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The Influence of Garlic Powder in Broiler Feed on Carcass and Breast Meat Quality

Natalija Džinić[1], Đorđe Okanović[2], Marija Jokanović[1], Vladimir Tomović[1], Dragan Palić[2]
[1]Faculty of Technology, University of Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia
[2]Institute of Food Technology, University of Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia,
djordje.okanovic@fins.uns.ac.rs

Abstract: In this study the carcass and quality (nutritive, technological and sensory) of broiler breast meat were analysed. Hubbard chickens were used for investigations (n=200). There were two groups of samples: control group (C) chickens fed with standard mixture, and experimental group (E) chickens fed with standard feed mixture supplemented with 2% of garlic powder. The trial lasted 42 days. Experimental group had higher ($p<0.05$) meat yield in chickens breast, but significant effect of garlic addition on nutritive quality of chicken breast meat were not noted.

In the breast meat of the experimental group E significantly ($P < 0.05$) higher protein content and lower ($P < 0.05$) fat content, compared to control (C), was found. Cholesterol levels in breast meat of the experimental group E (46.1 mg/100g) was significantly lower ($P < 0.05$) compared to the control group (60.1 mg/100g). The average technological quality of breast meat of groups regarding to pH_k, as the parameter and criteria for determining the quality of breast meat corresponds to PSE. The average technological quality of breast meat of control and experimental group according to $colour_u$ (L^*), as the parameter and criteria for determining the quality of breast meat, corresponds to "normal quality". According to results of sensory analyzes, roasted breast meat of the experimental group had significantly ($P < 0.01$) preferable juiciness and tenderness.

Key words: chickens, garlic powder, carcass and meat quality

Introduction

Modern poultry production is the fastest method to obtain quality products of animal origin for human consumption. Optimal and healthy feed is essential for reaching full genetic potential and improving broilers health and productivity. Use of new techniques in biotechnology is the solution for bigger production of foods and feeds. Basic orientations for that are new technological procedures that have the aim to improve the nutritive value of foods and feeds as well as the valorization of primary agricultural production (Tica et al., 2009; Radović et al., 2011).

Performances of broilers during fattening, slaughter characteristics and meat quality are linked to pre-mortal and post-mortal factors. It is considered that diet, as the pre-mortal factor, dominantly impacts the quality of carcasses and meat with more than 30% (Ristić et al., 2005; Džinić et al., 2011).

Standard meals for chicken fattening are based on corm, soybean and fish meal. Beside nutrients necessary for chicken growth and development, feed very often contains some medications used therapeutically in animal feed to improve the health and well-being of animals and to improve the production results in poultry industries (Bampidis et al. 2005). As alternatives for these synthetic growth promoters in animal feed, probiotics, prebiotics, organic acids and herbs, as well as essential oils, have been investigated. In recent years, aromatic plants and their extracts have received increased attention as potential alternatives to growth promoters (Simon, 2005).

Garlic (*Allium sativum*) has been used as spice and folk medicine since antiquity, mostly because of its antibacterial, antifungal and antioxidant properties. Bioactive components of garlic, including several sulphur-containing compounds such as alliin, diallylsulfides and allicin, may partly account for some of these effects of garlic (Freitas et al., 2001).

These components provide a characteristic flavor and well-known aroma, and also have hypocholesterolemic effect. Yeh and Liu (2001) and Chowdhury et al., (2002) reported that components of garlic inhibit cholesterol and fatty acids synthesis in the liver, thus affecting the lower fat content in meat.

Traditionally, the term 'meat quality' covers inherent properties of meat decisive for the suitability of the meat for eating, further processing and storage including retail display. Consequently, quality is now to be considered as complex and multivariate property of meat, which is influenced by multiple interacting factors including the conditions under which the meat is produced. Feeding strategy is the management factor which is most actively used as a quality control tool in the production of meat and in relation to improvement and/or control of performance, animal welfare, safety, nutritional value, and eating and technological quality (Andersen et al., 2005).

Because of its composition and properties of the basic ingredients, poultry meat is defined as dietetic. Its specificity is arising from richness in physiologically important components, their easy digestibility and a low energy value (Bonoli and Caboni, 2007).

Chicken meat is low in fat and cholesterol and is usually considered healthier than other animal protein sources, especially than red meats of mammalian origin (Mozdziak, 2004).

The objective of this study was to determine the effect of garlic powder addition in standard chicken feed on carcass and breast meat quality (nutritional, technological and sensory).

Material and Methods

Hubbard hybrids were used for the investigations. Chickens were divided in two groups, containing 100 birds each. Chickens were fed three basal diets: starter, finisher I and finisher II, each containing 23, 20 and 18% of protein, randomly. Diets were exchanged after every 14 days, and all the time chickens were fed *ad libitum*. Feed composition is presented in Table 1.

Table 1. Formula (%) of experimental diets fed to broiler chickens

Diet	Starter	Finisher I	Finisher II
Maize	41.78	50.91	57.80
Soybean meal	37.00	29.00	23.00
Soy grits	12.50	11.50	11.00
Soy oil	4.00	4.00	4.00
Monosodium phosphate	1.40	1.31	1.00
Limestone	1.60	1.60	1.49
Premix	1.00	1.00	1.00
Salt	0.25	0.30	0.40
DL methionine	0.27	0.23	0.23
Lysine	0.20	0.15	0.08
Total	100.00	100.00	100.00
Crude protein	23.21	20.18	18.03
Metabolic energy (MJ/kg)	12.95	13.29	13.60

Chickens from control group (C) were fed with basal diet, and diet of chickens from experimental group (E) was supplemented with 2% of garlic powder. Fattening were lasting 42 days, after which broilers were starved for 12 hours, slaughtered and processed by bloodletting, scalding, plucking and evisceration and chilled. Cutting and breast boneing were followed by measuring the meat yield and taking samples for determination of nutritive, technological and sensory quality.

Basic chemical composition of meat was estimated by determination of moisture (ISO 1442:1997), protein (ISO 937: 1991), free fat (ISO 1444:1998) and total ash (ISO 936: 1998) contents. Content of connective tissue was determined by multiplying hydroxyproline content by the factor (ISO 37496: 2002).

The cholesterol content of breast meat was determinate by High Performance Liquid Chromatography. Total cholesterol was extracted from lyophilized meat (dry matter), after saponification with saturated methanolic KOH, according to the procedure of Indyk (1990) and extracted with hexan and isopropanol. Cholesterol was separated and quantified by an HPLC system (HP 1090-Hewlett-Packard, USA). Cholesterol determination was done under the following conditions: column Hypersil ODS, 5 μm; flow: 0.2 ml/min; Mobile phase: Metanol; diode array detector: 212/4 nm.

Technological quality was evaluated by determinations of pH_u, $colour_u$, and WHC_u. Value pH_u was determined by portable pH meter ULTRA, type UX 390, with reinforced Ingold combined electrode for direct determination of pH in meat. Breast meat colour was determined on the fresh cross section 24 hour p.m. using Minolta Chroma Meter CR-400, and colour characteristics were presented in u CIE L*a*b* system (lightness L*, redness a*, yellowness b*) (Robertson, 1977). Water holding capacity (WHC_u) was determined by compression method and expressed as % of bound water (Grau and Hamm, 1953).

The samples of breast meat were roasted in the convection air oven at 175°C for 45 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 breast meat. Five trained panellists, experienced in the sensory evaluation of various meat products were employed. Sensory evaluation (smell, taste, tenderness and juiciness) was carried out according to point system of analytical descriptive test using a scale from 1 to 7 (1-unacceptable, 7-optimal).

All data are presented as mean values. Analysis of variance (Duncan test) was used to test the differences between obtained results. The software package STATISTICA 8.0 (2008) was used for analysis.

Results and Discusion

Investigation of carcasses quality (Table 2) of control and experimental group showed that higher weight of chilled carcasses (1578.5 g), and breast meat (491.1 g) were in the control group. Differences in weight of chilled carcasses and breast meat were not statistically significant ($p>0.05$). Although the breast meat weight in control group C was higher, meat yield in broilers breast was significantly higher ($p<0.05$) in experimental E group (73.36%), compared to the control. Bone, skin and subcutaneous fat shares were lower in experimental group.

Table 2. Mass of chilled carcases weight, breast meat and basic components parts in breast of the control (C) and experimental group (E)

Group	Chilled carcases [ns]		Breast meat [ns]		Meat part	Bone part [ns]	Skin and subcutaneous fat part [ns]
	(g)	(%)	(g)	(%)	(%)	(%)	(%)
C	1578.5	100	491.1	31.12	70.02 [a]	20.72	9.27
E	1539	100	476.9	31.01	73.36 [b]	19.95	7.48

[ns] (p > 0.05); [a,b](p < 0.5)

Results of basic chemical composition of breast meat of the control and experimental group are shown in Table 3.

Tabela 3. Basic chemical composition of breast meat of control (C) and experimental group (E)

Group	Moisture [ns]	Protein [ns]	Free fat [ns]	Total ash [ns]
	(%)	(%)	(%)	(%)
C	74.41 ± 0.53	21.82 ± 0.95	2.61 ± 1.43	1.15 ± 0.06
E	74.46 ± 0.51	22.86 ± 0.42	1.52 ± 0.59	1.15 ± 0.04

[ns] – not statistically significant (P > 0.05)

Water content of both examined groups, as well as total ash content, were equal. Group E had higher protein content, compared to the control group. Majewska et al. 2001 reported that usage of free extract of raw garlic in a proportion of 0.5 g/cm^3 of water for turkeys fattening achieved a highly significant increase in protein content in breast meat. On the contrary, Gardzielewska et al. (2003), reported lower protein content in breast meat within the group that received feed supplemented with 0.3% crushed fresh garlic. The content of free fat was 42% lower in experimental group E, than in control group C, what is in accordance with results of Gardzielewska et al. (2003), who noted fat reduction of 43%.

Kim et al., (2009) reported that garlic added in feed increased the protein and reduced fat content in drumstick meat, and also, it reduced cholesterol levels and significantly (P < 0.05) increase unsaturated fatty acids content in drumstick meat compared to the control group. The amount of fat is different in different anatomical parts of broilers, and is the smallest (2.8 g/100g) in breast meat.

It is significant that the broiler meat has a lower total fat content and higher content of mono-and polyunsaturated fatty acids than other meat (Barroeta, 2007).

In Table 4 content of cholesterol, connective tissue protein and relative content of connective tissue protein in total protein of breast meat of control and experimental group are presented.

Table 4. Content of cholesterol, connective tissue protein and relative content of connective tissue protein in total protein of chickens breast meat of control (C) and experimental group (E)

Group	Cholesterol, mg/100g	Connective tissue protein, %	Relative content of connective tissue protein, %
C	60.1[a] ± 2.53	0.35[a] ± 0.04	1.59[a] ± 2.53
E	46.1[b] ± 6.68	0.32[b] ± 0.00	1.40[b] ± 0.02

[a,b] – means within the column with different superscripts differ (P < 0.05)

Cholesterol content of chickens breast meat of control group (60.1 mg/100 g) was significantly ($P < 0.05$) higher than the content of 46.1 mg/100 g for exsperimental group.

Results of the present study are in agreement with results of Skrivan et al. (2002). Songsang et al. (2008), indicating that increased amount of garlic in broiler feed from 0.7% to 1.3%, decreased the cholesterol content of breast meat from 46.83 mg/100g to 40.24 mg/100g.

Table 2 shows that the content of connective tissue protein in the breast meat of groups E was 0.32%, and significantly ($P < 0.05$) was lower than in the control group (0.35%). The results confirm the well-known fact that broiler 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 (Mozdziak, 2004; Barroeta, 2007)

Results of technological properties of breast meat (Table 5) revealed that the muscles of experimental group had the higher average pH_u (5.61), then the muscles of the control group (average pH_u 5.59). The differences in the pH_u values between groups were not significant ($P > 0.05$). Average pH_u of muscles indicated altered meat quality. According to pH_u values as parameters and criteria for determining the meat quality, PSE (pale, soft, exudative) quality is when $pH_u < 5.8$, and "normal" quality is if $pH_u > 5.8$ (Lara et al., 2003). On average, the lightest muscles were for experimental group E with the lightness (L^*) of 52.61, while the darkest were muscles of the experimental group E (51.79). The differences in lightness of the analysed breast muscles were not significant ($P > 0.05$). According to lightness L^* as a parameter and the criteria by which the PSE quality is (+) ($L^* > 52$) and (-) ($L^* < 49$) (Qiao et al., 2001) breast meat of control group, was on average PSE quality, while breast meat of groups E was of "normal" quality.

Table 5. Technological characteristics of breast meat of control (C) and experimental group (E)

Group	pH_u ^{ns}	Color (L^*) ^{ns}	WHC, ^{ns} %	Cooking loss, ^{ns} %
C	5.59 ±	52.61 ±	88.99 ±	26.29 ± 3.45
E	5.61 ±	51.79 ±	80.48 ±	21.82 ± 7.20

^{ns} – not statistically significant ($P > 0.05$)

Cooking loss of roasted breast meat of the control group (26.29%) was higher than cooking loss of broilers fed with the addition of garlic powder (21.82%). Differences are not statistically significant ($P > 0.05$). Our results are in accordance with Holden et al. (1998) who suggested that the cooking losses decrease with garlic supplementation in diets for finishing pigs. Cooking loss depends on raw meat quality, centre temperature and cooking procedure (Aaslyng et al., 2003). Cooking loss is of interest because it is expected to explain part of the variation in juiciness but also because it influences the appearance of the meat. A high cooking loss gives an expectation of a less optimal eating quality. Cooking loss is also of great economic importance to industry (Aaslyng et al., 2003)

Result of sensory evaluation of roasted chickens breast meat of control and experimental group are presented in the Table 6.

Table 6. Sensory evaluation of chickens breast meat of control C and experimental groups E

Group	Odour	Taste	Juiciness	Tenderness
C	5.92^A ±	5.96^A ±	6.00^B ±	6.16^B ±
E	5.33^B ±	5.08^B ±	6.88^A ±	6.88^A ±

^{A,B}– means within the column with different superscirpts differ significantly ($P < 0.01$)

Even though the odour and taste of chickens breast meat from control (C) and experimental group (E) were on average evaluated as »good« (Table 6), control group had significantly better marks for these attributes. Sensory investigation of roasted breast meat showed that characteristic taste and pungent smell of garlic from broiler feed was transfered to meat, and ccould be observed in roasted breast meat. This characteristic flavour can be both non-benefitial and benefitial depending of consumeres affinities and demands. Flavour of roasted breast meat of the experimental group reminded on flavour of marinatied roasted meat. The most important sensory properties for meat quality are juiciness and tenderness. These two attributes are closely related: for more tender meat, juices are released more quickly by chewing, and the juicy sensation of the meat is higherer. Juiciness and tenderness of breast meat of experimental group was marked "excellent" (6.88), optimal and significantly better ($P < 0.01$) then juiciness (6.00) and tenderness (6.16) of breast meat of the control group. Better marks for juiciness in experimental group of breast meat were in agreement with lower cooking loss.

Conclusion

The results obtained in this investigation showed that the addition of garlic powder in broilers diet affected the carcass and quality of meat.

Chilled carcasses of control group had higher weight, but the meat yield in chickens' breast was significantly higher in experimental group. In the breast meat of the experimental group (with addition of 2% garlic powder) significantly ($P < 0.05$) higher protein content (22.86%) and lower ($P < 0.05$) fat content (1.52%), compared to control group (21.63%; 3.41%), was determined. The relative content of connective tissue protein in the breast meat of experimental group was significantly lower ($P < 0.05$) than in the control group.

Cholesterol level in breast meat of the experimental group was significantly lower ($P < 0.05$) compared to the control group.

The average technological quality of breast meat of experimental group according to colour$_u$ *(L*),* as the parameter and criteria for determining the quality of breast meat corresponds, to "normal quality". Garlic supplementation in feed had beneficial influence on juiciness and tenderness of roasted breast meat.

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