ISSN 1313 - 8820
Volume 8, Number 2
June 2016

AGRICULTURAL SCIENCE AND TECHNOLOGY

2016

An International Journal Published by Faculty of Agriculture,
Trakia University, Stara Zagora, Bulgaria

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The journal is accepted to be indexed with the support of a project № BG051PO001-3.3.05-0001 “Science and business” financed by Operational Programme “Human Resources Development” of EU. The title has been suggested to be included in SCOPUS (Elsevier) and Electronic Journals Submission Form (Thomson Reuters).

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Student's campus, 6000 Stara Zagora
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ISSN 1313 - 8820

Volume 8, Number 2
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AGRICULTURAL SCIENCE AND TECHNOLOGY, VOL. 8, No 2, pp 162 - 165, 2016
DOI: 10.15547/ast.2016.02.030

Product Quality and Safety

Composition of meat in La Belle and White Plymouth Rock chickens, slaughtered at different age

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(Manuscript received 16 May 2015; accepted for publication 8 June 2016)

Abstract. *An experiment with two lines of chickens – synthetic line La Belle and White Plymouth Rock was carried out in the Institute of Animal Science, Kostinbrod to assess the meat quality in regards to chemical composition and the fatty acid profile at the age of 9 and 18 weeks. The age affected the lipid content which decreased significantly in breast ($p<0.05$) and thighs ($p<0.01$) in the older chickens of both lines. The content of protein and moisture in breast differed between the lines ($p<0.05$), showing higher protein and lower moisture in White Plymouth Rock chickens, while in the thigh muscles the line and age significantly interacted ($P<0.001$) in regards to these traits. Interactions between the two factors ($p<0.01$) was observed for the ash content in the breast, whereas in the thighs it tended to decrease with the age in both lines. The fatty acid composition of the meat was influenced mainly by the age of the chickens. The total content of the saturated fatty acids was increased in the thighs of the older birds ($p<0.01$), while the proportion of the monounsaturated fatty acids was decreased in the breast ($p<0.01$) and thighs ($p<0.001$) with advancing age of the chickens. The opposite was observed for the content of the polyunsaturated fatty acids in the breast, which increased at higher age of slaughter ($p<0.001$). In thigh meat, the changes of the polyunsaturated fatty acids induced by age followed the same pattern, however significant interaction with the line was observed ($p<0.05$). The cholesterol content in the breast differed significantly between the two lines ($p<0.05$) and reduced with age ($p<0.001$). In the thighs considerable decrease ($p<0.001$) of the cholesterol was observed in La Belle birds.*

Keywords: chickens, line, age, meat chemical composition, fatty acids

Introduction

Chicken meat represents 79.8% of the poultry meat production in the European union (Marquer et al., 2015). This number has been based on a strong demand for chicken products due to the consumer perception of the health benefits of chicken meat. In comparison to the red meats, such as beef and pork, chicken meat is considered superior because of its lower fat, especially in breast, as well as the higher content of iron (Jathurasitha et al., 2008). Due to significant improvement in selection, nutrition and production systems, the modern meat chickens grow very fast and reach market weight usually for 6 weeks, displaying high yield. However, the fast growth and higher yield are associated with negative effects on meat quality characteristics (Dransfield and Sosnicki, 1999; Le Bihan-Duval, 1999). The consumers interest in high quality meat draws the attention to the chicken lines with slower growth. Despite their lower yield, research point that such chickens have much better sensory and nutritional quality of meat (Połtowicz and Doktor, 2012). In Bulgaria still the rearing of slow-growing chickens is relatively limited, and hence the studies on the quality of meat in such poultry in our country are scarce. According to Petkov (2015), some of the lines representative of the national gene pool for poultry exhibit good potential for production of slow-growing chickens with highly dietetic meat.

The differences in the meat quality of chickens are due to the sex, intensity of growth and muscle development, as well as the age of the birds. However, the effect of the various genotypes and lines on the meat quality traits is not clear, especially in slow-growing birds. Hence, the aim of this study was to assess the differences in the meat quality in terms of chemical composition and lipid profile in two different lines of chickens – La belle and White Plymouth Rock, reared conventionally and slaughtered at different age.

Material and methods

The research was carried out in the experimental poultry farm of the Institute of Animal Science, Kostinbrod with a total of 158 La Belle and 239 White Plymouth Rock male chickens. The two investigated lines are representative of the national gene pool and are kept in the Institute. The one day-old chickens were placed into a deep litter facility with stocking density of 14 birds/m^2. All the birds were fed *ad libitum* starter (20.52% protein, 2952.89 kcal/kg ME), grower (18.95% protein, 3045.20 kcal/kg ME) and finisher (18.07% protein, 3052.59 kcal/kg ME) diets. Water was provided *ad libitum* with a nipple waterer. The lighting regime was 15 h of light and 9 h of darkness, and the temperature ranged between 20 and 24°C. The average live weight of the birds at the age of 9 weeks was 1.258±0.05 kg for La Belle and 1.045±0.07kg for the White Plymouth Rock line, while at the age of 18 weeks the average live weight was 2.778±0.11 kg and 2.185± 0.10 kg, for La Belle and White Plymouth Rock respectively. At these two ages, 6 chickens of each line were selected for slaughter. After decapitating and bleeding, the birds were plucked and eviscerated. Their carcasses were then placed into chilling room, kept at 4°C for 24 hours, weighed and subjected to carcass analysis. Further, breast and

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thigh muscles of each chicken were separated, minced with meat grinder, and samples for determination of the chemical composition and fatty acid profile of the muscles were vacuum packed and stored at -20°C until analysis.

Analysis of the chemical composition of meat including determination of lipid, protein, ash and moisture content was performed according to the AOAC methods (2004).

For the fatty acid composition analysis, the total lipids from the breast and thigh muscles were extracted according to the method of Bligh and Dyer (1959). Aliquots of the lipid extract were subjected to determination of the total cholesterol content (Sperry and Webb, 1950). The fatty acid composition of the total lipids was determined by GLC analysis, using chromatograph C Si 200 equipped with capillary column (DM-2330-30 m x 0.25 mm x 0.20 μm) and hydrogen as a carrier gas. The oven temperature was first set at 160°C for 0.2 min, then raised until 220°C at a rate of 5°C/min and hold for 5 minutes. The temperatures of the detector and injector were 230°C. Methyl esters were identified comparing to the retention times of the standards. The quantities of the individual fatty acids were used to calculate the total amounts of saturated (SFA), mono- (MUFA) and polyunsaturated fatty acids (PUFA).

Data were statistically analysed by two ways ANOVA as the genetic line of the birds, age and their interaction were included in the model. JMP v.7 software package was used to perform the statistical analysis.

Results and discussion

Chemical composition of the breast and thighs

The analysis of the chemical composition of the breast and thigh muscles revealed differences due to the genetic line and the age of the chickens (Table 1). The lipid content in the muscles did not differ between lines, however slaughtering chickens at later age led to decrease in the lipids in the breast ($p<0.05$) and thighs ($p<0.01$).

Contrary to the lipids, the protein content in the breast was affected by the line of the chickens, showing higher content in White Plymouth Rock birds ($p<0.05$), as the difference was more pronounced at later age. In the thigh muscles of the chickens, differences in the protein content were more associated with the age, however significant interaction with line was observed ($p<0.001$). Nine weeks old White Plymouth Rock displayed lower protein content compared to La Belle, while at later age (18 weeks) the opposite was observed. Similar to protein, the moisture in the breast was affected by the genetic line ($p<0.05$), revealing higher content in La Belle at the two ages of slaughter, while in White Plymouth Rock it remained constant. In the thighs, no differences between the lines were detected in regards to this trait. As for protein, the moisture content differed between ages, however depending on the genetic line ($p<0.001$). At the age of 9 weeks La Belle displayed lower moisture when compared to the White Plymouth Rock birds, while the opposite was observed at the age of 18 weeks.

The ash content of the breast meat depended on both line and age of slaughter ($p<0.01$). It was higher in White Plymouth Rock than in La Belle chickens at earlier age, while at 18 weeks it decreased in Plymouth Rock birds. In the thighs a tendency towards decreasing ash with age was observed in both genetic lines.

Genetic line and slaughter age are important factors affecting the chemical composition of poultry meat. Although in this study we failed to detect differences between lines in regards to the lipid content of the muscles, other studies (Baéza et al., 2006) reported such. Significant decrease of the total lipids was found with age. Such changes of the lipid content in the muscles of slow-growing birds with advancing age is not surprising. In a previous study with male layer-type chickens of Lohmann Brown Classic, we detected considerable decrease in this parameter between 5 and 12 weeks of age (Popova et al., 2015). Similar to our results, Suchý et al. (2002) detected decrease in the lipids in the breast and thighs in chickens slaughtered at 42 and 52 days. The values for the lipid content in the breast in the slow-growing chickens in this study are similar to those found by Mikulski et al. (2011). On the other hand, Küçükyılmaz et al. (2012) reported a content of 2.81 %. In thigh muscles, however, both authors determined considerably higher content of lipids – 7.79% (Mikulski et al., 2011) and 8.29 % (Küçükyılmaz et al., 2012) than the reported in this study. The protein content in the breast differed between La Belle and White Plymouth Rock chickens, while in the thighs both line and age at slaughter interacted in regards to this parameter, showing inverse changes in the two lines with advancing of the age. Surprisingly, La Belle showed decrease in protein at the age of 18 weeks, while White Plymouth Rock had higher content of the protein at older age. This is in accordance with other studies. Suto et al. (1998) reported constant increase in the protein content in

Table 1. Chemical composition of the breast and thigh meat in La Belle and White Plymouth Rock chickens, slaughtered at the age of 9 and 18 weeks (values least squares means)

Item	La Belle		White Plymouth Rock		SE	Significance of the factors		
	9 w	18 w	9 w	18 w		Line	Age	Line x Age
Breast								
Lipids, %	0.74	0.63	0.75	0.67	0.10	NS	*	NS
Protein,%	21.74	21.09	21.93	22.16	0.71	*	NS	NS
Moisture, %	74.39	75.09	74.08	74.09	0.71	*	NS	NS
Ash, %	1.13	1.18	1.25	1.09	0.03	NS	**	**
Thigh								
Lipids, %	1.98	1.22	1.80	1.23	0.42	NS	**	NS
Protein,%	19.84	18.00	18.14	18.88	0.63	NS	*	***
Moisture, %	75.03	77.65	76.94	76.77	0.61	NS	***	***
Ash, %	1.18	1.13	1.15	1.13	0.04	NS	NS	NS

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

male broilers from 2 till 12 weeks of age, while Abdullah et al. (2010) observed decrease in the protein content in breast between 32 and 42 days of age. In line with the differences induced by the genetic line, Berri et al. (2001) determined significant differences in protein content between commercial and some experimental broiler hybrids. On the other hand, Sogunle et al. (2010) comparing two commercial hybrids (Arbor Acres and Marshal MY) reported higher protein content in the breast and thigh muscles in Arbor Acres than in Marshal MY. The content of the protein in our study was within the range determined by Dal Bosco et al. (2011).

The line and age of the slow-growing birds in this study affected the moisture content respectively in the breast and thigh meat. It was higher in the breast of La Belle chickens compared to White Plymouth Rock, however in the thighs this difference depended on the age of slaughter. With advancing of the age moisture in the thighs of La Belle increased which corresponded to the decreased protein in these birds. Analysis of the chemical composition in La Belle is made for the first time and provided in this study. We suggest that the higher moisture content is probably breed characteristic for this line of birds similar to some poultry lines in East Asia (Jayasena et al., 2013). Interaction between the line and age at slaughter was observed in regards to the ash content in the breast. Usually the ash content of the muscles increases with increasing the age (Prändl et al., 1994). Such change was observed in the breast of La Belle. In the thigh muscles, the ash tended to differ between ages in both lines, showing decrease older birds. This was already observed in our previous study (Petkov et al., in press).

Lipid profile

The analysis of the lipid profile of the breast and thighs showed that it was mainly affected by the age of slaughter of the birds (Table 2). While neither the line, nor the age influenced the content of SFA in the breast, in the thighs they were significantly higher ($p<0.01$) in the older birds. The total MUFA in the breast were significantly affected by the age ($p<0.01$) revealing lower content in the birds slaughtered at 18 weeks. The opposite was observed for the total content of the PUFA, which considerably increased with age ($p<0.001$) in both La Belle and White Plymouth Rock chickens. Similarly, in the thighs of both lines, MUFA decreased while PUFA increased in the older birds, however significant interaction between the line of the birds and the age of slaughter was observed ($p<0.05$). The changes in the content of MUFA and PUFA with advancing of the age correspond to the decrease of the total lipids. It is known that lower lipid content is associated with increase in the PUFA while MUFA decrease (Raes et al., 2001; Wood et al., 2008). Effect of the genetic line on the fatty acid composition was observed in a study of Michalczuk et al. (2016), as slow-growing line exhibited lowest SFA but highest PUFA from 5 to 8 weeks of age, compared with fast and medium growing genetic lines. In our study, however we fail to observe effect of the line of the chickens on the lipid profile in the breast and thighs.

Table 2. Lipid profile of the breast and thigh meat in La Belle and White Plymouth Rock chickens, slaughtered at the age of 9 and 18 weeks (values least squares means)

Item	La Belle		White Plymouth Rock		SE	Significance of the factors		
	9 w	18 w	9 w	18 w		Line	Age	Line x Age
Breast								
SFA, %	39.73	39.35	41.05	39.65	1.95	NS	NS	NS
MUFA, %	29.39	21.83	26.48	23.91	3.68	NS	**	NS
PUFA, %	30.88	38.82	32.47	36.44	3.28	NS	***	NS
Cholesterol, mg/100g	46.66	40.55	47.77	45.27	2.67	*	***	NS
Thigh								
SFA, %	34.65	37.74	35.76	39.49	2.18	NS	**	NS
MUFA, %	37.02	25.00	31.55	26.99	3.67	NS	***	*
PUFA, %	28.33	37.26	32.69	33.52	2.87	NS	***	*
Cholesterol, mg/100g	77.77	61.66	69.16	68.05	6.53	NS	***	*

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

The cholesterol content in the breast was affected by the line of the birds ($p<0.05$) and their age at slaughter ($p<0.001$). La Belle chickens exhibited lower cholesterol content when compared to the White Plymouth Rock as this difference was highly pronounced at the later age. The age affected to a certain extent the cholesterol content in the thighs and significantly interacted with the line ($p<0.05$). The difference between the two ages at slaughter was substantial in La Belle birds, while in Plymouth Rock it was negligible. Our results are in agreement with those reported by Talat et al. (2000). The authors demonstrated difference in the cholesterol content in the meat between different chicken genotypes. Contrary to us, Fakolade et al. (2015) did not observe difference in the cholesterol content in chicken breast and thigh meat with advancing the age from 4 to 20 weeks. In a previous study (Popova et al., 2015), we observed significant decrease of cholesterol content in the breast and thigh meat from the age of 5 till 12 weeks. On the other hand, Michalczuk et al. (2016) reported gradual increase of cholesterol in breast from 5 till 7 weeks of age and further decrease. The difference in the total cholesterol content is visible between the breast and thigh meat and considerably lower in the breast. This is associated with the significantly lower intramuscular lipid content in this muscle. The values of the cholesterol in breast together with the more favourable fatty acid profile confirms the more beneficial dietetic value of this meat compared to thighs.

Conclusion

The differences in the chemical composition in the chicken meat in this study were related to the age rather than the genetic line of the birds. The latter had significant effect on the protein, moisture

and cholesterol content in the breast. On the other hand, the age of the birds had strong influence on the content of lipids, as well as their composition in the breast and thighs. Overall, the increase of the age led to decrease in the total lipids, monounsaturated fatty acids and cholesterol, while increasing the proportion of polyunsaturated fatty acids in the breast and thigh meat.

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AGRICULTURAL SCIENCE AND TECHNOLOGY

Volume 8, Number 2
June 2016

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