*Ann. Anim. Sci., Vol. 11, No. 2 (2011) 207–217*

# COMPARATIVE STUDY ON FATTENING RESULTS OF ZATORSKA AND WHITE KOŁUDA® GEESE*

Ewa Kapkowska[1], Małgorzata Gumułka[1], Andrzej Rabsztyn[1], Katarzyna Połtowicz[2], Krzysztof Andres[1]

[1]Department of Poultry and Fur Animal Breeding and Animal Hygiene, University of Agriculture, Al. Mickiewicza 24/28, 30-059 Kraków, Poland
[2]Department of Animal Genetics and Breeding, National Research Institute of Animal Production, 32-083 Balice n. Kraków, Poland

**Abstract**

**The aim of the study was to evaluate and compare fattening results and quality of meat from Zatorska geese, which represent protected waterfowl genetic resources in Poland, and White Kołuda® geese. The experiment was carried out on 120 geese (30 males and 30 females in each group) and lasted for 17 weeks. Geese were fattened with oats between 14 and 17 weeks of age. Carcass composition and technological properties of breast muscles ($pH_{15min}$ and $pH_{24h}$, colour on the CIE L*a*b* scale, water holding capacity, thermal loss, drip loss, tenderness) were evaluated after dissection. The body weight of Zatorska geese (combined sexes) at 17 weeks of age (5648 g) was significantly lower (P<0.01) than that of White Kołuda® (6814 g). Zatorska males and females had statistically lower (P<0.01) body weight than White Kołuda® males and females, respectively. Zatorska geese were characterized by lower dressing percentage (P<0.05) but higher percentage of thigh and drumstick muscles (P<0.01), which also holds true for males and females separately. The carcasses of Zatorska geese had lower percentage of skin with subcutaneous fat (P<0.01). From the economic point of view, oat fattening of Zatorska geese was less efficient compared to White Kołuda® geese but the weight of carcass, the proportion of skin with subcutaneous fat and tenderness of breast meat of Zatorska geese indicate that it could meet the modern consumers' demands.**

**Key words: goose, poultry genetic resources, oat fattening, slaughter value, meat quality**

Consumers of poultry meat have recently shown an increasing interest in products with different carcass composition and taste compared to that of broiler chickens. Goose meat could meet these expectations. In Poland, oat fattening of geese is based on crosses of W33 and W11 strains of White Kołuda® which are characterized by good meat quality (Wężyk et al., 2003; Bochno et al., 2006; Łukaszewicz et al.,

*This work was conducted as part of statutory activity, project no. DS 3241/KHDZFiZ/09.

2008). Some experiments were also conducted to create the crossbreds of White Kołuda® with other varieties of geese (Mazanowski et al., 2002; Mazanowski and Dziadek, 2003). According to many authors, special attention should be paid to experiments on geese from populations representing the protected genetic resources of waterfowl (Mazanowski and Szukalski, 2000; Mazanowski and Dziadek, 2003; Mazanowski et al., 2004). The world's genetic resources conservation programme currently includes 11 Polish goose populations maintained in Poland. These geese are characterized by good musculature and low carcass fatness as well as high dressing percentage (Okruszek et al., 2008). Moreover, local breeds of geese are very appropriate for extensive production. These flocks may provide highly valued dietetic meat products and serve as a natural gene resource for selection of improved quality traits of raw poultry meat material in the future.

Zatorska geese represent the national poultry genetic resources. Literature referring to the fattening ability of these populations is scarce (Szado et al., 1991; Gumułka et al., 2006, 2009). The aim of the study was to compare the oat fattening results of Zatorska and White Kołuda® geese.

## Material and methods

The experiment was carried out in the Experimental Station of the University of Agriculture in Kraków on Zatorska and White Kołuda® geese (30 males and 30 females each) hatched on May 30. Up to four weeks of age birds were kept in confinement in eight pens, 15 birds per pen, with two replications for each breed and sex. Geese were divided into 2 groups (Zatorska and White Kołuda®) and kept with an access to free range from 5 to 14 weeks. From 14 to 17 weeks they were kept indoors like at the beginning of the experiment.

Geese were fed according to the fattening programme for White Kołuda® geese. Up to four weeks of age birds were fed *ad libitum* and from 5 to 14 weeks a semi-controlled feeding regime was used, allowing daily feed consumption of 230–300 g for Zatorska and 270–350 g for White Kołuda® geese. According to the producer's specifications, the commercial mixtures contained: 12 MJ $ME_N$/kg and 195 g CP/kg (1–4 weeks of age), 11.5 MJ $ME_N$/kg and 165 g CP/kg (5–8 weeks of age), and 11.3 MJ $ME_N$/kg and 150 g CP/kg (9–14 weeks of age). In order to prepare the birds for oat fattening, daily rations were diminished at 14 weeks of age and replaced with oats and carrot given *ad libitum*. From 15 to 17 weeks of age geese were fed only with oats provided *ad libitum*.

At 17 weeks of age, 10 males and 10 females from each group, with body weight close to the mean, were sampled and dissection analysis was carried out. Dressing percentage I was calculated as the ratio of chilled carcass with neck, edible giblets and peritoneal fat to live body weight. Dressing percentage II was estimated as the ratio of chilled carcass with neck to live body weight. Percentages of breast, thigh and drumstick muscles, and skin with subcutaneous fat in the chilled carcass with neck were also estimated.

Technological properties of breast muscles were evaluated. The pH value of breast muscles was analysed 15 minutes post mortem ($pH_{15min}$) and after 24-h cooling of carcasses ($pH_{24h}$) with a CyberScan 10 pH-meter equipped with a glass electrode. The pH measurements were taken by placing the electrode directly at half-thickness of the *m. pectoralis superficialis*. Meat colour was determined on the CIE L*a*b* scale (lightness, redness, yellowness) with a Minolta CR-310 colorimeter and water holding capacity as the amount of free water according to the filter paper press method (Grau and Hamm, 1953). Drip loss was measured in duplicate samples. After weighing (e = 0.001 g), samples were placed in sealed containers. Following 24-h meat storage at 4ºC, samples were removed from individual containers, wiped with absorbent paper and weighed again. For measurements of thermal loss, samples were cooked in a water bath at 95ºC until core temperature reached 80ºC. After cooking samples were cooled and weighed for thermal loss determination. Tenderness of breast muscles was measured by maximum shear force [N] of cooked meat with an Instron 5542 device fitted with a Warner-Bratzler shear blade.

The economic efficiency index was estimated according to the following formula:

$$EEI = \frac{BW_1 \times BW_2}{A \times FI} \times 10$$

*EEI* – economic efficiency index,
*BW1* – mean body weight at 17 weeks of age (g),
*BW2* – mean body weight at 17 weeks of age in terms of one gosling taken for rearing (g),
*A* – age of geese (119 days),
*FI* – feed intake per kg of body weight to 17 weeks of age (g).

Data were analysed by one-way analysis of variance (ANOVA) using the SAS GLM procedure and Tukey's test for comparison of means (SAS Institute Inc., Cary, 2001).

## Results

Total mixtures consumption per bird over 14 weeks averaged 25.6 kg for Zatorska and 26.6 kg for White Kołuda® geese. Oat consumption during the fattening period was 7.8 kg for Zatorska and 9.5 kg for White Kołuda®. The feed conversion ratio in White Kołuda® was 5.4 kg/kg of gain, while in Zatorska 6.0 kg/kg of gain. The economic efficiency index was 714 points in White Kołuda® geese and 455 points in Zatorska. Zatorska males and females were characterized by significantly lower body weight ($P<0.01$) compared to the White Kołuda® (Table 1). Variation coefficients for body weight were relatively low.

Table 1. Body weight (mean [g] ± SEM; CV% [coefficient of variation]) of Zatorska and White Kołuda® geese (W31) up to 17 weeks of age

| Week of age | Males | | Females | | Males and females | |
|---|---|---|---|---|---|---|
| | Zatorska n = 30 | White Kołuda® n = 30 | Zatorska n = 30 | White Kołuda® n = 30 | Zatorska n = 60 | White Kołuda® n = 60 |
| 4 | 2241 A±45.4 | 2563 B±36.4 | 1964 A±37.7 | 2346 B±40.7 | 2103 A±34.3 | 2453 B±30.6 |
| | 11.1% | 7.7% | 10.5% | 9.5% | 12.7% | 9.6% |
| 8 | 4542 A±90.4 | 5040 B±82.3 | 3733 A±75.2 | 4352 B±79.9 | 4138 A±78.6 | 4703 B±70.5 |
| | 10.9% | 8.6% | 11.0% | 10.1% | 14.7% | 11.4% |
| 14 | 5580 A±137.1 | 6609 B±94.0 | 4585 A±126.1 | 5755 B±126.1 | 5083 A±112.8 | 6167 B±97.0 |
| | 13.5% | 7.5% | 15.1% | 12.0% | 17.2% | 12.0% |
| 17 | 6253 A±136.4 | 7389 B±109.9 | 5042 A±111.1 | 6279 B±145.5 | 5648 A±117.6 | 6814 B±117.2 |
| | 11.9% | 7.9% | 12.1% | 12.7% | 16.1% | 13.1% |

Average values in rows within sex (columns 1–4) and for mixed sexes (columns 5,6) with different letters differ significantly (A, B – $P<0.01$).

Table 2. Dissection data of Zatorska and White Kołuda® geese at the age of 17 weeks (means [g, %] ± SEM)

| Trait | Males | | Females | | Males and females | |
|---|---|---|---|---|---|---|
| | Zatorska (n = 10) | White Kołuda® (n = 10) | Zatorska (n = 10) | White Kołuda® (n = 10) | Zatorska (n = 20) | White Kołuda® (n = 20) |
| Body weight before slaughter (g) | 6232.5 A±80.8 | 7329.0 B±51.8 | 4876.5 A±51.6 | 6057.5 B±84.8 | 5554.5 A±161.8 | 6693.2 B±157.5 |
| Weight of carcass with neck (g) | 4026.3 A±63.0 | 4811.4 B±58.5 | 3131.2 A±48.1 | 4001.0 B±82.6 | 3578.7 A±108.9 | 4406.2 B±107.6 |
| Dressing percentage I | 73.9 a±0.4 | 75.7 b±0.7 | 74.0 A±0.5 | 76.2 B±0.6 | 74.0 a±0.5 | 75.9 b±0.5 |
| Dressing percentage II | 64.6±0.4 | 65.7±0.7 | 64.2 a±0.5 | 65.9 b±0.6 | 64.8 a±0.5 | 65.8 b±0.5 |
| Breast muscles (g) | 652.3 A±21.0 | 822.2 B±14.7 | 542.6 A±15.7 | 703.6 B±20.9 | 597.7 A±18.3 | 766.9 B±18.7 |
| Breast muscles (%) | 16.2±0.5 | 17.1±0.2 | 17.3±0.4 | 17.6±0.4 | 16.7±0.5 | 17.4±0.3 |
| Thigh muscles (g) | 366.4±8.2 | 376.8±5.8 | 293.6 A±3.8 | 331.0 B±8.4 | 330.4±9.6 | 356.4±7.2 |
| Thigh muscles (%) | 9.1 A±0.2 | 7.8 B±0.1 | 9.4 A±0.1 | 8.3 B±0.2 | 9.2 A±0.1 | 8.1 B±0.1 |
| Drumstick muscles (g) | 329.8±5.9 | 337.0±6.3 | 272.2 a±4.0 | 296.2 b±6.7 | 299.8 A±7.4 | 317.0 B±6.6 |
| Drumstick muscles (%) | 8.2 A±0.1 | 7.0 B±0.1 | 8.7 A±0.2 | 7.4 B±0.2 | 8.4 A±0.2 | 7.2 B±0.1 |
| Thigh and drumstick muscles (g) | 695.8±6.0 | 713.8±8.6 | 565.9 A±5.8 | 627.8 B±7.0 | 630.0±15.4 | 674.0±11.3 |
| Thigh and drumstick muscles (%) | 17.3 A±0.2 | 14.9 B±0.2 | 18.1 A±0.3 | 15.7 B±0.3 | 17.6 A±0.3 | 15.3 B±0.2 |
| Skin with subcutaneous fat (g) | 1041.8 A±29.2 | 1356.5 B±35.3 | 743.0 A±32.6 | 1156.5B±53.7 | 887.7 A±40.3 | 1260.5 B±38.4 |
| Skin with subcutaneous fat (%) | 25.9±0.7 | 28.0±0.9 | 23.7 A±0.9 | 28.9 B±1.1 | 24.8 A±0.9 | 28.6 B±0.7 |

Average values in rows within sex (columns 1–4) and for mixed sexes (columns 5,6) with different letters differ significantly (A, B – P≤0.01; a, b – P≤0.05).

Table 3. Technological properties of breast muscles (*m. pectoralis superficialis*) of Zatorska and White Kołuda® geese at the age of 17 weeks (means±SEM)

| Trait | Males | | Females | | Males and females | |
|---|---|---|---|---|---|---|
| | Zatorska (n = 10) | White Kołuda® (n = 10) | Zatorska (n = 10) | White Kołuda® (n = 10) | Zatorska (n = 20) | White Kołuda® (n = 20) |
| $pH_{15min}$ | 6.34 a±0.08 | 6.41 b±0.07 | 6.34±0.05 | 6.35±0.05 | 6.34±0.04 | 6.30±0.04 |
| $pH_{24h}$ | 6.07±0.02 | 6.08±0.03 | 6.12±0.06 | 6.16±0.06 | 6.09±0.03 | 6.10±0.04 |
| L* (Lightness) | 40.41±0.43 | 39.32±0.63 | 36.68±0.50 | 37.12±0.48 | 38.55±0.76 | 38.22±0.46 |
| a* (Redness) | 17.45±0.28 | 17.26±0.40 | 15.95±0.27 | 16.96±0.42 | 16.70±0.36 | 17.11±0.28 |
| b* (Yellowness) | 4.05±0.20 | 4.41±0.22 | 2.91±0.33 | 3.43±0.24 | 3.48±0.32 | 3.92±0.22 |
| Water holding capacity (%) | 18.94±1.21 | 19.88±1.07 | 18.03±1.13 | 17.78±0.85 | 18.49±0.81 | 18.83±0.71 |
| Drip $loss_{24h}$ (%) | 0.53±0.05 | 0.57±0.05 | 0.48±0.03 | 0.45±0.05 | 0.51±0.04 | 0.51±0.04 |
| Thermal loss (%) | 32.13±1.02 | 29.75±1.12 | 29.17±1.27 | 29.35±1.35 | 30.65±1.22 | 29.55±0.86 |
| Shear force (N) | 47.05±3.00 | 49.72±1.91 | 43.22 a±1.79 | 50.26 b±2.54 | 45.14 a±2.48 | 49.99 b±1.55 |

Average values in rows within sex (columns 1–4) and for mixed sexes (columns 5, 6) with different letters differ significantly (a, b – $P<0.05$).

Statistically significant ($P<0.01$) differences between the compared genetic groups were noted in the weight of eviscerated carcass and dressing percentage I and II, when compared in males and females together (Table 2). However, there were no statistical differences in dressing percentage II between males. Also, the percentage of breast muscles did not differ significantly between groups, regardless of sex, while percentage of thigh and drumstick muscles in eviscerated carcass with neck was significantly higher in the Zatorska breed ($P<0.01$). Zatorska carcasses contained less skin with subcutaneous fat ($P<0.01$) when comparison was made between males and females together or females alone (Table 2).

Parameters of technological quality of breast muscles are presented in Table 3. No significant differences were found in $pH_{24h}$ postmortem but higher values ($P<0.05$) of $pH_{15min}$ were observed in White Kołuda® than in Zatorska males. Muscle colour indicators did not differ significantly between groups. Similarly, no significant differences were observed in values of drip loss after 24 h, thermal loss and water holding capacity. However, higher shear force values were found for breast muscles of White Kołuda® ($P<0.05$).

## Discussion

In recent years, a relatively large number of studies on fattening of geese (Bielińska et al., 2002; Mazanowski et al., 2002; Mazanowski and Dziadek, 2003; Mazanowski et al., 2004; Gumułka et al., 2006) have been published in Poland. This coincided with a growing interest in the quality of goose meat. In our experiment the White Kołuda® geese were heavier than in previous studies by Rosiński et al. (2000) and Bielińska et al. (2002) and Zatorska had higher body weight than in our previous study (Szado et al., 1991). As expected, the body weight of 17-week-old White Kołuda® was higher than that of Zatorska, males being heavier by 1100 g and females by 1200 g. Comparison of the growth pattern of Zatorska and White Kołuda® using the Richards model pointed to earlier maturity and smaller asymptotic body weight of birds of the Zatorska (Rabsztyn et al., 2007).

During 14 weeks of rearing, feed consumption by White Kołuda® geese was higher and oat consumption was lower compared to the results reported by Bielińska et al. (2002), with similar feed conversion ratio. In the experiment by Bielińska et al. (2002), geese were kept in confinement and cut forage was provided *ad libitum*. The intake of grass amounted to 45 kg per bird. The economic efficiency index was lower for Zatorska than for White Kołuda®, which is consistent with the results reported by Mazanowski and Szukalski (2000) for the hybrids of White Kołuda® and Suwalska geese and by Mazanowski et al. (2004) for the crossbred progeny of Kartuska and White Kołuda® hybrid males and Astra G (White Kołuda® and Kuban cross) females. Mazanowski and Szukalski (2000) stated that the economic efficiency index diminishes with age of geese and they suggested that 500 points are a minimum for the index of 17-week-old geese to be efficient.

In our experiment dressing percentage II in White Kołuda® geese was lower than that reported by Rosiński et al. (2000) and Bielińska et al. (2002). Dressing percent-

age of Zatorska in our experiment was smaller than in White Kołuda®. Mazanowski et al. (2004) stated that crosses of males derived from White Kołuda®, Greylag and Slovakian and females of Astra G were characterized by lower carcass weight and dressing percentage at 17 weeks of age compared to crosses between White Kołuda® and Kartuska hybrid males and Astra G females. Breast yields in all groups mentioned above were similar. Bielińska et al. (2002) noted a similar percent yield of breast muscles in eviscerated carcasses of White Kołuda® to that observed in our experiment but the proportions of thigh and drumstick muscles were higher in males and lower in females.

Skin with subcutaneous fat content was smaller in Zatorska than in White Kołuda® geese, which might be favourable from the consumer's point of view. Rosiński et al. (2000) and Bielińska et al. (2002) determined the percentage of skin with subcutaneous fat in White Kołuda® not in the whole carcasses but only in breast and leg muscles, which is why their values are lower and cannot be compared to our findings. Szado et al. (1991) obtained very similar results for the proportion of skin with subcutaneous fat in Zatorska. Cywa-Benko et al. (2000) pointed to distinctly lower mass of abdominal fat in Zatorska compared to White Kołuda®, and Gumułka et al. (2006) stated that the meat and abdominal fat of Zatorska was characterized by better fatty acid profile from the human nutrition standpoint compared to White Kołuda® geese.

In most cases there were no statistical differences in breast meat quality traits between Zatorska and White Kołuda® geese. The values of $pH_{15min}$ and $pH_{24h}$ mostly did not differ significantly in both genetic groups. The values of $pH_{15min}$ were about 6.4 on average and decreased by about 0.3 after 24 h of cooling. Similarly, Mazanowski et al. (2004) did not notice differences in pH value of breast muscles from crossbreds derived from ganders of Kartuska or Graylag ancestry and Astra G geese. The ultimate pH values of breast muscles obtained by Skrabka-Błotnicka et al. (1997), based on analysis of 4 genotypes of 17-week-old males and females of White Italian geese, were smaller than those found in our experiment. A lower value of $pH_{24}$ (5.8) was stated by Szado et al. (1991) for breast muscle of Zatorska geese. Also Okruszek et al. (2008) reported that the rate of pH decline in breast muscles was dependent on goose genotype. A greater difference in $pH_{15min}$ and $pH_{24h}$ values was observed in Kartuska and Suwalska than in Podkarpacka and Kielecka geese. Postmortem changes in meat depend mainly on a decrease in pH and on protein degradation after protease activity. In selected Muscovy ducks, the rate and extent of the decrease in pH postmortem were lower than in the unselected group (Baeza et al., 2002). The juice loss after storage at 4°C was slightly modified by selection or remained unchanged. Selection of White Kołuda® geese considerably increased the meat yield, particularly in the breast part of the carcasses.

The difference in breast muscle weight between Zatorska and White Kołuda® did not influence most of the technological properties of meat. There were no differences in drip loss and water holding capacity values of breast muscles between these two genetic groups. The values of these parameters were lower than those reported by Wężyk et al. (2003) in White Kołuda®. Mazanowski et al. (2004) observed differences in water holding capacity depending on the type of the cross. Thermal loss of

breast muscles was similar in both experimental groups we had studied. According to Baeza (2002), the selection of ducks had an influence on meat colour. In selected birds the meat was paler and less red, which was related to the lower content of haematic pigments and myoglobin. The same tendencies were observed in chickens. Sandercock et al. (2009) reported that breast muscles from broiler lines were paler and less yellow compared with layer and traditional lines. In our study no differences were seen in the colour of breast muscles between Zatorska and White Kołuda®. Similarly, Larmond et al. (2006) did not find any differences in colour of meat from Pilgrim, Hungarian and Chinese geese and their crosses. On the contrary, the investigation of Okruszek et al. (2008) confirmed the influence of goose genotype on breast meat colour. The most critical quality factor associated with consumer satisfaction is probably the meat texture. It is affected by maturity of the connective tissue and by contractile state of the myofibrillar proteins. Unfortunately, studies related to meat tenderness in geese are limited. Our findings showed a significant effect of goose genotype on shear force value of cooked breast meat. We also found that the meat of 17-week-old Zatorska was characterized by higher tenderness compared to the meat of White Kołuda® geese.

Carcass weight of the oat-fattened Zatorska geese was about 800 g lower compared to White Kołuda®, which is in agreement with the recent consumer preference for smaller goose carcasses. The proportion of breast, which is known to have a high commercial value, was similar in both genetic groups. Also, technological parameters of breast muscles indicated that the value of meat of the compared groups was similar. Lower shear force of breast muscles in Zatorska can be related to better tenderness. Further studies on the sensory evaluation of meat would be needed in the future to confirm this suggestion. From the economic point of view, oat fattening was more efficient for White Kołuda® compared to Zatorska geese.

In summary, carcasses of Zatorska geese can be used to increase the range of goose meat available on the market in Poland, offering a product of good dietetic quality because of its lower proportion of skin with fat. This can also help to secure financial support for the conservation of waterfowl genetic resources in Poland.

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Accepted for printing 2 IV 2011

EWA KAPKOWSKA, MAŁGORZATA GUMUŁKA, ANDRZEJ RABSZTYN,
KATARZYNA POŁTOWICZ, KRZYSZTOF ANDRES

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STRESZCZENIE

Badania miały na celu ocenę i porównanie wyników tuczu oraz jakości mięsa gęsi Zatorskich, należących do chronionych zasobów genetycznych drobiu wodnego w Polsce i gęsi Białych Kołudzkich®.

Doświadczenie przeprowadzone było na 120 gęsiach (30 samców i 30 samic w każdej grupie) i trwało 17 tygodni. Pomiędzy 14. a 17. tygodniem życia zastosowano tucz owsiany. Po wykonaniu dysekcji oceniono skład tuszek i wybrane parametry technologiczne mięśni piersiowych: $pH_{15min}$ i $pH_{24h}$, kolor według skali CIE L*a*b*, wodochłonność, straty termiczne, wyciek swobodny i kruchość mięsa.

Masa ciała gęsi Zatorskich (obu płci) w 17 tyg. życia (5648 g) była istotnie niższa ($P<0.01$) niż Białych Kołudzkich® (6814 g). Samce i samice gęsi Zatorskich miały statystycznie istotnie niższą ($P<0.01$) masę ciała niż samce i samice gęsi Białych Kołudzkich®. Gęsi Zatorskie charakteryzowała niższa ($P<0.05$) wydajność poubojowa a wyższy udział mięśni uda i podudzia ($P<0.01$). Dotyczyło to również samców i samic ocenianych oddzielnie. Tuszki gęsi Zatorskich cechował mniejszy udział skóry z tłuszczem podskórnym ($P<0.01$).

Z ekonomicznego punktu widzenia tucz owsiany gęsi Zatorskich był mniej efektywny niż Białych Kołudzkich® ale masa tuszki, udział skóry z tłuszczem podskórnym oraz kruchość mięsa mięśni piersiowych tuczonych gęsi Zatorskich wskazują, że mogą one spełniać wymagania współczesnych konsumentów.