farm belonging to the Department of Poultry Science, UMW, Olsztyn, Poland. The birds were held in four groups and fed on standard mixes. The feeding differed among the groups only in the plant supplements added to the ration. The chickens in group I, the control group, received balanced rations alone without a supplement. The birds in group II were fed on the ration but with addition of powdered dried echinacea herb as 1% of the ration, group II received a supplement of crushed fresh garlic as 0.3% of the ration, and chickens in group IV were twice a week provided with water containing 5.5 $g \cdot cm^{-3}$ of ground fresh ginger. After 6 weeks of raising, the birds were weighed and 6 cockerels of body weight close to the mean were selected from each group. These chickens were next subjected to 12-hour starvation followed by slaughter and gutting. The carcasses were cooled at 4°C. After the next 24 hours, breast muscles were dissected from the carcasses to be next divided into two parts. Each one part of the muscles, weighing 100 g, was packed to a separate plastic bag and frozen, the other was subjected to chemical, physicochemical, and sensory analyses. The chemical assay comprised the content of dry matter, crude protein, raw fat, and ash [1]. Free water content was determined with Grau and Hamm method [12], colour brightness was measured using a "Spekol" spectrocolorimeter with R 45/0 remission attachment at a wavelength 560 nm, the meat pH was measured with a pH-meter (Radiometer) using a PHC 4406 glass electrode. Sensory analysis was performed according to the procedure developed by Baryłko-Pikielna et al [2].

Frozen samples of the breast muscle meat were stored at –18°C for 4 months. After this period, the samples were transported to a laboratory of the Department of Animal Product Evaluation, Agricultural University of Szczecin, Poland, where the thawing drip loss was calculated as a difference between the sample weight before freezing and after 12-hour thawing at 10°C. The meat pH was measured with a PM-600 pH-meter using a combined glass electrode ESAgP-307, whereas the thawed meat colour was evaluated visually and instrumentally. The visual appraisal involved a 5-grade scale, where score 1 meant very bright colour, 5 – a very dark meat, and score 3 – colour normal for broiler meat. The instrumental evaluation was carried out using a "Spekol" spectrocolorimeter with R 45/0 remission attachment at a wavelength 560 nm. Cholesterol was determined in extracts from the samples prepared according to the method described by Bitman and Wood [3] and with a spectrophotometric assay based on Libermann's colour reaction as described by Krause et al. [16]. Also, cooking loss was determined as difference between the sample weight before and after cooking. After cooking the meat at 85°C until it became soft, sensory evaluation (grade scale) was performed for both the broth and the meat.

The data collected during the experiment were computed using one-way analysis of variance in orthogonal design with Duncan test, by means of the STATISTICA analytical software package.

RESULTS AND DISCUSSION

Plant supplements applied in the ration of the broiler chickens had no significant effect on chemical composition of fresh meat or, except for pH, on its physicochemical parameters (Tables 1 and 2). Some positive trends have been found, however. Dry matter content was from 0.16% to 1.32% higher, and the content of ash was by 5.8% higher, in the meat of the experimental groups compared to those found in the muscles of the control group chickens. Moreover, although non-significantly, a higher level of crude protein was found in the groups where echinacea (group II) and ginger (group IV) had been applied. Within the group that had received garlic, the level of crude protein was lowest (22.97%), which did not confirm the results found by Majewska et al. [17], who, using free extract of raw garlic in a proportion of 0.5 g per cm^3 of water fed to slaughter turkeys, achieved a highly-significant increase in protein content in breast muscle. The meat of the birds that had received either echinacea or garlic exhibited a better pH value (pH = 5.5) and a better, darker colour. The content of intramuscular fat decreased considerably in the experimental groups of birds, by 10.8% in group II (echinacea), by 43% in group III (garlic), and by as much as 51% in group IV (ginger), compared to the level of 0.74% in the control group of chickens. The addition of ginger deteriorated meat physicochemical parameters; meat colour grew brighter (28.67%) and acidity rose significantly (pH = 5.37). The bright colour persisted also throughout the period of storing (23.27% or 1.67 points). The lighter meat colour and the lower pH in the meat of the ginger group chickens may demonstrate a higher level of glycogen the live chickens had had in the muscles as well as a fast process of glycolysis [10]. As a consequence of this, proteolytic processes that lead to a release of lactic-acid neutralising compounds [14] in this group during thawing were more advanced, which resulted in a higher pH after thawing (pH = 6.23) compared to the remaining groups. In the control group, pH was lowest (pH = 5.94). The groups that had received echinacea and garlic showed intermediate pH values (pH = 6.00 and pH = 6.07).

Table 1. Chemical composition and physicochemical properties of breast muscles – fresh

Item	Statistic	Group			
		I Control	II Echinacea	III Garlic	IV Ginger
Dry matter, (%)	**x**	**24.97**	**25.30**	**25.01**	**25.26**
	v	1.66	1.60	1.00	0.16
Crude protein, (%)	**x**	**23.07**	**23.27**	**22.97**	**23.30**
	v	1.64	0.25	1.26	1.14
Raw fat, (%)	**x**	**0.74**	**0.66**	**0.42**	**0.36**
	v	26.62	52.88	37.21	35.46
Ash, (%)	**x**	**1.20**	**1.26**	**1.26**	**1.27**
	x	1.44	4.96	1.37	3.94
Free water, cm^2	**x**	**5.07**	**5.96**	**6.84**	**6.14**
	v	16.69	8.52	17.57	9.35
Colour lightness, (%)	**x**	**26.67**	**26.00**	**25.00**	**28.67**
	v	5.37	3.85	4.00	10.07
Meat pH	**x**	**5.50^{a}**	**5.43^{ab}**	**5.43^{ab}**	**5.37^{b}**
	v	1.82	1.06	1.06	1.08

Means accompanied by lower case letters a, b differ significantly at $p \leq 0.05$.

Table 2. Sensory analysis score for breast muscles – fresh (points)

Item		Group			
		I Control	II Echinacea	III Garlic	IV Ginger
Odour – intensity	**x**	**5.0**	**5.0**	**5.0**	**5.0**
	v	0.00	0.00	0.00	0.00
Odour – attractiveness	**x**	**5.0**	**5.0**	**5.0**	**5.0**
	v	0.00	0.00	0.00	0.00
Brittleness	**x**	**5.0**	**5.0**	**5.0**	**5.0**
	v	0.00	0.00	0.00	0.00
Juiciness	**x**	**4.8**	**5.0**	**5.0**	**4.7**
	v	5.97	0.00	0.00	6.19
Palatability – intensity	**x**	**5.0**	**5.0**	**5.0**	**5.0**
	v	0.00	0.00	0.00	0.00
Palatability – attractiveness	**x**	**5.0**	**5.0**	**5.0**	**5.0**
	v	0.00	0.00	0.00	0.00

Table 3. Physicochemical and sensory evaluation of breast muscles thawed after 4-month storage at –18°C

Item		Group			
		I Control	II Echinacea	III Garlic	IV Ginger
Physicochemical evaluation					
Freezing loss, (%)	**x**	**11.22**	**12.25**	**10.23**	**13.57**
	v	21.57	29.90	20.08	37.98
Meat pH	**x**	**5.94**	**6.00**	**6.07**	**6.23**
	v	1.94	1.09	1.37	5.19
Cooking loss, (%)	**x**	**29.53**	**33.40**	**28.15**	**30.67**
	v	2.37	6.54	3.46	8.43
Visually assessed colour, (pts.)	**x**	**3.00**	**3.00**	**3.00**	**1.67**
	v	0.00	0.00	0.00	5.45
Colour, (nm)	**x**	**20.42**	**20.00**	**20.73**	**23.27**
	v	4.51	5.49	5.94	19.26
Total cholesterol, (mg per100g)	**x**	**51.76**[a]	**53.80**[a]	**52.16**[a]	**47.46**[b]
	v	6.20	7.26	5.81	6.40
Sensory evaluation – cooked meat and broth					
Broth odour, (pts.)	**x**	**4.33**	**4.50**	**4.50**	**4.50**
	v	6.66	0.22	0.22	0.22
Broth flavour, (pts.)	**x**	**4.33**	**4.17**	**4.33**	**4.00**
	v	6.66	6.93	6.66	12.50
Cooked meat odour, (pts.)	**x**	**3.00**	**4.00**	**3.00**	**2.00**
	v	57.74	0.25	57.74	86.60
Cooked meat flavour, (pts.)	**x**	**4.00**	**3.30**	**3.50**	**3.30**
	v	0.25	34.64	24.74	34.64

Sensory analysis of fresh meat before freezing (fresh meat) in most cases revealed no differences (Table 2). A trend appeared, however, for better juiciness in the groups with echinacea and garlic. In the studies by Schleicher et al. [18], meat of birds fed on garlic-supplemented diet also achieved the highest sensory score. The noticeable difference in meat juiciness did not endure the 4-month period of frozen storage, as no significant differences were found after this period in sensory evaluation of either boiled meat or its broth between the particular groups of chickens.

Thawing loss of meat juice, as well as cooking loss, were lower, although statistically non-significant for the meat of chickens fed with garlic addition. Cholesterol content in breast muscles ranged from 47.46 to 53.80 mg per 100 g of tissue. These values are similar to those reported by other authors [4, 5, 7, 15]. The analysis of meat cholesterol content revealed that supplementation in the form of echinacea or garlic did not affect its levels. On

the other hand, feeding with and addition of ginger resulted in a statistically significant reduction of cholesterol (47.46 mg per 100g), compared to the control group (51.76 mg per 100g).

CONCLUSIONS

1. Feeding supplementation with echinacea, garlic, or ginger did not influence significantly dry matter, crude protein, or crude fat in breast muscles.
2. Ginger-supplemented diet resulted in brightened meat colour, significantly higher acidity, and reduced levels of cholesterol.
3. Application of the studied herbal supplements did not affect meat quality after 4-month period of frozen storage.

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