

DIFFERENCE IN THE CARCASS QUALITY AND MEAT CHEMICAL COMPOSITION IN TWO LINES OF SLOW-GROWING CHICKENS WITH OR WITHOUT ACCESS TO PASTURE

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ABSTRACT

The study was carried out to compare the carcass quality and the chemical composition of breast and thigh meat in two lines of slow-growing male chickens - La Belle (LB) and Bresse Gauloise (BB) reared conventionally or outdoors, having access to pasture. The birds were slaughtered at 12 weeks of age. Two-way ANOVA was used to assess the effect of the rearing strategies as well as the line on the carcass quality and meat chemical composition. Rearing system affected significantly the carcass traits of the birds. The lines reared on pasture had lower live and carcass weight as well as lower dressing percentage ($P < 0.001$). On the other hand they had higher percent ($P < 0.001$) of the edible by-products (neck and giblets). The percentage of the breast meat was significantly reduced in the birds that had access to pasture ($P < 0.001$), while thigh remained unaffected. The pastured chickens displayed higher part of the wings ($P < 0.01$). Outdoors rearing influenced the chemical composition in the breast and thigh meat of the lines. Chickens reared on pasture were characterised by lower lipid content ($P < 0.01$) in breast and reduced protein in thigh ($P < 0.05$), as well as increased moisture in both kinds of meat, however depending on the line ($P < 0.05$). Furthermore, pasture access resulted in reduced ash content of the breast meat ($P < 0.001$), which was lower in the LB chickens ($P < 0.01$), while in thigh this parameter was strongly determined by the interaction of the rearing system and line of the birds ($P < 0.01$).

Keywords: *Slow-growing lines, carcass, meat, indoors rearing, pasture access.*

INTRODUCTION

In recent years, the outdoors rearing systems have gained much attention due to the increasing consumer demands for natural poultry products. It is known that chickens grown conventionally experience higher stocking density, increased levels of stress and hence are more susceptible to diseases (Doziers *et al.*, 2005; Lin *et al.*, 2006), as these factors generally decrease the quality of the meat. Hence, one of the main expectations of the outdoors rearing is to increase the safety, as

well as the nutritional and healthy value of the poultry meat. So far, studies report influence of the outdoors systems on the quality attributes of poultry meat, however the findings are inconsistent, and mostly dependent on other factors. Fanatico *et al.* (2005) observed more tenderness in outdoors reared chickens when compared to the indoors grown, but differences were also attributed to effect of the genotype and sex. Yang *et al.* (2015) reported decrease in the drip loss of the meat of free-range reared birds but increased shear force that resulted in tougher meat. On the other hand, Ponte *et al.* (2008) recorded higher overall acceptability including tenderness in the meat of free range reared chickens with pasture access. The outdoors rearing with pasture access is very similar to the natural environment with positive influence on the welfare of the birds. This however, is associated with different levels of pasture intake and might affect negatively the performance in fast growing genotypes due to decreased weight gain and feed efficiency. Furthermore, as shown by Mancinelli *et al.* (2017), the fast growing lines may be less adaptive to outdoors rearing, which makes such practices suitable for the slow – growing lines. Two such lines are used in this study- the autochthonous La Belle - representative for the national gene pool in Bulgaria, as well as the old French Bresse Gauloise. Research on these lines concerning their carcass and meat quality are relatively few (Popova *et al.*, 2016; Popova *et al.*, 2017; Popova *et al.*, 2018). However, based on the results so far, these lines draw much interest in finding possibilities and best rearing practices for raising slower-growing chickens to produce high quality meat. Hence, the aim of this study was to evaluate the differences in the carcass traits and meat chemical composition in these two lines of slow-growing chickens, as affected by the conventional rearing or pasture access.

MATERIAL AND METHODS

Experimental birds and rearing systems

The experiment was designed as two trials that were carried out respectively in the experimental poultry farm of the Institute of Animal Science–Kostinbrod, Bulgaria (conventional rearing) and Livadi symbiotic farm located in Damyanitsa village, Bulgaria (pasture rearing) with male slow-growing chickens of the two lines La Belle (LB) and Bresse Gauloise (BB). For the first trial, a total of 73 LB and 51 BB 1-day old male chickens obtained from the parent stock in the Institute were placed into a deep litter facility with a stocking density of 14 birds/m² in separate pens but in the same poultry house in the Institute. All the birds were fed ad libitum starter (ME - 13.18 MJ.kg⁻¹; protein content - 19.41%) and finisher (ME - 13.00 MJ.kg⁻¹, protein content - 17.77%) for 4 weeks and 8 weeks, respectively. Water for the chickens was provided ad libitum with a nipple drinker. The lighting regime was 15 h of light and 9 h of darkness, and the temperature ranged between 20 and 24°C (started from 32-36°C in the first 3 days after hatching and decreased afterwards). For the second trial, the total number of male chickens reared in Livadi farm was 48, divided into two groups, each containing 21 and 27 chickens according to the line – LB and BB. The birds were reared in controlled

microclimate conditions until they reached 3 weeks of age (as described by Salatin, 1998). From 4 to 12 weeks of age, the chickens were reared in wooden cages covered inside with aluminium plates to prevent the overheating. The cages were equipped with nipple drinkers and feeders while being open so that the birds could have access to pasture. Additionally, the chickens were fed ad libitum the same diet as the ones from the trial in the Institute.

Carcass composition

At 12 weeks of age, 6 birds of each line from both trials (rearing systems) were selected for slaughter based on the average live weight. After stunning, decapitation and bleeding, the carcasses were plucked, eviscerated and their feet removed. The edible by-products (neck, liver, gizzard, heart and spleen) were weighed and their content was calculated as percentage of the live weight. Hot carcass weight was recorded and dressing percentage was calculated. The carcasses were then stored at 4°C for 24 h and weighed again. Further the internal fat was removed from the carcasses and they were separated into breast, thigh, back and wings. The weight of the internal fat and the parts was recorded. The skin and bones from the breast and thighs were removed to obtain the muscles and they were also weighed. The content of the separated parts, muscles and internal fat was calculated as percentage of the cold eviscerated carcass weight. Then the muscles were minced and frozen at -20 °C until further analysis of the chemical composition of the meat.

Meat chemical composition

The breast and thigh meat was analysed for lipid, protein, moisture and ash content following the AOAC 2004 Official method of analysis.

Statistical evaluation

The data were statistically evaluated by two-way ANOVA as the line of the birds, the rearing system and their interaction were included in the model. The JMP v.7 software package was used to perform the statistical analysis (JMP Version 7, SAS Institute Inc. Cary, NC).

RESULTS AND DISCUSSION

Carcass traits

As presented in Table 1, regardless of the line, the chickens that had access to pasture exhibited significantly lower live weight at 12 weeks of age ($P < 0.001$), when compared to the conventionally grown. Consequently, the carcass weights were also considerably lower in the pastured lines ($P < 0.001$), as was the dressing percentage ($P < 0.001$). Different studies have examined the conventional rearing or pasture access in chickens, however, the effect of the rearing system on the live weight of the birds remains inconclusive and dependent on other factors such as chicken genotype and sex. Sogut *et al.* (2011) reported considerably lower live weight in broilers reared organically with access to pasture when compared to conventionally grown ones. Similarly, Poltowicz and Doktor (2011) showed that free range with pasture decreased the live weight in the chickens, but only in the male ones. On the other hand, Cömert *et al.* (2016) observed significantly higher

live weight in fast-growing chickens, reared outdoors, but no effect of the rearing system in slow-growing lines. Our results are in line with Wang *et al.* (2009) who reported lower live weight in slow-growing chickens reared free-range with access to grass paddocks and Li *et al.* (2017) in medium-growing chickens raised indoors on floor and outdoors with pasture. However, both studies did not observe any significant difference between the free-range and conventional system in regard to the dressing percentage. Despite that no significant difference was found in regard to the carcass weight, Fanatico *et al.* (2008) reported lower ready to cook carcass yield in slow-growing chicks reared outdoors which coincides with our results. On the other hand the same study did not report effect of the rearing system on this trait in fast growing genotype.

Table 1. Live weight, carcass weight, dressing percentage, edible and inedible parts, and abdominal fat deposition in La Belle and Bresse Gauloise chickens, reared conventionally or with pasture access

Item	Conventional		Pasture access		S.E.	Significance of the factors		
	LB	BB	LB	BB		Rearing system	Line	Rearing system x Line
Live weight/ g	1986.67	1973.83	1317.66	1370.66	52.01	***	NS	NS
Carcass weight (hot)/g	1235.33	1201.16	794.66	818.33	52.06	***	NS	NS
Carcass weight (cold),g	1211.83	1172.50	748.00	740.00	56.01	***	NS	NS
Dressing percentage, %	62.18	60.86	56.80	53.93	2.38	***	NS	NS
Inedible parts, %	12.19	12.01	14.66	13.33	1.00	***	NS	NS
Neck, %	2.01	2.18	2.79	2.88	0.25	***	NS	NS
Liver, %	1.87	1.89	3.12	3.26	0.32	***	NS	NS
Gizzard, %	1.84	2.12	2.43	2.42	0.29	**	NS	NS
Heart, %	0.53	0.54	0.67	0.66	0.08	***	NS	NS
Spleen, %	0.17	0.18	0.22	0.20	0.06	NS	NS	NS
Edible, %	6.42	6.91	9.42	9.53	0.55	***	NS	NS
Abdominal fat, %	2.37	2.58	2.44	1.94	0.96	NS	NS	NS

S.E.- standard error; ** P<0.01; ***P<0.001.

The content of the inedible parts were higher in the birds reared on pasture (P<0.001), and the same influence of the outdoor access was observed in regard to the percentage of the neck (P<0.001), liver (P<0.001), gizzard (P<0.01) and heart (P<0.001) in both LB and BB lines. The significantly increased content of the internal organs, especially those involved in the digestion that we observed in this study in the birds reared outdoors could be associated with the pasture and consequently the higher fiber content which stimulated the development of the gastrointestinal tract. In line with this statement, Dou *et al.* (2009) showed higher percentage of the stomach in chickens reared free-range with access to grass. On the other hand, contrary to us, Bartlett *et al.* (2015) did not find any significant difference between conventionally and pastured broilers for the content of their heart, liver and gizzard, however they recorded decreased intestines in the pastured chickens.

One of the major goals in the poultry meat industry is to reduce the carcass fatness and mainly the deposition of the abdominal fat (Fouad and El-Senousey, 2014). Jiang *et al.* (2011) and Li *et al.* (2017) found significant decrease in the abdominal

fat as a result of the pasture rearing, while Cömert *et al.* (2016) observed generally increased abdominal fat in outdoor reared lines, more pronounced in the fast growing ones. No effect of pasture was detected on the percentage of the deposited abdominal fat in our study, which is in agreement with the results of Mikulski *et al.* (2011) and Chen *et al.* (2013).

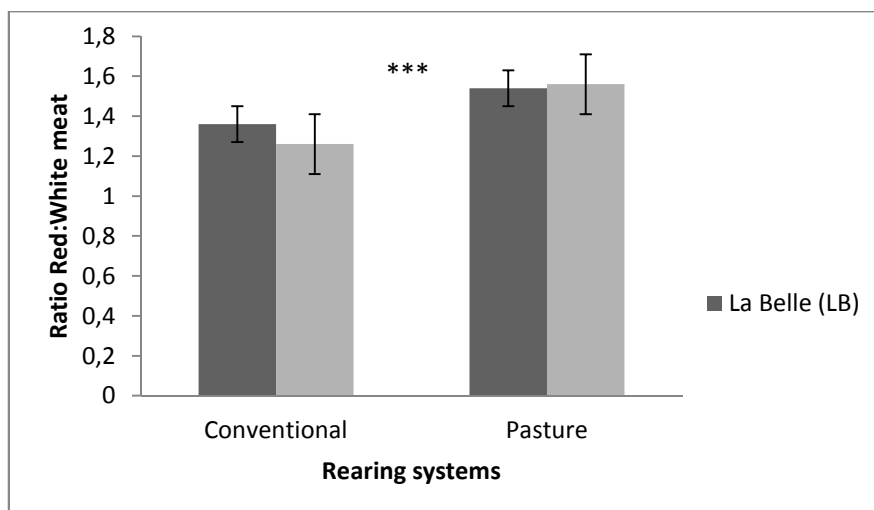
While there were no differences between the lines in regards to the main carcass parts, the latter were affected to a great extent by the pasture access of the birds (Table 2).

Table 2. Main carcass parts in LB and BB lines reared conventionally or with pasture access

Item	Conventional		Pasture access		S.E.	Significance of the factors		
	LB	BB	LB	BB		Rearing system	Line	Rearing system x Line
Breast(skin+bone), %	27.09	29.04	26.24	25.96	1.56	**	NS	NS
Breast (muscle), %	18.10	19.60	15.44	15.76	1.38	***	NS	NS
Thigh (skin+bone), %	37.34	36.09	36.71	37.07	1.59	NS	NS	NS
Thigh (muscle), %	24.62	24.49	23.69	24.40	1.59	NS	NS	NS
Back, %	21.41	20.57	22.36	21.88	1.87	NS	NS	NS
Wings, %	14.21	14.22	15.11	14.59	0.51	**	NS	NS

S.E. –standard error; ** P<0.01; ***P<0.001.

The percentage of the breast with skin and bones were reduced in the pastured birds (P<0.01). On the other hand thighs were not affected by the rearing system. The same effect of the pasture was observed for the part of the breast and thigh muscles. Furthermore, the ratio between the red and white meat obtained from the thigh and breast muscles as presented on Figure 1 showed that the pastured chickens had reduced development of the breast muscles. The percentage of the wings was increased in the pastured birds (P<0.01), while the back was not significantly affected by the rearing strategy. In line with our observations, Batkowska *et al.* (2015) found decrease in the breast muscle proportion in extensively reared hybrid chicks, but no effect of the rearing system was found in regard to the thighs. On the other hand, the authors did not find any effect on wings while the trunk was increased in the pastured birds. Contrary to our results, Kü ükiyalmaz *et al.* (2014) and Inci *et al.* (2016) did not find significant change in the percentage of breast meat respectively in broilers and quails as affected by organic rearing with pasture access, however the latter observed decrease in the drumstick ratio in the male birds on pasture, compared to the conventional rearing.



***P<0.001

Figure 1. Difference in the ratio between red and white meat in LB and BB lines reared conventionally or with pasture access

Meat chemical composition

The breast and thigh meat chemical composition (Table 3) showed that pasture access had stronger influence than the line of the birds in regard to the examined traits. Both lines reared on pasture had lower lipid content ($P<0.01$) in breast as well as higher moisture ($P<0.001$) in both breast and thigh meat when compared to the indoors reared birds. Significant interaction between the rearing system and the line, however, was observed in regard to the moisture content ($P<0.05$), showing that this parameter could be modified not only through the rearing strategy.

Table 3. Chemical composition of breast and thigh meat in LB and BB chickens reared conventionally or having access to pasture

Item	Conventional		Pasture access		S.E.	Significance of the factors		
	LB	BB	LB	BB		Rearing system	Line	Rearing system x Line
Breast								
Lipid, %	1.86	1.32	1.00	0.92	0.65	**	NS	NS
Protein, %	23.02	22.59	22.33	22.47	0.99	NS	NS	SN
Moisture, %	72.02	72.92	73.67	73.57	0.58	***	NS	*
Ash, %	1.14	1.19	1.01	1.05	0.03	***	**	NS
Thigh								
Lipid, %	5.40	5.85	6.01	6.16	1.44	NS	NS	NS
Protein, %	19.43	19.49	18.13	17.77	1.80	*	NS	NS
Moisture, %	72.20	71.77	72.97	73.16	0.80	***	NS	*
Ash, %	1.07	0.99	1.00	1.02	0.02	*	**	***

S.E. –standard error; ** $P<0.01$; *** $P<0.001$

In line with our results, Lin *et al.* (2014) found lower lipid content in breast in free range reared Taiwan game hens when compared to indoors reared. The authors stated that thigh lipid content was also lower in the outdoors reared birds. Küçükiyalmaz *et al.* (2012) observed no effect between organic rearing system with pasture and conventional in slow growing lines in the fat content of breast and thigh meat, however they found differences induced by the genotype in the thigh meat. On the other hand, they reported no effect of the rearing system on the moisture content. The results of the studies examining the effect of the rearing on the moisture content remain inconsistent. Dou *et al.* (2009) did not observe any difference in the moisture content in three rearing systems including also pasture access. This has been confirmed by Bartlett *et al.* (2015) and Michalczyk *et al.* (2017). Husak *et al.* (2008) reported lower moisture in organically and free range reared chickens compared with conventionally grown ones. Our results are in line with the reported by Castellini *et al.* (2002), who determined higher moisture in organically reared birds with access to pasture. Protein content did not differ between rearing systems and lines in breast, however in thigh meat significantly lower content was observed in the pastured birds, corresponding to the increased lipid content. Several studies reported increased protein content in meat of the outdoors reared birds (Fanatico *et al.*, 2007; Mikulski *et al.*, 2011; Cömert *et al.*, 2016), while others did not find significant effect of the rearing systems on this trait (Wang *et al.*, 2009; Sosnówska-Czajka *et al.*, 2017). The ash content in breast meat was lower in the pastured birds ($P < 0.001$) but significant difference was found also between the lines ($P < 0.01$). In thigh meat, the values of this parameter were again found to be lower in the pastured birds ($P < 0.05$), however significant dependence with the line was also observed ($P < 0.001$). In contrast, with our results Küçükiyalmaz *et al.* (2012) found increased ash content in breast meat of slower growing lines reared organically with pasture access in comparison with conventionally reared, however, earlier studies (Fanatico *et al.*, 2005; 2007) did not report any effect of the indoors or outdoors rearing on the ash content in the breast meat of slow-growing lines.

CONCLUSIONS

The results of this study showed that when slaughtered at the same age, the birds of both slow-growing lines reared on pasture were considerably smaller than the ones grown indoors. They had significantly reduced dressing percentage, but more developed gastrointestinal tract and higher proportion of the edible by-products. Furthermore, the proportion of breast meat was reduced while that of the wings was increased in the birds having access to pasture. In addition to the reduced contents of the breast meat, the pasture access led to significantly lower lipid content of the breast and protein in thigh, but higher moisture in both kinds of meat. Further experiments are needed, in order to find the best age for slaughter of the outdoors reared birds to compensate the effect of the pasture access on the carcass traits of the chickens and on the chemical composition of the meat.

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