

CARCASS COMPOSITION, PHYSICO-CHEMICAL AND SENSORY PROPERTIES OF MEAT OF COCKERELS AND BROILER BREEDER HENS AFTER REPRODUCTIVE CYCLE

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ABSTRACT

The purpose of this research was the comparison of 64-week-old cockerels and the Ross 308 broiler breeder hens in terms of their weight and the carcass composition, the physico-chemical and sensory properties of the breast and leg muscles. Twenty males and twenty females of broiler breeder hens after the reproductive cycle were included in the research. The males of broiler breeder hens were characterized by a significantly higher carcass weight, higher percentage content of neck, wings ($P \leq 0.01$) and leg muscles ($P \leq 0.05$) in the carcass and significantly less fatness ($P \leq 0.01$) in comparison to the assessed females. The evaluation of the meat quality included the pH measurement and electrical conductivity after 24 hours from slaughter, determination of natural and thermal leakage, determination of colour parameters (L^* , a^* , b^*) and the sensory evaluation of cooked meat. The breast muscles of males were significantly more likely to have a thermal leakage ($P \leq 0.05$), while leg muscles were characterized by darker colour and less saturation in the yellow direction ($P \leq 0.01$). The meat from breast muscles of females from broiler breeder hens had a more definite and desirable aroma and tastiness ($P \leq 0.01$).

Key words: carcass, quality of meat, sex, broiler breeder hen

INTRODUCTION

The poultry industry in Poland belongs to essential segments of the agricultural market. Poultry is more and more important in the country's food balance and its consumption is steadily increasing [Szybiga 2009]. One of the main tasks of modern poultry is to obtain the end products of a reproducible quality standard ensuring health and sensory appeal. In Poland, the basic raw material for the production of poultry meat is taken from the slaughter of young birds; mainly broiler chickens, young slaughter turkeys, broiler ducks and young slaughter geese. On a much smaller scale, the slaughter of adult poultry is conducted in slaughterhouses, i.e. laying hens of commercial flocks and birds of other species of poultry from parental and breeding flocks [Grabowski 2004]. For a dozen or so years, the 'convenient food' produced from poultry meat of lower culinary properties, which is also the meat

of laying hens after the reproductive period, has been gaining importance in the meat processing in Poland. Convenient food is an alternative both for the poultry industry and customers looking for cheap, ready-to-eat products in the household [Nowak and Trziszka 2006]. This category of products can be classified as 'processed', i.e. mechanically forming of ground meat or meat stuffing [Cegiełka and Nadrowska 2013]. In addition, less technologically attractive raw material such as meat from hens after the laying period is used for the production of canned poultry and MDM (i.e. mechanically deboned meat). The main raw material for the MDM production are whole carcasses of hens after the laying period and the carcasses heavier broiler chickens or only the ridges, wings and necks, after cutting out the breast and leg muscles. MDM is characterized by inferior technological properties and lower durability, as compared to hand-separated meat – the breast and leg muscles. However, the

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production of MDM is the most rational way of managing large number of carcasses remaining after manual separation of the breast and leg muscles. The mechanically deboned meat is primarily used in the production of finely ground sausages (e.g. poultry sausages and mortadella) pâté and many types of roasts. It may also be a component of the meat emulsion used in the production of steamed sausages and rolls [Lyon et al. 2003, Grabowski 2004].

The purpose of this research was to compare carcass composition, physicochemical and sensory properties of meat of cockerels and broiler breeder hens after the reproductive cycle.

MATERIAL AND METHODS

The research was conducted on 20 males and 20 females of broiler breeder hens of the Ross 308 hybrid. The animals were slaughtered at 64th week of life and then subjected to plucking and eviscerating. After 24 hours, the eviscerated carcasses were chilled to 4°C and weighed on the WLC 6/12/F1/R weighing scale of the Radwag® company with the accuracy to 0.1 g. The chilled carcasses were dissected according to the method developed by Ziotecki and Doruchowski (1989). During the dissection of carcasses, the following components were distinguished: necks without skin, wings with skin, breast muscles, leg muscles, skin with subcutaneous fat, abdominal fat and the remainders of the carcasses. Individual items were weighed and their percentage in the carcass were calculated.

24 hours after the slaughter, the degree of acidification of the muscle tissue and the EC electrical conductivity in the breast and leg muscles was determined. For pH measurement, we used a portable pH-meter (Matthäus, Germany), equipped with a glass combined dagger electrode, and for the measurement of the electrical conductivity used a portable conductivity meter.

The free leakage of meat juice was determined on the basis of the samples taken from the breast and leg during dissection. The breast and leg muscles were weighed and then placed in a foil bag which was cut a notch several times at the bottom to let the meat juice leak. The samples thus prepared were inserted into a second bag and suspended so that the leaking juice was not in contact with the meat sample. The prepared samples were stored at 4°C for 24 hours. After this time, the samples were reweighed and on the basis of the differences of weight the percentage of free leakage of meat juice was calculated.

The size of the thermal leakage was determined according to the Walczak [1959] method. The meat samples of 20 g were ball-shaped, wrapped in a hygroscopic gauze and placed in a water bath at 85°C for 10 minutes. After cooling for 30 minutes at 4°C, the samples were weighed. From the difference in weight before and after the heat

treatment, the percentage loss of meat weight was calculated in this process.

By the use of the Konica Minolta CR 400 photocolorimeter, 24 hours after the slaughter of broiler breeder hens, measured the meat colour on the inner surface of raw muscle of the breast and leg muscles, determining the colour lightness (L^*), redness (a^*), and yellow colour (b^*) [Itten 1997].

The sensory analysis of the breast and leg muscles was conducted according to the scale given by Baryłko-Pikielna and Matuszewska [2009]. The aroma, juiciness, tenderness and tastiness of the cooked meat were determined. The ratings were made on a five point scale, assuming the highest value of 5 points and the lowest of 1 point.

The obtained results were calculated statistically by calculating the arithmetic average and the standard deviation of the examined treats. The significance of the differences between the examined groups was verified using Student's *t*-test.

RESULTS AND DISCUSSION

Table 1 shows the carcass weight and the percent share of the selected pieces of 64-week-old broiler breeder hens after the reproductive cycle. The males of broiler breeder hens were characterized by a significantly higher ($P \leq 0.01$) weight of the eviscerated carcass compared to females. Robinson et al. [2005] in the research on the 58-week-old hens of the Hubbard Hi-Y, Ross 508 and Ross 708 hybrids, obtained a higher average weight of the carcass (3784 g, 3823 g, 3834 g, respectively), as did Renema et al. [2001] in the 61-week-old broiler breeder hens (3724 g) and Robinson and Robinson [1991] in the 62-week-old broiler breeder hens (3587 g).

Compared to female carcasses, the carcasses of males from broiler breeder hens had statistically significant ($P \leq 0.01$) percentage content of neck and wings. Approximate percentages of neck and wing share in the carcasses of 64-week-old broiler breeder hens from the Ross 308 breed were obtained by Kokoszyñski et al. [2016 a].

There were no statistically significant differences in the percentage share of breast muscles in carcasses of the studied groups of broiler breeder hens. Significantly lower values of the trait were obtained for the Green-legged Partridge, Rhode Island Red, New Hampshire and Banded Rock breeds of hens by Puchała et al. [2014, 2015]. Robinson et al. [2005] states that in 58-week-old hens of the Hubbard Hi-Y, Ross 508 and Ross 708 hybrids the breast muscles constituted 18.7%, 18.1%, 20.2% respectively of the body weight. In the studies conducted by Renema et al. [2001], the percentage of breast muscles in

Table 1. Carcass weight and composition of 64-week-old broiler breeder

Tabela 1. Masa i skład tuszki 64-tygodniowych kur mięsnych

Trait – Cecha	Sex, characteristics – Płeć, charakterystyki			
	males – samce (n = 20)		females – samice (n = 20)	
	\bar{x}	SD	\bar{x}	SD
Carcass weight, g – Masa tuszki, g	3894.5 ^A	317.9	3205.2 ^B	260.3
Neck, % – Szyja, %	4.4 ^A	0.6	3.5 ^B	0.7
Wings, % – Skrzydła, %	10.6 ^A	1.0	9.3 ^B	0.5
Breast muscles, % – Mięśnie piersiowe, %	22.3	3.0	24.4	2.0
Leg muscles, % – Mięśnie nóg, %	25.3 ^a	1.8	22.8 ^b	1.8
Skin with fat, % – Skóra z tłuszczem, %	9.1 ^A	1.5	11.3 ^B	2.1
Abdominal fat, % – Tłuszcz sadelkowy, %	0.0 ^A	0.0	2.6 ^B	1.4
Remainders of carcass, % – Pozostałości tuszki, %	28.3	2.5	26.1	3.8
Giblets, g – Podroby, g	138.8	27.4	128.5	22.1

a, b – statistically significant differences between the males and females at ($P \leq 0.05$).

a, b – statystycznie istotne różnice między samcami i samicami przy ($P \leq 0,05$).

A, B – statistically significant differences between the males and the females at ($P \leq 0.01$).

A, B – statystycznie istotne różnice między samcami i samicami przy ($P \leq 0,01$).

the body of a 61-week-old females of the broiler breeder hens was 15%.

The percentage of leg muscles in the carcasses of the 64-week-old males (25.3%) was significantly higher ($P \leq 0.05$) than in the females (22.8%) of broiler breeder hens. In the Puchała et al. [2014] experiment, the percentage of the leg muscles in the carcasses of the 56-week-old hens was lower and constituted 17.77% for the Green-legged Partridge breed, 19.79% for the Rhode Island Red breed, 18.97% for the New Hampshire breed and 20.69% for the Barred Rock breed. Similar values of this trait in males (25.6%) and smaller in females (20.3%) than in this experiment were obtained by Kokoszyński et al. [2016 a] in the research on the 64-week-old broiler breeder hens from the Ross 308 hybrid.

64-week-old males of broiler breeder hens compared with the females were characterized by statistically significantly ($P \leq 0.01$) smaller percentage of skin with the subcutaneous fat content and the lack of abdominal fat in the carcasses. This may indicate their proper nutrition, high physical activity and reproducibility. There were no significant differences in the remainders of carcasses and giblets in the study groups. The higher proportion of the abdominal fat in the 56-week-old hens from the Green-legged Partridge breed and the Rhode Island Red breed was obtained by Puchała et al. [2015] (5.97%, 6.79% respectively). Robinson et al. [1996] stated that in the 60-week-old females of broiler breeder hens Starbro, the content of the abdominal fat was 6.2 to 6.4% of body weight. Renema et al. [2001] in the experiment on the 61-week-old broiler breeder hens obtained 5% the abdominal fat content.

The data characterizing the physical and chemical properties of the breast and leg muscles of the 64-week-old broiler breeder hens from the Ross 308 hybrid are shown in Table 2. The breast muscles were characterized by lower values of the acidity level of the muscle after 24 hours from the slaughter than the leg muscles. The mean values of pH_{24} of the breast muscles were the same in the study groups regardless of sex. pH_{24} of the leg muscles of males were slightly higher than the pH_{24} of the 64-week-old females of the broiler breeder hens. Lower values of pH_{24} of the breast muscles were obtained by Puchała et al. [2014] in the 56-week-old hens from the breeds of Green-legged Partridge (5.50), Rhode Island Red (5.41), New Hampshire (5.68) and Barred Rock (5.56). In the studies of Sanfelice et al. [2010] the pH_{24} of the breast muscles from the females of broiler breeder hens from the Ross hybrid in week 68. and 69. (after the laying period) constituted 5.65. In the opinion of Komiyama et al. [2010], the reaction of the breast muscles of the broiler breeder hens after the laying period, measured 24 hours after the slaughter constituted 5.70. The obtained pH_{24} values of the breast muscles from the 64-week-old broiler breeder hens from the Ross 308 hybrid were comparable to those reported in the literature (Puchała et al. 2014, Puchała et al. 2015, Kokoszyński et al. 2016 a).

The electrical conductivity values 24 hours after the slaughter were higher in the breast muscles than the leg ones in the broiler breeder hens from the Ross 308 hybrid. Furthermore, the electrical conductivity measurement of the breast and leg muscles was higher in males than in females from the 64-week-old broiler breeder hens. Kryza et al. [2016] in the studies on turkey toms and turkey hens of the heavy type BIG 6, obtained higher

Table 2. Physico-chemical properties of breast and leg muscles of 64-week-old broiler breeder

Tabela 2. Właściwości fizykochemiczne mięśni piersiowych i mięśni nóg 64-tygodniowych kur mięsnych

Trait – Cecha		Sex, characteristics – Płeć, charakterystyki			
		males – samce (n = 20)		females – samice (n = 20)	
		\bar{x}	SD	\bar{x}	SD
pH ₂₄	MP	5.85	0.20	5.84	0.16
	MN	6.05	0.17	5.98	0.15
EC ₂₄	MP	8.8	2.3	8.1	3.5
	MN	6.8	2.5	6.3	2.9
Drip loss, % – Wyciek swobodny, %	MP	2.7	1.6	1.7	1.6
	MN	1.1	1.0	0.9	0.3
Thermal loss, % – Wyciek termiczny, %	MP	36.3 ^a	4.1	32.1 ^b	4.6
	MN	42.4	3.3	40.1	2.2
L* – lightness – L* – jasność barwy	MP	59.5	3.6	59.8	2.0
	MN	43.6 ^A	6.0	50.1 ^B	7.0
a* – redness – a* – natężenie barwy czerwonej	MP	14.2	2.2	14.0	2.7
	MN	20.2	2.1	18.2	3.6
b* – yellowness – b* – natężenie barwy żółtej	MP	10.5	2.0	12.9	3.9
	MN	5.6 ^A	3.1	10.4 ^B	2.7

a, b – statistically significant differences between the males and females at ($P \leq 0.05$).

A, B – statistically significant differences between the males and the females at ($P \leq 0.01$).

MP – breast muscles; MN – leg muscles.

a, b – statystycznie istotne różnice między samcami i samicami przy ($P \leq 0.05$).

A, B – statystycznie istotne różnice między samcami i samicami przy ($P \leq 0.01$).

MP – mięśnie piersiowe; MN – mięśnie nóg.

values of the electrical conductivity in the breast muscles 24 hours after the slaughter ($9.58 \text{ mS} \cdot \text{cm}^{-1}$ and $9.26 \text{ mS} \cdot \text{cm}^{-1}$, respectively). The same authors report that the electrical conductivity of the thigh muscles 30 hours after the slaughter constituted $6.53 \text{ mS} \cdot \text{cm}^{-1}$ for turkey toms and $5.68 \text{ mS} \cdot \text{cm}^{-1}$ for turkey hens. Batkowska and Brodacki [2011] in the experiment on the medium-sized turkey hens BUT 6 and heavy BIG 6, obtained lower values of electrical conductivity 24 hours after the slaughter for the breast muscles ($6.22 \text{ mS} \cdot \text{cm}^{-1}$ and $7.32 \text{ mS} \cdot \text{cm}^{-1}$ respectively) and comparable for the thigh muscles ($6.10 \text{ mS} \cdot \text{cm}^{-1}$ and $6.44 \text{ mS} \cdot \text{cm}^{-1}$ respectively). Kokoszyński et al. [2016 b] report that the electrical conductivity EC₂₄ in the breast muscles of ducks from the Peking hybrid constituted $6.99 \text{ mS} \cdot \text{cm}^{-1}$, and in the leg muscles $6.49 \text{ mS} \cdot \text{cm}^{-1}$. In the opinion of Okruszka [2012], the electrical conductivity values 24 hours after the slaughter in the breast muscles of geese were $6.82 \text{ mS} \cdot \text{cm}^{-1}$, while in the leg muscles $6.57 \text{ mS} \cdot \text{cm}^{-1}$.

An important distinguishing trait of the quality of meat is the free flow of its juice. It characterizes the losses of meat weight during the storage and distribution. The obtained in the study means of the free leakage of juice were higher in the breast muscles than in leg ones in the 64-week-old broiler breeder hens from the Ross 308 hybrid. The free leakage of the juice from the breast muscles was greater in males than females from the broiler

breeder hens, while in the leg muscles it was on the same level. Similar values of this trait in the breast muscles were obtained by Komiyama et al. [2010] and Sanfelice et al. [2010]. Much smaller free leakage of the juice both of the breast and leg muscles was obtained by Puchała et al. [2014].

The characteristic of meat, which is important for the culinary usefulness, is the ability to retain the endogenous water during the thermal processing. The phenomenon associated with thermal denaturation of meat is the loss of water because of proteins, occurring in the form of so called thermal leakage. This leakage is undesirable as it significantly reduces the juiciness of meat and causes great economic losses [Adamczak and Szczepińska 2004]. A significant increase of thermal leakage occurs in the case of meat which is not ground and earlier frozen. However, smaller thermal leakage is characterized by ground meat. The magnitude of thermal losses was lower in the breast muscles than in the leg ones in the studied birds. In addition, more water loss during the thermal processing was characterized by breast and leg muscles in males. Significant differences ($P \leq 0.05$) were recorded in the case of thermal leakage of breast muscles in males and females. Similar values, in the range of the discussed trait, to those obtained in the study for both breast and leg muscles were obtained by Puchała et al. [2014]. While Komiyama et al. [2010] and Sanfelice et al. [2010]

Table 3. Sensory properties of breast muscles of 64-week-old broiler breeder

Tabela 3. Właściwości sensoryczne mięśni piersiowych 64-tygodniowych kur mięsnych

Trait – Cecha	Sex, characteristics – Płeć, charakterystyki			
	males – samce (n = 20)		females – samice (n = 20)	
	\bar{x}	SD	\bar{x}	SD
Aroma intensity, pts – Natężenie zapachu, pkt	3.5 ^A	0.6	4.1 ^B	0.5
Aroma desirability, pts – Pożądalność zapachu, pkt	3.2 ^A	0.9	4.0 ^B	0.4
Juiciness, pts – Soczystość, pkt	2.4	1.0	2.1	1.1
Tenderness, pts – Kruchosc, pkt	2.9	0.9	3.0	1.1
Tastiness intensity, pts – Natężenie smakowitości, pkt	3.1 ^A	0.7	3.7 ^B	0.7
Tastiness desirability, pts – Pożądalność smakowitości, pkt	2.8 ^A	0.7	3.8 ^B	0.7

A, B – statistically significant differences between the males and the females at $P \leq 0.01$.

A, B – statystycznie istotne różnice między samcami i samicami przy $P \leq 0.01$.

obtained in their studies a significantly smaller thermal leakage from the breast muscles (17.92% and 22.02%, respectively).

The colour is one of the most important characteristics of the poultry meat. No significant differences were found in the colour of breast muscles between males and females of the broiler breeder hens from the Ross 308 hybrid. The values of this trait within both sexes were at the same level and were greater from the brightness of the leg muscles colour. The statistically significant differences ($P \leq 0.01$) were found in the assessment of the L^* component of the leg muscles. The leg muscles of males were characterized by a darker colour of 43.6 compared to the leg muscles of females 50.1. The intensity of the red colour (a^*) was lower in the breast muscles than the leg ones. While the yellowness (b^*) of breast muscles was greater than the leg ones in the studied birds. In terms of the value of the (b^*) parameter of the leg muscles showed statistically significant ($P \leq 0.01$) differences between the studied males and females (5.6 vs. 10.4). Franco et al. [2012] while evaluating the breast muscles in the 40-week-old broiler breeder hens obtained lower values of the L^* and a^* colour parameters and similar values of the b^* colour parameter. In the studies of Sanfelice et al. [2010] and Puchała et al. [2015] the breast muscles of the broiler breeder hens were characterized by lower variable values L^* , a^* and b^* . Puchała et al. [2014] in the experiment on the 56-week-old hens from the laying breeds obtained similar parameters characterizing the colour of the leg muscles.

The results of the sensory evaluation of the breast and leg muscles of the 64-week-old broiler breeder hens after the reproduction period are shown in Table 3. The breast muscles of males were significantly lower in intensity (3.5 vs. 4.1 p, $P \leq 0.01$) and the desirable aroma (3.2 vs. 4.0 p; $P \leq 0.01$) than the breast muscles of females. The tastiness of meat, taking into consideration its

intensity and desirability, was more favorably assessed in females than males. Those differences were statistically significant ($P \leq 0.01$). In the studies by Puchała et al. [2014], the breast muscles of 56-week-old laying hens were characterized by a better aroma and tastiness on a five-point scale than the breast muscles of the assessed birds. Significantly higher scores of the sensory evaluation of 68-week-old broiler breeder hens after the laying period but in the nine-point scale were obtained in their experiment by Komiyama et al. [2010].

CONCLUSIONS

The results of the conducted studies showed the influence of sex on the slaughter characteristics of 64-week-old broiler breeder hens from the Ross 308 hybrid. The males from the broiler breeder hens were characterized by a significantly higher carcass weight, higher percentage content of neck, wings ($P \leq 0.01$) and leg muscles ($P \leq 0.05$) in the carcass and by less fatness ($P \leq 0.01$) in relation to the evaluated females. The results of the conducted physico-chemical evaluation of the breast and leg muscles of the 64-week-old broiler breeder hens were correct and indicated the meat of normal quality. It was characterized by appropriate pH values which proves the correct course of its maturation process. It also had small loss of the natural leakage and a significant the thermal one, and it also had the desired colour parameters. The sensory evaluation of the cooked meat has shown the sex impact on its quality. The meat from the female breasts from the broiler breeder hens, had a more definite and desired aroma and tastiness ($P \leq 0.01$). In the case of both males and females, the meat from breasts turned out to be dry and hard.

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SKŁAD TUSZKI, WŁAŚCIWOŚCI FIZYKOCHEMICZNE I SENSORYCZNE MIĘSA KOGUTÓW I KUR MIĘSNYCH PO CYKLU PRODUKCYJNYM

STRESZCZENIE

Celem badań było porównanie 64-tygodniowych kogutów i kur mięsnych Ross 308 pod względem masy i składu tuszki, cech fizykochemicznych i sensorycznych mięśni piersiowych i mięśni nóg. Badaniami objęto 20 samców i 20 samic kur mięsnych po cyklu produkcyjnym. Samce kur mięsnych charakteryzowały się istotnie większą masą tuszki, większą procentową zawartością szyi, skrzydeł ($P \leq 0,01$) i mięśni nóg ($P \leq 0,05$) w tuszce oraz istotnie mniejszym otłuszczeniem ($P \leq 0,01$) w stosunku do ocenianych samic. Ocena jakości mięsa obejmowała pomiar pH i przewodności elektrycznej po 24 godzinach od uboju, określenie wycieku naturalnego i termicznego, oznaczenie parametrów barwy (L^* , a^* , b^*) oraz ocenę sensoryczną mięsa gotowanego. Mięśnie piersiowe samców cechowały się istotnie większym wyciekami termicznym ($P \leq 0,05$), natomiast mięśnie nóg charakteryzowały się ciemniejszą barwą i mniejszym jej wysyceniem w kierunku żółtym ($P \leq 0,01$). Mięso z piersi samic kur mięsnych miało bardziej zdecydowany i pożądany zapach oraz smak ($P \leq 0,01$).

Słowa kluczowe: tuszka, jakość mięsa, płeć, kura mięsna

