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# EFFECT OF CAPONIZING YELLOWLEG PARTRIDGE (Ż-33) COCKERELS ON BODY WEIGHT AND MEAT QUALITY

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**Abstract.** The aim of the study was to determine the effect of caponization on the body weight and selected meat quality parameters of Yellowleg Partridge (Ż-33) cockerels. Ż-33 cockerels were randomly assigned to two groups with 40 birds. Group I (control) consisted of uncastrated cockerels and birds from group II were castrated at 9 wk of age. The castration was performed under local anesthesia by a veterinary surgeon. Birds were kept until 24 wk of age and fed the same diet *ad libitum*. Dressing percentage, proportion of breast and leg muscles, giblets and abdominal fat were determined postmortem. Physical characteristics of meat: pH, CIE L*a*b* colour, drip loss, cooking loss, and shear force were determined and sensory evaluation was performed. It was established from the results obtained that the castration of Ż-33 cockerels had a beneficial effect by increasing their body weight, dressing percentage and carcass muscling, and by improving the technological parameters and sensory appeal of meat, thus making it possible to use surplus cockerels as valuable material for producing poultry meat of special quality.

**Key words:** caponization, body weight, meat quality

## INTRODUCTION

Capon production has recently attracted increasing interest in Poland and across the world [Calik 2014]. The centuries-old practice of caponization was

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initially associated with religious rites (making offerings to the gods) but later the procedure was performed to increase the body weight of cockerels (Lex Faunia). The quality of capon meat was noticed much later when it turned out to be more delicate, juicier and more tender than meat from an uncastrated rooster [Sirri et al. 2009, Volk et al. 2011]. In Poland capons reigned supreme in the 16th and 17th centuries, mainly on royal and noble tables in the form of excellent roasts, and tasty and aromatic broths, which were an excellent basis for dainty sauces. After the Second World War the castration procedure in poultry was less popular and became banned until 2008. According to the Commission Regulation No 543/2008 of 16 June 2008, "a capon is a male fowl castrated surgically before reaching sexual maturity and slaughtered at a minimum age of 140 days; after castration the capons must be fattened for at least 77 days".

Today, cockerels are caponized on a wider scale in China, Taiwan and the USA, as well as in Europe (France, Spain and Italy), where capons are marketed as high quality products [Jacob and Mather 2000]. Most capons are produced from native or locally adapted breeds. Literature data indicate that the castration procedure increases body weight of the birds, contributing to better metabolism and more delicate and juicy meat. Increased intramuscular fat content was also observed, which has a favourable effect on the sensory attributes of the meat [Mast et al. 1981, Tor et al. 2002, Chen et al. 2007, Shao et al. 2009, Mahmund et al. 2013, Calik et al. 2015].

The aim of the study was to determine the effect of caponizing Yellowleg Partridge (Ż-33) cockerels on body weight and selected parameters of meat quality.

## MATERIAL AND METHODS

Because native or locally adapted breeds with a slow growth rate are most often used in capon production, the present study involved the native Yellowleg Partridge breed (Ż-33), which has been under the genetic resources conservation programme since the 1970s. The study used 80 cockerels, which were weighed, individually tagged and randomly assigned to two groups with 40 birds per group. Birds from group II (experimental) were subjected to castration at 9 weeks of the experiment, whereas uncastrated cockerels constituted group I (control). Birds were caponized/castrated under local anesthesia by a veterinary surgeon. All the procedures complied with the requirements established by the Ethics Commission No 953 of 10 July 2012. Birds were kept under good environmental conditions (temperature of 18–20°C, relative humidity of 75%) on litter, at a stocking density of 7 birds/m2. Throughout the rearing and fattening period, i.e. until 24 weeks of age, birds were provided with free access to water and feed. A three-phase feeding

programme with diets I to III was applied. Nutrient analysis of the feed mixture was performed at the Central Laboratory of the National Research Institute of Animal Production (Table 1). The mixtures were analysed for dry matter [ISO–6496, 1999], crude protein [ISO–5983–2, 2009], crude ash [PN–76/R–64795], crude fibre [PN–EN–ISO 6865, 2002] and crude fat [PN–ISO 6492, 2005].

Table 1. Results of chemical analysis of feed mixtures, %

Tabela 1. Wyniki analizy chemicznej mieszanek, %

| Item<br>Wyszczególnienie | Dry matter, %<br>Sucha masa, % | Crude ash, %<br>Popiół surowy, % | Crude protein, %<br>Białko ogólne, % | Crude fat, %<br>Tłuszcz surowy, % | Crude fibre, %<br>Włókno surowe, % |
|---|---|---|---|---|---|
| Mixture I: day 1–7 weeks<br>Mieszanka I: 1 dzień–7 tyg. | 88.38 | 7.37 | 19.30 | 2.23 | 2.34 |
| Mixture II: 8–16 weeks<br>Mieszanka II: 8–16 tyg. | 87.86 | 5.83 | 18.66 | 2.02 | 2.54 |
| Mixture III: 17–24 weeks<br>Mieszanka III: 17–24 tyg. | 88.54 | 3.96 | 16.30 | 2.29 | 2.38 |

At 24 weeks of age, 8 birds whose body weights were similar to the group average were selected for slaughter from each group. Cockerels and capons received no feed for about 12 hours prior to slaughter but had continuous access to water. After slaughter, group II was checked for castration success (removal of the testes), which was followed by standard post-slaughter processing (scalding, defeathering, evisceration). Chilled carcasses (24 h at 4°C) were subjected to simple slaughter analysis. Percentage carcass weight loss during chilling, dressing percentage with giblets, dressing percentage without giblets, percentage of breast muscle, percentage of leg muscle, giblets (liver, gizzard, heart), bone and abdominal fat were determined. In addition, samples of breast and leg muscles were collected from every carcass to determine:

- acidity, determined postmortem as $pH_{15min}$. and $pH_{24h}$ using a CyberScan 110 pH meter equipped with a glass electrode for meat analysis,
- instrumental colour evaluation, made 24 h postmortem with the L*a*b* system (CIE 1976), using a Minolta CR 310 reflectance colorimeter (2°observer, illuminant D65), where L* is lightness, a* indicates redness when positive, and b* indicates yellowness when positive,
- water holding capacity based on the volume of meat juices squeezed from a sample – using the Grau and Hamm method [1953],
- drip loss, determined after 24-hour storage of the samples at +4°C,
- cooking loss based on weight loss during cooking at 100°C for 15 minutes,
- meat tenderness, using a Stable Micro Systems texture analyser fitted with a Warner–Bratzler shear blade.

As part of the experiment, cooked breast and leg muscles were subjected to sensory assessment according to the methodology developed by Baryłko-Pikielna

and Matuszewska [2009]. The assessment was made by a panel of 8 adult individuals based on a scale of 1 to 5, with the best score being 5 and the worst score being 1. For each parameter, the scores were accurate to 0.5 point. Aroma, juiciness, tenderness and flavour were included in the assessment.

The results were statistically analysed by analysis of variance (ANOVA). The calculations were made using Statgraphics plus 5.1 package.

## RESULTS AND DISCUSSION

Following the castration procedure, males soon develop changes in appearance and behaviour as a result of testosterone deficiency [Rahman et al. 2004, Chen et al. 2006, Shao et al. 2009]. Also in our experiment we observed changes in the appearance of the birds. The comb and wattle of the capons became pale yellow and flaccid, and regressed within several weeks. Behavioural changes were also observed in the birds, which after the procedure became calmer, less active and aggressive, did not crow, and were unwilling to mate. Deaths and health-related culling (7.5%) occurred during the first days after castration. As reported by Rikimaru et al. [2009], losses due to caponizing range from 5 to 20%. Table 1 shows that depending on the rearing and fattening periods, feed mixtures contained from 16.30 to 19.30% protein, from 2.02 to 2.29% fat, and from 2.34 to 2.54% fibre.

Results concerning the physicochemical characteristics of meat from cockerels and capons are presented in Tables 2–6.

The results show that castration procedure had a beneficial effect on the final body weight of the birds, which was confirmed statistically. At the end of fattening at 24 weeks of the experiment, capons had higher body weights by 212 g. This agrees with the findings of Mast et al. [1981], Tor et al. [2002] and Chen et al. [2006], who stress that sterilized birds have a higher body weight. According to Mahmud et al. [2013], this may be due to a decrease in the male sex hormones in the group of caponized cockerels. The authors state that lower locomotor activity of castrated birds contributes to better feed conversion, which is associated with higher weight gain and deposition of intramuscular fat, and this, in turn, helps to improve the quality of meat, as also reported by Jacob and Mather [2000]. The group of capons showed lower carcass weight loss during chilling and higher dressing percentage with and without giblets ($P < 0.05$). Statistically significant differences were also found in the content of breast and leg muscles, which is consistent with the findings of Tor et al. [2002] and Hsu and Lin [2003]. As indicated by Rahman et al. [2004] and Mahmund et al. [2013], castrated birds have a higher percentage of internal organs and this was also observed in the present study, with statistically significant differences ($P < 0.01$). However, this is most

Table 2. Body weight and results of slaughter analysis

Tabela 2. Masa ciała i wyniki analizy rzeźnej

| Item<br>Wyszczególnienie | | Group I<br>Grupa I | Group II<br>Grupa II |
|---|---|---|---|
| Body weight, g – Masa ciała, g | | 2066 ±128.45 a | 2278 ±41.68 b |
| Carcass weight loss during chilling, % – Straty masy tuszki podczas schładzania, % | | 2.21 ±0.26 a | 1.87 ±0.08 b |
| Dressing percentage with giblets, % – Wydajność rzeźna z podrobami, % | | 71.26 ±0.67 a | 72.87 ±1.61 b |
| Dressing percentage without giblets, % – Wydajność rzeźna bez podrobów, % | | 66.77 ±0.72 | 67.64 ±1.27 |
| Breast muscles, % – Mięśnie piersiowe, % | | 16.78 ±0.69 A | 18.40 ±0.84 B |
| Leg muscles, % – Mięśnie nogi, % | | 23.26 ±1.04 a | 24.54 ±0.33 b |
| Giblets, % – Podroby, % | | 4.49 ±0.18 A | 5.23 ±0.09 B |
| Liver, % – Wątroba, % | | 1.75 ±0.15 a | 2.25 ±0.58 b |
| Gizzard, % – Żołądek, % | | 2.09 ±0.13 | 2.43 ±0.19 |
| Heart, % – Serce, % | | 0.66 ±0.09 | 0.57 ±0.05 |
| Leg bones, % – Kości nóg, % | | 6.42 ±0.30 | 6.18 ±0.55 |
| Abdominal fat, % – Tłuszcz sadełkowy, % | | 1.60 ±1.13 A | 3.56 ±0.46 B |
| Carcass colour – Barwa tuszki | L* | 71.01 ±0.82 A | 73.26 ±1.15 B |
| | a* | 3.15 ±0.99 A | 1.80 ±0.60 B |
| | b* | 12.12 ±1.40 a | 13.67 ±0.75 b |

a, b – values in rows with different letters differ significantly $P \leq 0.05$,
a, b .. – wartości w wierszach oznaczone różnymi literami różnią się przy $P \leq 0,05$
A, B,.. – values in rows with different letters differ highly significantly $P \leq 0.01$,
A, B.. – wartości w wierszach oznaczone różnymi literami różnią się przy $P \leq 0,01$.

Table 3. Physical characteristics of breast muscles

Tabela 3. Cechy fizyczne mięśni piersiowych

| Item<br>Wyszczególnienie | | Group I<br>Grupa I | Group II<br>Grupa II |
|---|---|---|---|
| $pH_{15}$ | | 6.23 ±0.07 | 6.14 ±0.07 |
| $pH_{24}$ | | 5.77 ±0.14 | 5.75 ±0.13 |
| Drip loss, % – Wyciek po 24 h, % | | 0.57 ±0.04 | 0.53 ±0.04 |
| Cooking loss, % – Straty termiczne, % | | 24.25 ±2.14 | 24.02 ±2.37 |
| Muscle colour – Barwa mięśni | L* | 57.82 ±2.87 | 58.34 ±1.05 |
| | a* | 12.85 ±0.66 | 11.84 ±1.84 |
| | b* | 9.91 ±2.43 | 10.70 ±1.76 |
| WHC, % – Wodochłonność, % | | 17.44 ±1.39 | 16.53 ±1.52 |
| Meat tenderness, N – Kruchość mięsa, N | | 18.60 ±4.76 a | 14.75 ±1.06 b |

For explanations, see Table 2 – Oznaczenia jak w tabeli 2.

influenced by liver percentage, which was significantly higher in castrated birds. No significant differences were found for bone percentage, with a tendency for higher values to occur in uncastrated cockerels. The analysed groups differed si-

Table 4. Physical characteristics of leg muscles

Tabela 4. Cechy fizyczne mięśni nóg

| Item<br>Wyszczególnienie | | Group I<br>Grupa I | Group II<br>Grupa II |
|---|---|---|---|
| $pH_{15}$ | | 6.50 ±0.15 | 6.57 ±0.07 |
| $pH_{24}$ | | 6.17 ±0.06 | 6.23 ±0.09 |
| Drip loss, % – Wyciek po 24 h, % | | 0.52 ±0.06 A | 0.29 ±0.05 B |
| Cooking loss, % – Straty termiczne, % | | 32.51 ±4.87 | 31.24 ±3.29 |
| Muscle colour – Barwa mięśni | L* | 43.45 ±1.50 | 44.37 ±2.01 |
| | a* | 18.24 ±1.17 | 17.87 ±1.15 |
| | b* | 6.69 ±0.69 | 7.52 ±0.47 |
| WHC, % – Wodochłonność, % | | 19.04 ±1.61 a | 16.75 ±2.67 b |
| Meat tenderness, N – Kruchość mięsa, N | | 23.94 ±3.38 a | 20.33 ±2.07 b |

For explanations, see Table 2 – Oznaczenia jak w tabeli 2.

Table 5. Results of sensory analysis of breast muscles

Tabela 5. Wyniki analizy sensorycznej mięśni piersiowych

| Item<br>Wyszczególnienie | Group I<br>Grupa I | Group II<br>Grupa II |
|---|---|---|
| Aroma, pts – Zapach, pkt | 4.23 ±0.33 | 4.45 ±0.45 |
| Juiciness, pts – Soczystość, pkt | 4.01 ±0.88 a | 4.40 ±0.44 b |
| Tenderness, pts – Kruchość, pkt | 3.85 ±0.89 a | 4.35 ±0.47 b |
| Flavour, pts – Smak, pkt | 4.05 ±0.67 a | 4.50 ±0.39 b |

For explanations, see Table 2 – Oznaczenia jak w tabeli 2.

Table 6. Results of sensory analysis of leg muscles

Tabela 6. Wyniki analizy sensorycznej mięśni nóg

| Item<br>Wyszczególnienie | Group I<br>Grupa I | Group II<br>Grupa II |
|---|---|---|
| Aroma, pts – Zapach, pkt | 4.11 ±0.78 a | 4.69 ±0.59 b |
| Juiciness, pts – Soczystość, pkt | 4.05 ±0.36 a | 4.55 ±0.74 b |
| Tenderness, pts – Kruchość, pkt | 4.15 ±0.51 a | 4.58 ±0.52 b |
| Flavour, pts – Smak, pkt | 4.20 ±0.63 a | 4.65 ±0.58 b |

For explanations, see Table 2 – Oznaczenia jak w tabeli 2.

gnificantly in the proportion of abdominal fat, which was significantly higher in capons; this corresponds with the results obtained by Tor et al. [2005], Chen et al. [2006], Sinanoglou et al. [2011] and Volk et al. [2011]. These authors state that higher fat accumulation improves the technological parameters of meat, namely mellowness, juiciness and tenderness, which make the meat more attractive. Also in line with the study of Lin and Hsu [2002], capon carcass colour was characterized by higher L* ($P < 0.01$) and b* ($P < 0.05$), and lower a* values ($P < 0.01$).

This means that in relation to uncastrated cockerels, capon carcasses have a lighter and more yellow colour and lower redness. Similar tendencies occurred for the colour of breast and leg muscles, which is consistent with Sirri et al. [2009]. As indicated by Lyon and Cason [1995], an increase in muscle fat decreases muscle myoglobin, which results in lower a* and higher L* values.

The caponization procedure had no effect on the pH of breast and leg muscles. That caponization has no significant effect on muscle pH was also reported by Miguel et al. [2008] and Volk et al. [2011]. In turn, Sirri et al. [2009] reported that capon breast muscles were characterized by lower pH, with no differences in the acidity of leg muscles. The same authors found no differences in water holding capacity of the muscles. In the present study, muscles (especially leg muscles) were characterized by more favourable water holding capacity ($P < 0.05$) as well as lower drip loss ($P < 0.01$) and cooking loss. Instrumentally measured breast and leg muscles from the capons were more tender than those from uncastrated cockerels, which was confirmed statistically. The higher tenderness of meat from capons compared to cockerels was reported by Lin and Hsu [2002] and Rikimaru et al. [2009]. Likewise, Symeon et al. [2010] reported that an increase in intramuscular fat is associated with higher tenderness of meat. In addition, as shown by Lin et al. [2011], Lin and Hsu [2013] and Miguel et al. [2008], higher fat accumulation in the muscles improves the sensory parameters and such meat is characterized by better flavour, juiciness and tenderness, which is in agreement with the present results. In the sensory evaluation, both breast and leg muscles from the capons were awarded higher scores for all assessment categories. It should be noted, however, that the tasters gave a better rating especially to the fat-rich leg muscles, which received significantly higher scores for aroma, juiciness, tenderness and flavour.

## CONCLUSIONS

It is concluded from the results obtained that the castration of Ż-33 cockerels had a positive effect on increasing body weight, dressing percentage and carcass muscling. Capon muscles, especially leg muscles, were characterized by better water holding capacity and tenderness, lower drip loss, lower cooking loss and better sensory scores. Therefore, capon production may provide poultry meat producers with a niche product for consumers who look for meat of special quality.

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## WPŁYW KAPŁONOWANIA KOGUTÓW RASY ŻÓŁTONÓŻKA KUROPATWIANA (Ż-33) NA MASĘ CIAŁA I JAKOŚĆ MIĘSA

**Streszczenie.** Celem badań było określenie wpływu zabiegu kapłonowania kogutów rasy żółtonóżka kuropatwiana (Ż-33) na masę ciała i wybrane parametry jakości mięsa. Materiał badawczy stanowiło 80 kogutków, które przydzielono losowo do dwóch grup po 40 osobników. W 9. tygodniu doświadczenia ptaki grupy II poddano kastracji, zaś grupę I (kontrolną) stanowiły kogutki niekastrowane. Zabieg kastracji został przeprowadzony w znieczuleniu miejscowym przez lekarza weterynarii. Ptaki utrzymywano do 24 tygodnia życia i żywiono *ad libitum* jednakowymi mieszankami paszowymi. Po uboju określono wydajność rzeźną, udział mięśni piersiowych i mięśni nóg, podrobów i tłuszczu sadełkowego. Oceniono fizyczne cechy mięsa tj. pH, barwę CIE L*a*b*, WHC, wyciek swobodny, straty termiczne, siłę cięcia oraz przeprowadzono ocenę sensoryczną. Na podstawie uzyskanych wyników stwierdzono, że zabieg kastracji kogutków Ż-33 wpłynął korzystnie na zwiększenie masy ciała, wydajność rzeźną i umięśnienie tuszki oraz na poprawę parametrów technologicznych i atrakcyjność sensoryczną mięsa, dając przez to możliwość wykorzystania nadliczbowych kogutków jako cennego materiału do produkcji mięsa drobiowego o specyficznej jakości.

**Słowa kluczowe:** kapłonowanie, masa ciała, jakość mięsa

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