The effects of season and rearing systems on meat quality traits

S. Bogosavljević-Bosković, V. Kurćubić, M. Petrović, V. Dosković

Department for Animal Husbandry, Faculty of Agronomy, Cacak, Serbia and Montenegro

ABSTRACT: With the aim to examine the effect of season and rearing system on major broiler meat quality traits appropriate experimental investigations were conducted. Trial material included a total of 800 one-day-old broilers of the Hybro line hybrid. The experiment was organized in two replications, as trial I (conducted in the spring season) and trial II (conducted in the summer season). Two broiler fattening methods were employed, the intensive and semi-intensive one (using free-range rearing). The experimental chicks were slaughtered after seven weeks of fattening. Following the fattening period, 60 broilers (30 broilers from each experimental group) were chosen at random and slaughtered, with the aim of examining major broiler meat quality traits. At the slaughter line, determination of meat quantitative traits was done accompanied by sampling for chemical analyses. The rearing systems (intensive and semi-intensive system) affected significantly ($P < 0.05$) the proportion of class I meat in the broilers reared under the semi-intensive system, whereas in the class II and III meat proportions the rearing system did not exert any statistically significant effect ($P > 0.05$). The broilers reared under the semi-intensive system had a 1.44% higher proportion of muscular tissue on average than the intensively reared ones ($P < 0.01$). The bone and skin proportion was 0.82 and 0.67% lower in the broilers reared by the semi-intensive method ($P < 0.05$). The differences between the results of two trials organised at different seasons were not statistically significant ($P > 0.05$). The broilers reared semi-intensively had a statistically highly significantly higher protein proportion ($P < 0.01$) in breasts, drumsticks and thighs compared to the intensively reared broilers. The broilers reared in the summer season had higher breast and drumstick proportions ($P < 0.01$) as well as a higher thigh proportion ($P < 0.05$). The effect of both the season and the rearing system on the lipid content in the breasts, thighs and drumsticks was statistically highly significant ($P < 0.01$). The lipid content in the breasts, thighs and drumsticks was higher in the broilers during the summer season as well as in the intensively reared chicken. Finally, having thoroughly examined the research results, or more precisely, considering the established advantages in terms of the meat quality, the use of the free-range broiler rearing system can be deemed scientifically and professionally justifiable.

Keywords: broilers; season; rearing system; meat quality

Poultry production in the last few decades (Havenstain et al., 1994) has been so intensified that nowadays it has all characteristics of industrial production, including the rearing of highly productive strain hybrids, confinement rearing under strictly controlled microclimatic conditions and balanced nutrition, adequate care and health protection. This intensification in modern poultry has also resulted in high performance. As illustrated, in 1950, the fattening period required to reach the slaughter chicken weight of 1.8 to 2 kg was 12 weeks and it is only a little more than four decades later that the duration of the fattening period required to reach the same weight is even less than 6 weeks (Remignon et al., 1994). Nevertheless, this development trend in poultry production sets more and more new questions and dilemmas before breeders and researchers. One of the most frequently asked questions is the issue of the quality of products from intensive poultry production.

Broiler meat quality is generally concerned as a very complex issue that can be looked at from several points of view. In terms of meat processing industry and consumers' interests, fattened chicks

should be characterized by good dressing percentage, desired conformation, as much meat on the carcass as possible, optimal distribution of fat tissues, appropriate skin colour and least damage possible due to fattening, loading and unloading. With respect to that, the proportions of basic carcass parts (breasts, drumsticks and thighs), the presence of certain tissues in them, as well as the chemical composition of the muscle tissue, are regarded as vital parameters determining broiler meat quality (Lewis et al., 1997; Suto et al., 1998; Holcman et al., 2003; Ristić, 2003). The quality traits mentioned depend on a number of factors. Of the biological ones, the greatest impact is produced by genotype, sex and age (Lewis et al., 1997; Bokkers and Koene, 2003; Hellmeister et al., 2003).

Among numerous non-genetic factors that may have a considerable effect on some meat quality traits, a broiler rearing system has been recognized over the past years by a large number of authors as being particularly important (Lewis et al., 1997; Bakkers and Koene, 2003; Hellmeister et al., 2003; Ristić, 2003).

Considering the aforementioned, the objective of this research was an analysis of selected meat quality traits of broilers reared by two different methods (intensive and free range rearing). The meat quality parameters selected for the analysis included the proportions of certain meat categories, the proportions of basic tissues in higher-quality carcass parts and the chemical composition of the drumstick, thigh and breast meat. The aim of the investigation was to analyze the broiler meat quality traits in relation to the rearing systems.

MATERIAL AND METHOD

The material at the start of the experiment consisted of 800 one-day-old chicks of the line hybrid Hybro G. The experiment was conducted in two replications, as trial I and trial II, employing the same rearing technology (Table 1). The first trial was conducted in the spring season and the second one in the summer season. Fattening of the broilers lasted 49 days. In the first 4 weeks the rearing was performed in a deep-litter chicken pen. The trial broilers were then divided into two groups. The first one was reared in the chicken pen at a stocking density of 17 chicks per 1 m^2. The second group was provided with the same useful area within the confinement, with access to about 1 m^2 of free range per chick. The trial chickens were fed two complete feed mixtures: starter (BS) up to the 28th day and finisher feed (BF) from the 28th to the 49th day of fattening. The broilers were fed *ad libitum*.

Following the fattening period, 60 broilers (30 broilers from each experimental group) were chosen at random and slaughtered, with the aim of examining major broiler meat quality traits. Processed and cold carcasses were dissected into basic parts (breasts, thighs, drumsticks, wings, pelvis and backs observing the method prescribed by the Poultry Meat Quality Regulation (Official Gazetteer of the SFRY 1/81 and 51/88). Joint drumstick and thigh separation was done by a cut starting above the thigh, stretching towards the acetabulum and ending behind the pubis (the pelvic-thigh cut). The drumstick-thigh separation was then performed by a cut vertical to the joint between drumstick and thigh bones. The wings were separated by the so-called "shoulder" cut going through the joint (articulatory) regions of the shoulder blade and the raven bone. The breasts were separated by a cut vertical to the ventral joint rib region – the "rib" cut. The back-pelvis separation was performed by a cut vertical to the spinal column at the final vertebra – the "lumbar" cut. According to the Poultry Meat Quality Regulation (Official Gazetteer of the SFRY 1/81 and 51/88), category I of meat is breasts, thighs and drumsticks, category II of meat is wings and category III is pelvis and backs. After separation of the basic parts, dissection of the right drumstick, right thigh and breasts was done and data on the muscle tissue, bone and skin weights were registered, coupled with a simultaneous sampling

Table 1. Weight of broilers before slaughtering (g)

Season	Rearing system		Weight of broilers before slaughtering (g)
Spring	intensive	$\bar{x}$	1.936
		CV	12.31
	semi-intensive	$\bar{x}$	1.864
		CV	11.22
Summer	intensive	$\bar{x}$	1.958
		CV	12.61
	semi-intensive	$\bar{x}$	1.847
		CV	12.22

of the muscle tissues of the higher-quality carcass parts for chemical analyses.

The analysis of research data was done by the standard variation statistics methods. The significance of the expressed differences was tested by the following mathematical model of the analysis of variance:

$$y_{ijk} = \mu + (RS)_i + (S)_j + (SRS)_{ij} + e_{ijk}$$

The model corresponds to a two-factorial experiment 2 × 2 (2 rearing systems – RS and 2 seasons – S).

The examined parameters were processed by the analysis of variance ANOVA, Microsoft STATISTICA Ver. 5.0, Stat Soft Inc. (1995).

All the significant differences were determined according to the analysis of variance and the F_{exp} value results were estimated by the LSD test.

RESULTS AND DISCUSSION

Within the research results, major meat quality traits were individually presented and examined, being as follows: the proportions of some meat categories in broiler dressed carcasses, the proportions of basic tissues in the higher quality carcass parts (breasts, drumsticks and thighs, i.e. in category I meat) and the chemical composition of the meat of the major carcass parts mentioned. The content of proteins and lipids was analysed in muscles with skin.

Data on the proportions of some meat categories are presented in Table 2.

The data in Table 2 show that a higher proportion of category I meat was registered in the broilers reared with access to free range compared to those reared intensively that produced somewhat higher proportions of category II and III meat.

Table 2 data show that a higher proportion of class I meat was registered in the free-range broilers compared to the intensively fattened ones with a higher class II and III meat percentage recorded.

The used rearing systems (intensive and semi-intensive system) significantly affected ($P < 0.05$) the class I meat proportion in the broilers reared under the semi-intensive system, whereas in the class II and III meat proportions the rearing system did not exert a statistically significant effect ($P > 0.05$).

It was determined by the analysis of variance that the season (spring-summer) did not have a statistically significant effect ($P > 0.05$) on the proportion of all meat classes (I, II and III) investigated in broiler dressed and chilled carcasses.

The season and rearing system interaction did not have a significant effect ($P > 0.05$) on meat proportions in all 3 classes investigated.

The results of dissection into basic breast, drumstick and thigh tissues were discussed as relevant for further quality estimation (Table 3).

Table 2. The proportions of some meat categories in dressed and cold carcasses (%)

Season (1)	Rearing system (2)		Meat category		
			I	II	III
Spring	intensive	$\bar{x}$	59.73	12.82	26.88
		CV	3.19	6.22	7.21
	semi-intensive	$\bar{x}$	60.27	12.57	26.51
		CV	3.34	5.86	7.77
Summer	intensive	$\bar{x}$	59.18	12.69	27.33
		CV	2.90	5.76	5.90
	semi-intensive	$\bar{x}$	60.24	12.52	26.60
		CV	3.72	8.64	6.37
F_{exp}		F_1	0.638^{ns}	0.389^{ns}	0.671^{ns}
		F_2	4.857^{*}	1.887^{ns}	2.688^{ns}
		F_{12}	0.518^{ns}	0.041^{ns}	0.290^{ns}

ns = $P > 0.05$; $^{*}P < 0.05$

Table 3. The proportions of basic tissues (muscle tissue, bones and skin) in category I meat (%)

Season (1)	Rearing system (2)		Muscles (%)	Bones (%)	Skin (%)
Spring	intensive	$\bar{x}$	65.73	23.43	9.72
		CV	4.63	10.22	13.54
	semi-intensive	$\bar{x}$	67.63	22.26	8.93
		CV	5.92	11.36	12.22
Summer	intensive	$\bar{x}$	66.04	22.95	9.82
		CV	3.98	12.89	13.20
	semi-intensive	$\bar{x}$	67.01	22.48	9.28
		CV	4.76	11.66	12.10
F_{exp}		F_1	0.130^{ns}	0.261^{ns}	0.516^{ns}
		F_2	10.591**	4.826*	5.006*
		F_{12}	1.063^{ns}	0.437^{ns}	0.132^{ns}

ns = $P > 0.05$; *$P < 0.05$; **$P < 0.01$

From Table 3 data it could be concluded that the broilers reared under the semi-intensive system had a 1.44% higher muscle tissue proportion on average than the intensively reared ones ($P < 0.01$). The bone and skin proportion was 0.82 and 0.67% lower in the broilers reared by the semi-intensive method ($P < 0.05$). The differences between the results of two trials organised at different seasons were not statistically significant ($P > 0.05$).

The above-mentioned results are due to the fact that the two different broiler production systems, the one employed in confinement conditions under strictly controlled microclimatic conditions and the second one referring to broiler rearing in free range and natural environmental conditions, resulted also in differences regarding biochemical metabolism processes and, indirectly, physiological and structural tissue and organ manifestations of the broiler organism.

Additionally, it should be emphasized that, in spite of the reduced possibilities of making comparisons with the available literature data (due to the well-known effects of genetic background, age, and also the dissection method on both the yield or proportion of basic carcass parts and specific tissue proportion), the research results are in conform-

Table 4. Average protein (P) contents in the breast, drumstick and thigh muscle systems (%)

Season (1)	Rearing system (2)		Breasts (%)	Thighs (%)	Drumsticks (%)
Spring	intensive	$\bar{x}$	22.84	18.62	20.70
		CV	1.84	1.70	0.87
	semi-intensive	$\bar{x}$	23.55	19.21	21.75
		CV	1.20	1.32	0.99
Summer	intensive	$\bar{x}$	23.32	19.42	20.92
		CV	1.30	1.58	2.03
	semi-intensive	$\bar{x}$	23.64	19.50	21.92
		CV	0.96	1.19	1.06
F_{exp}		F_1	9.798**	45.579**	5.816*
		F_2	31.625**	17.221**	160.689**
		F_{12}	4.457*	9.978**	0.095^{ns}

ns = $P > 0.05$; *$P < 0.05$; **$P < 0.01$

Table 5. Average lipid (L) contents in the breast, drumstick and thigh muscle systems (%)

Season (1)	Rearing system (2)		Breasts (%)	Thighs (%)	Drumsticks (%)
Spring	intensive	$\bar{x}$	2.64	8.18	5.21
		CV	5.66	3.09	3.33
	semi-intensive	$\bar{x}$	2.27	7.08	4.86
		CV	2.59	3.06	4.62
Summer	intensive	$\bar{x}$	2.22	8.56	5.25
		CV	6.23	3.40	2.87
	semi-intensive	$\bar{x}$	2.04	7.45	3.86
		CV	7.26	4.07	5.16
F_{exp}		F_1	75.836**	23.390**	77.317**
		F_2	54.297**	203.094**	254.000**
		F_{12}	6.480*	0.004^{ns}	90.740**

ns = $P > 0.05$; *$P < 0.05$; **$P < 0.01$

ity with the data reported by Lewis et al. (1997), Milošević et al. (2003) and Ristić et al. (2003).

The chemical composition of the meat is another important quality parameter. Tables 4 and 5 present results of the examination of the basic chemical composition of breast, drumstick and thigh muscular systems.

Table 4 presents results of the investigation on the protein content in breast, drumstick and thigh muscles. The broilers reared semi-intensively had a statistically highly significantly higher protein proportion ($P < 0.01$) in breasts, drumsticks and thighs compared to the intensively reared broilers. The broilers reared in the summer season had higher breast and drumstick proportions ($P < 0.01$) as well as a higher thigh proportion ($P < 0.05$). The season and rearing system interaction statistically significantly influenced the protein content in the breasts ($P < 0.05$), whereas the effect on the thigh protein content was highly significant ($P < 0.01$).

From the data presented in Table 5 it could be concluded that the effect of both the season and the rearing system on the lipid content in breasts, thighs and drumsticks was statistically highly significant ($P < 0.01$). The lipid content in breasts, thighs and drumsticks was higher in the broilers during the summer season as well as in the intensively reared chickens.

The differences established in the meat chemical composition may have resulted from accelerated lipid and carbohydrate metabolism due to the specificities of the free range rearing. This primarily refers to the processes in the organism caused by a more active involvement of some muscles and body parts in providing more pronounced motion functions of the chicks. This conclusion is in accordance with the results of the study conducted by Ricard (1989), who registered a lower lipid carcass content in the broilers reared in groups with a smaller stocking density per m^2 of floor, and also by Abaseikong (1989), whose results, in terms of the above mentioned, did not show any significant effect of high temperatures.

CONCLUSION

Based on the results of the study on the effect of rearing system on some broiler meat quality parameters it can be concluded that the free range rearing or semi-intensive fattening produced better results in comparison with the intensive system. A higher category I meat proportion and a greater muscle tissue proportion in the higher-quality carcass parts were recorded for the broilers reared using the free range. Furthermore, a lower lipid content and a somewhat higher protein content were characteristic of the muscular system of these broilers, indicating that the meat concerned is of a special nutritive and dietary value.

As the differences in the results of the two trials, i.e. in the results produced in the spring and summer rearing seasons for most investigated traits, were small and statistically unjustifiable, it could

be concluded that broiler free-range rearing can be successfully performed in the greater part of the year.

Finally, having thoroughly examined the results of this study, or more precisely, considering the established advantages in terms of the meat quality, the use of the free-range broiler rearing system can be deemed scientifically and professionally justifiable.

REFERENCES

Abaseikong S.F. (1989): Effect of environmental temperature on broiler meat production: growth pattern and carcass composition. Poult. Abstr., *15*, No. 12.

Bookers E.A.M., Koene P. (2003): Behaviour of fast- and slow growing broilers to 12 weeks of age and the physical consequences. Appl. Anim. Behav. Sci., *81*, 59–72.

Havenstein G.B., Ferkett P.R., Scheideler S.E., Rives D.V. (1994): Carcass composition and yield of 1991 vs 1957 broilers when feed typical 1957 and 1991 diets. Poult. Sci., *73*, 1795–1804.

Hellmeister Filho P., Machado Menten J.F., Neves da Silva M.A., Coelho A.A.D., Savino V.J.M. (2003): Efeito de genotipo e do sistema de criacao sorbe o desempenho de frangos tipo caipira. R. Brsa. Zootec., *32*, 1883–1889.

Holcman A.R., Vadnjal B., Žledner, Stibilj V. (2003): Chemical composition of chicken meat from free range and extensive indoor rearing.Arch. Geflügelk., *67*, 120–124.

Lewis P.D., Perry G.C., Farmer L.J., Patterson R.L.S. (1997): Responses of two genotypes of chicken to the diets and stocking densities typical of UK and «Label Rouge» production systems: I. Performance, behaviour and carcass composition. Meat Sci., *45*, 501–516.

Milošević N., Perić L., Supić B. (2003): Raising chickens on a free range system 1. Evaluation of carcass quality. Institute for Animal Husbandry Belgrade-Zemun. Biotechnol. Anim.Husb., *19*, 335–343.

Remignon H., Lafaucheur L., Blum J.C., Ricard F.H. (1994): Effects of divergent selection for body weight on three skeletal muscle characteristics in the chicken. Brit. Poult. Sci., *35*, 65–76.

Ricard F.H. (1989): Influence of housing density on growth and carcass traits of broiler folws reared on floors. Poult. Abstr., *15*, No. 7.

Ristić M. (2003): Fleischqualität von broilern der ökologishen produktion. Institute for Animal Husbandry Belgrade-Zemun. Biotechnol. Anim. Husb., *19*, 335–343,

Suto Z., Horn P., Jensen J.F., Sorensen P, Csapo J. (1998): Carcass traits, abdominal fat deposition and chemical composition of commercial meat type chicken during a twenty growing period. Arch. Geflügelk., *62,* 21–25.

Received: 2005–07–12
Accepted after corrections: 2006–03–15

Corresponding Author

Prof. Snezana Bogosavljevic-Boskovic Ph.D., Department for Animal Husbandry, Faculty of Agronomy, Cara Dusana 34, 32 000 Cacak, Serbia
e-mail: sbb@tfc.kg.ac.yu