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Comparison of growth parameters, yields and qualitative properties of muscles in broiler hybrids

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Summary

The aim of this study was the comparison of growth parameters, yields and qualitative properties of muscles in broiler hybrids ISA 220 and intermediate type ISA 257. One hundred and one one-day-old chicks, comprising approximately equal numbers of males and females were used. During the experiment the feed consumption (per 1 kg of body weight gain), weight gains, and body weight were recorded. After the processing of the broiler chickens, the weight of carcass, and yields (of the whole carcass, breast muscle, thighs, boned thigh muscles, wings, skeleton) were recorded. The breast and thigh muscles were analyzed for the content of nitrogen compounds, fat, water, amino acid, and weight losses during the cooking. The sensory properties of breast and thigh muscles of both groups were compared.

The mean body weight of the broiler chickens at the beginning of the experiment was 43 g (ISA 257), and 36 g (ISA 220) respectively. On day 45, the mean body weights and carcasses were significantly higher ($p < 0.05$) in group ISA 220 (2507 g and 1676 g respectively) in comparison with ISA 257 (1890 g and 1249 g). These results corresponded with the results of carcass yields. The mean yield of the whole carcass was significantly higher ($p < 0.05$) in ISA 220 (66.64%) in comparison with ISA 257 (66.06%). However, the mean yields of thighs, boned thigh muscle, and wings, which are considered as ideal parts, for grilling were significantly higher ($p < 0.05$) in ISA 257. Higher differences were recorded in fat and water content. The hybrids ISA 220 contained a higher amount of water in breast and thigh meat, and fat content was higher in meat of ISA 257, mainly in breast meat. The results of sensory examination showed better acceptability of ISA 257 hybrid than ISA 220.

Keywords: broiler chickens, hybrid ISA 257, hybrid ISA 220, meat quality

Poultry is known for good feed conversion to meat, which decreases production expenses. It means that the prices of poultry products on the world market are lower than the prices of other products of animal origin. Increased consumption of poultry meat leads to the increase of farm breeding of poultry, and more effective production is also required. It is an effort to breed more productive broilers, improve feed conversion, and shorten the time of feeding (10). Poultry meat takes second place in meat consumption in front of beef. Success is caused primarily by low prices, a widespread target group of consumers, as most cultures and religions, and the relative safety of poultry meat (9). The importance of poultry meat increases in relation to the increased requirement of the population for softer and leaner types of meat such as are poultry meat (11).

Tremendous improvement in commercial broiler performance has taken place since the early 1950s. This change has occurred via selection for rapid early growth, combined with improved environmental factors affecting broiler performance, such as nutrition (4, 6, 7).

As knowledge of heritable traits increased, selective breeding became more sophisticated. The fact that growth rate and body size is inherited characteristics can be used to increase the efficiency of food conversion, although there is also increased fat content of the carcasses. In broilers, for example, the feed conversion rate has improved from about 2.76 units of feed to produce 1 unit of poultry meat in 1960 to about 1.8 units in 1995. Birds reach slaughter weight at a younger age, which means that houses can be used to produce more birds in a given period (2).

The trend of breeding companies from the beginning of poultry production is the feeding of broiler chickens with feed consumption as low as possible. On the other hand, all these factors also produce negative impacts as are circulation problems, heart – failure, the occurrence of ascites (edema disease), the

need for antibiotic administration, growth stimulators, vitamin programs, etc. The shortening of the feeding period from 42 days to 37-38 days has an influence on meat quality, such as a high water content and change of sensory properties, and the ageing process of meat. Nowadays, meat hybrids reach a body weight of 2 kg (with feed conversion lower than 2 kg per 1 kg of weight increase) on day 35 of feeding (10). In some countries, the opposite trend of alternative ways of organically poultry production leads to the prolongation of the feeding period and intensity of broiler growth is reduced. In this way broilers show a big difference in the composition of the carcasses and the chemical content of breast and thigh meat. But his method of production shows no major improvement in the sensory characteristics of the meat when compared with conventionally produced birds (8).

Alternative ways of poultry meat production are spread mostly in EU countries such as France, Italy, the Netherlands, Germany, Austria, and the Czech Republic. Alternative ways are introduced in the following order: system of nutrition, foodstuff of animal origin, e.g. meat or bone meal, fish meal, blood meal, and animal fat are not used, extensive way of feeding, using of intermediate types of broiler chickens.

Intermediate types of broiler chickens are presented with: lower morbidity and mortality, possibility of feeding in worse animal hygienic conditions, better classification in the slaughterhouse, less intensive growth, better quality and taste of meat, ideal type for grilling.

ISA 257 is a representative of the intermediate types of broiler chickens with less intensive growth, but higher quality of meat and skin. These properties are very important for a good quality classification, to avoid wing breaks and skin damage.

The aim of this study was comparison of growth parameters, yields and qualitative properties of muscles in broiler hybrids ISA 220 and intermediate type ISA 257. Feed consumption, weight gains, and body weight were recorded. After the processing of the broiler chickens, the weight of carcasses, yields, and content of nitrogen compounds, fat content, water content, amino acid compounds, and weight losses during the cooking were analyzed. Finally, the sensory properties of breast and thigh muscles of both groups were compared.

Materials and methods

All methods and procedures used in this experiment were approved by the State veterinary and food administration of Slovak Republic.

One hundred and one one-day-old chickens, comprising approximately equal numbers of males and females of two broiler strain-crosses (ISA 257 and ISA 220) were used. The broiler chickens were delivered by the hatchery Incuba a.s. Žabčice (The Czech republic).The experiment was carried out at the Section of Meat Hygiene and Technology, Department of Food Hygiene and Technology. ISA 257 group consisted of 48 chickens and ISA 220 group consisted of 53 chickens. Each pen was fitted with two bell water drinkers and two cylinder feeders. The chickens were bedded on pine shavings on cement floors. The lighting regimen was adjusted to the age of the broiler chickens (day 1 = 24 hours, day 2 = 23 hours, day 3 = 22 hours, day 4 = 21 hours, days 5-9 = 18 hours, days 10-20 = 16, days 21-27 = 13 hours, days 28-44 = 16 hours).

In the beginning, up to day 16 of age, the broiler chickens of both groups were fed with complete feed mixture HYD-01 consisting of nitrogen compounds (210 $g.kg^{-1}$) and metabolizable energy (12.0 $MJ.kg^{-1}$). HYD-02 consisting of nitrogen compounds (190 $g.kg^{-1}$) and metabolizable energy (12.0 $MJ.kg^{-1}$) followed from day 16 up to day 28 of age. HYD-03 consisting of nitrogen compounds (170 $g.kg^{-1}$) and metabolizable energy (12.0 $MJ.kg^{-1}$) was used from day 28 up to day 44 of age. Feed and water were consumed *ad libitum.* The vitamins A, D_3, E (5000 I.U. of vitamin A/*per capita*/day; and 2400 I.U. of vitamin D_3/*per capita*/day, and vitamin E 8 mg/*per capita*/day) were added to the drinking water twice a week during the first two weeks of the feeding period. The vitamins were adjusted by producer (Galena, the Czech Republic) to be soluble in water.

During the experiment the feed consumption (per 1 kg of body weight gain), weight increase (on day 2, 7, 17, 26, 44), and body weight were recorded. The broiler chickens were slaughtered on day 45 of age. After the processing of the broiler chickens, the weight of carcass, and yields (of the whole carcass, breast muscle, thighs, boned thighs, wings, skeleton) were recorded.

The breast and thigh muscles were analyzed for the content of nitrogen compounds (Kjeltec auto 1030 analyzer, Tecator, Sweden). Procedure consists of mixing of homogenized samples with concentrated H_2SO_4 and selenium catalyzator and mixture mineralization in Digestion system 20 1015 (Tecator, Sweden) at 450°C for 45 minutes. After cooling, distilled water, Taschir indicator and 30% NaOH were added and Kjeltec analyzer analyzed samples. Fat content (Soxhlet method) was estimated by extraction with inorganic solvents (diethylether) in Soxhlet apparatus at boiling temperature for 4 hours. Drying in the oven at 105°C until the time when sample weight was without change performed water content estimation. Amino acid compounds (Amino acid analyzer T 339, Mikrotechna Praha, The Czech Republic) were expressed as a total sum of amino acids. Ionex chromatography with chromatographic column (34.5 × 0.37 cm), and flow rate of buffer solutions 14 $ml.h^{-1}$, ninhydrine reagent 12 $ml.h^{-1}$ at reaction temperature 100°C were used. Detection was carried out by spectrophotometric analysis at 520 nm. Weight losses during the cooking at 88°C in fresh and frozen (–18°C) breast and thigh muscles were calculated.

Sensory properties of breast and thigh muscles of both groups were compared. A panel of experts performed the sensory evaluation of the poultry meat. The panel consisted of 8 persons and evaluated the following attributes of meat samples (odour, taste, consistency, juiciness, tenderness) according to a 5 point scale. Samples were processed by cooking at 88°C, grilling at 200°C for 3 minutes and roasting at 200°C for 40 minutes.

Statistical analysis were performed by Graph Pad Prism software, version 3.00 (1999) using unpaired t-test for comparing mean values between groups. A significance level of $p < 0.05$ was used. All results were expressed as mean ± SD.

Results and discussion

Mean body weight of broiler chickens during the fattening is shown in tab. 1. The mean body weight at the beginning of the experiment was 43 g (ISA 257), and 36 g (ISA 220) respectively. From this time, the growth of broiler chickens in group ISA 220 was more intense. On day 45, the mean body weight was 1890 g (ISA 257), and 2507 g (ISA 220). The mean body weight in group ISA 220 was significantly higher ($p < 0.05$) from 17th day of fattening than in group ISA 257. The observed progress of growth of both broiler hybrids is shown on fig. 1. Five trials (on 5 farms) that were directed at the fattening of ISA 257 broiler chickens were performed by Incuba a.s. Žabčice. The mean body weights on slaughter day were similar to our results, and feed conversion ranged from 1880 g to 2230 g.

The mean weight of carcass was lower in ISA 257 group (1249 g) in comparison with ISA 220 group (1676 g) (tab. 2) and these results corresponded with the results of carcass yields. The mean yield of the whole carcass and yield of breast muscles were significantly higher ($p < 0.05$) in ISA 220 (66.64% and 20.52% respectively) in comparison with ISA 257 (66.06% and 19.46% respectively). On the other hand, the mean yields of thighs, boned thigh muscle, and wings were significantly higher ($p < 0.05$) in ISA 257 (tab. 2). According to Cabadaj and Turek (3) the thighs are the greatest part of the carcass (31.8-33.5%), followed by the breast (24.3-24.8%), and less valuable parts such as the back (14.2%), wings (13.1%) and neck (7.5%). According to Grossklaus (5) the chicken's carcass consists mainly of breast (25%), thighs (36%), wings (13.5%), and back parts (25.5%). Goliomytis et al. (4) showed similar results of the mean yield of major component parts on day 42 of age. The portion of breast meat was 24.6%, and thigh meat 10.6% related to carcass weight.

The mean values of N-compounds, fat content, water content, and the sum of amino acids are shown in tab. 3. No significant differences ($p > 0.05$) between ISA 257 and ISA 220 were ascertained. The mean values of N-compounds were at the similar level, however slightly higher values in the breast of ISA 220 (24.34 versus 24.67%) and slightly higher values in the thigh of ISA 257 (19.42 versus 19.12) were recorded. The fat content was significantly higher ($p < 0.05$) in the group of ISA 257 than in ISA 220, mainly in the breast (ISA 257 – 0.909%, ISA 220 –

Tab. 1. Body weight of broiler chickens during the fattening (mean ± SD)

Age (day)	Body weight (g)	
	ISA 257	ISA 220
2	43 ± 6	38 ± 4
7	104 ± 14	106 ± 15
17	396 ± 27	412 ± 31^{a}
26	864 ± 61	954 ± 72^{b}
44	1890 ± 158	2507 ± 163^{c}

Explanation: a, b, c – means within the same line with different letters differ ($p < 0.05$)

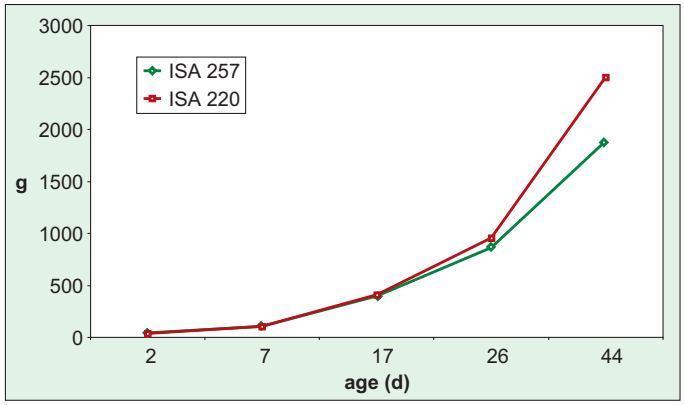

Fig. 1. Body weight of hybrids ISA 257 and ISA 220 during the fattening period

Tab. 2. Body weight and yields of body parts (mean ± SD)

Parameters	ISA 257	ISA 220
Body weight (g)	1890 ± 157.9	2507 ± 162.7^{c}
Weight of carcass (g)	1249 ± 115.7	1676 ± 113.0^{c}
Yield of carcass (%)	66.06 ± 1.74	66.64 ± 1.87^{a}
*Yield of breast meat (%)	19.46 ± 0.96	20.52 ± 0.79^{b}
*Yield of thighs (%)	32.83 ± 0.97^{a}	32.45 ± 0.82
*Yield of thigh meat (%)	9.82 ± 0.87^{b}	9.61 ± 0.85
*Yield of wings (%)	12.04 ± 0.45^{c}	11.72 ± 0.44
*Yield of skeleton (%)	35.20 ± 2.20	35.04 ± 2.01

Explanation: a, b, c – means within the same line with different letters differ ($p < 0.05$); * % related to carcass weight

Tab. 3. Basic chemical components (mean ± SD)

Chemical components	ISA 257		ISA 220	
	Breast	Thigh	Breast	Thigh
N-compounds (%)	24.34 ± 0.93	19.42 ± 0.99	24.67 ± 1.71	19.12 ± 0.80
Fat content (%)	0.909 ± 0.07^{c}	4.536 ± 0.49	0.575 ± 0.08	4.405 ± 0.18
Water content (%)	73.85 ± 2.55	75.86 ± 1.98	74.78 ± 1.44	76.49 ± 1.79^{a}
Sum of aminoacids (g.kg^{-1})	221.6 ± 9.06	172.5 ± 8.64	227.8 ± 12.02	172.4 ± 10.43

Explanation: as in tab. 1.

0.575%). Water content was higher in breast and thigh meat of ISA 220. Berri et al. (1) found the 23.73% content of protein in pectoral major muscle. According to Grossklaus (5) the poultry meat contains 73.28% (thigh), and 74.37% (breast) of water, 5.53% and 1.22% of fat, and 20.00 and 23.29% of protein. The sum of amino acids was slightly, but no significant ($p > 0.05$) higher in the ISA 220 group.

Weight losses during cooking correspond to the chemical composition (water and fat content). Significantly higher ($p < 0.05$) weight losses were recorded in the meat from ISA 220 (tab. 4).

A panel of experts performed the sensory evaluation of the poultry meat. A higher number of points were given to samples of the ISA 257 group, mainly for odour and taste properties. Also, the fat content of ISA 257 was higher, which could explain the preference for this group. Generally, rearing duration from 5 to 8 weeks improved the properties (juiciness, tenderness) in commercial production conditions and significantly higher score appeared at 46 days (8).

Conclusion

The mean body weight and yield of the whole carcass was significantly higher in ISA 220 in comparison with ISA 257. However, the mean yields of thighs, boned thigh muscle, and wings which are considered as ideal parts for grilling were significantly higher in ISA 257. Differences were recorded in fat and water content. The higher fat content in meat of ISA 257, mainly in breast meat caused better acceptability of meat derived from ISA 257 hybrid during sensory examination.

Tab. 4. Weight losses after thermal treatment (mean ± SD)

Weight losses	ISA 257		ISA 220	
	Breast	Thigh	Breast	Thigh
Fresh meat (%)	20.80 ± 0.86	22.60 ± 0.96	25.70 ± 0.89^{c}	27.60 ± 1.15^{c}
Frozen meat (%)*	20.48 ± 0.92	25.90 ± 1.12	22.06 ± 0.85^{c}	27.40 ± 1.29^{b}

Explanation: a, b, c – means within the same line with different letters differ ($p < 0.05$); *any thawing loss

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