



Obtaining Capons from Hybrid Autosexed Chickens and Assessment of Their Meat Colour

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RESEARCH ARTICLE

Abstract

We realised an experimental model for observing the effects of caponisation from autosexed chicken hybrids between red Rhode Island males with barred Plymouth Rock females, thereby the one-day old chicks obtained through artificial incubation presented distinctive morphological characteristics between their gender. Male autosexed chicken hybrids were grown in a traditional (extensive) husbandry system, thus it was observed a good development pattern through manifesting the heterosis phenomenon. At the age of fourteen weeks, before sexual maturity the cockerels have undergone caponisation. The unilateral gonadectomy method was performed using a human tonsillectomy instrument and, in some individuals, gonadectomy was performed by squeezing the testes with the fingers, to test if there is any difference between intervention and recovery time. The individuals had a 100% surviving rate. After gonadectomy the caponised and the intact group were raised in the same environment and feeding conditions and monitored for morphological and weight differences. At the age of thirty weeks the cockerels from the two groups, nine chickens each, were slaughtered in order to assess the quantitative and qualitative differences of the carcass. Weight determination revealed a higher mean weight before slaughtering in the caponised cockerels than of the intact group (i.e. 3.3 kg vs. 3.0 kg) and after in carcass (i.e. 2.5 kg vs. 2.2 kg). Visual examination of the carcasses revealed that the skin is of a more intense yellow in the capons and upon section the drumstick muscles had a lighter colour than the drumstick muscles from the intact cockerels (i.e. light red vs. dark red). There is also a difference regarding consistency of the meat in the control group is much harder than of the capons.

Keywords: cockerels, capon, caponisation, autosexed chickens, traditional husbandry

INTRODUCTION

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The capon meat is a delicacy and is cooked for special occasions. In Italy, capons' production is a seasonal activity because the consumers demand is predominant in the Christmas period (Sirri et al., 2009). A study realised by the Institute of Animal Sciences, The Chinese Academy of Agricultural Sciences and the Central State Laboratory of animal nutrition from Beijing, showed that caponisation, significantly reduce the testosterone levels. In males, androgen levels play an important role in adipogenesis. Until now the molecular mechanisms about the way in which androgens influence lipogenesis in birds is still unknown (Cui et al., 2018). Between the proposed breeds for caponisation are barred Plymouth Rock and red Rhode Island, which we have experienced, and others like Black Penedesenca, Beijing-You, Leghorn, Sonali Chicken, Greenleg Partridge, White Plymouth Rock. In France (the largest producer of capons, over 2 million/year) the Bresse breed is recommended, which is the only breed in the world with A.O.C. (Appellation d'Origine Contrôlée) like the noble wines. The meat colour is

lighter compared with the one of mammals. Due to a reduced blood flow in the meat, the pigments quantity is reduced. The poultry meat is classified as white meat, the two pigments hemoglobin and myoglobin being weakly represented from a quantitative point of view (Bondoc, 2014).

The main factors which influence the colour of the meat are the content of myoglobin, orientation of the muscle fibers, the space between the muscle fiber and the pH. The muscles from different zones have a variable myoglobin content, which can directly influence the colour and its stability. The chicken breast is composed mainly by white muscle fibers, which have a low quantity of myoglobin, while the thigh is composed from red muscle fibers, which are richer in myoglobin, resulting in a darkish colour aspect (Barbut, 2015).

Meat colour influences decisions in retail purchasing more than any other quality factor because consumers use colour as an indicator of alteration and expiration date (Mancini, 2009; Guidi și Castigliero, 2010)

In pursuance to obtain an autosexed hybrid with light coloured skin and meat we cross-bred two dual-purpose chicken breeds, Plymouth Rock females with Rhode Island males in order to obtain a good development pattern (heterosis phenomenon), thus the males can be early grouped in order to prepare them for caponisation. The growth of the autosexed hybrid cockerels to the optimal age for caponisation was followed, gonadectomy performed and slaughtered after for assessing the quantitative and qualitative differences of the carcasses compared to the intact cockerels.

MATERIALS AND METHODS

We used in this study two dual-purpose chicken breeds with good meat and egg production, which are suitable for breeding in an extensive system and are resistant to the environmental conditions but also to diseases. The maternal component was barred Plymouth Rock, and the paternal component red Rhode Island individuals.

The groups were composed by seven females and a male to ensure a good fecundability and not to extinguish the male. The groups were formed in the winter-spring season to stimulate egg production, the daylight was increased by two hours of artificial light and the feedstuff enriched with a vitamin and mineral supplement for the reproductive system. Because of the cold season the eggs were harvested every hour to avoid low temperature exposure which could affect the embryo (about 3 °C in the henhouse). Storage was realised in a space with a temperature of 12 °C for a period of maximum 7-8 days to avoid the decrease of the hatching percentage.

Obtaining the chickens was realized through artificial incubation. A professional MIP 110 (Romania) incubator with automatic turner, adjustable temperature and humidity system was used. The device was set at a 37,7 °C, 57% humidity and the eggs arranged in the incubation sites with the blunt end up to support the embryo development in a position which eases the hatching for an 18-day period. In this period the was altered at 9 days, respectively at the end of the incubation period, after which the eggs were moved in the hatching sites in horizontal position for 3 days. The temperature was set at 37,5 °C and humidity at 72% to help hatching. In adequate incubation, the chickens start to hatch from the 20th day, but they will not be taken out until the 21st day.

The chickens were moved in a special arranged space, equipped with adjustable poultry infrared heating lamps with, disposed at a distance from the ground that assures the bedding material temperature of 30°C and a 20-22 °C in the air at the room edges. The groups were made so that under a one lamp to be 25 chickens, to prevent them from over agglomeration and suffocation.

Therefore, we have obtained autosexed chickens from which males and females present different morphological characteristics, to help us to differentiate them. The males were grouped for caponisation and separately. Males are black with a white spot on the head and the females are darker with no white spot on the head.

In the first 3 weeks of life, we administered the chickens complex granular feed with incorporated coccidiostat (robenidine hydrochloride) to assure the chickens a good start in growth and to prevent coccidiosis.

We used the next feed rations depending on the chicken's age:

- *Period 1-21 days:* "Starter combined feed Viva NC1151" (Viva, Hungary)-complete feed. Composition in Table 1.
- *Period 21-35 days:* "Starter combined feed Viva NC1152" (Viva, Hungary). Composition in Table 1.
- *After 35 days- ad libitum with cereals, green fodder, boiled potatoes.*

The biologic material of the study was represented by 18 cockerels at 14 weeks' age, divided in two groups. From them 7 were caponised by the unilateral gonadectomy method with a human tonsillectomy instrument and 2 others were neutered by squeezing out the testes with the fingers, obtaining the same results. The others remained intact as a control group.

We performed caponisation at fourteen weeks and after neutering in the same breeding conditions we followed the development of capons compared with the intact control group. The husbandry system is a traditional long term (extensive) system. After slaughtering the two groups of neutered and intact roosters we followed quantitative and qualitative differences of the carcasses.

Table 1. Composition of the starter combined diet

	STARTER COMBINED FEED Viva NC1151 (Viva, Hungary) – Period 1-21 days*	STARTER COMBINED FEED Viva NC1152 (Viva, Hungary) – Period 21-35 days**
NUTRITIONAL INGREDIENTS	PERCENTAGE %	PERCENTAGE %
DRIED SUBSTANCE (S.U.)	88.84%	88.70%
GROSS PROTEIN	20.53%	18.59%
GROSS FATS	3.05%	3.39%
GROSS CELULOZIS	3.48%	-
GROSS FIBERS	3.17%	5.29%
GROSS ASH	-	3.17%
VITAMIN D3	4500 UI/KG	3090 UI/KG
VITAMIN E	90 UI/KG	ECHIVALENT 6MG
METABOLISABLE ENERGY (E.M.)	12.46 MJ/KG	12.85 MJ/KG
VITAMIN A	13500 UI/KG	10000 UI/KG
CALCIUM	0.92%	0.99%
PHOSPHORUS	0.61%	0.52%
SODIUM	-	0.16%
LYSINE	-	1.02%
METHIONINE	-	0.36%
METHIONINE+CYSTEINE	-	0.66%

Preparation of the cockerels was realised before gonadectomy, thus they underwent alimentary diet for 17 hours, In the surgical procedure the contention of the individuals was done in lateral recumbency on the left side with the wings and legs extended. The plumage was removed and the incision site antiseptised with 10% povidone iodine solution and locally anaesthetised with local xyline infiltrations,

Incision site was in the last intercostal space and a 4 cm incision on the anterior edge of the last rib, through the skin and muscular layer. In the surgical gap the costal retractor was applied to facilitate access. Dilaceration of the air sac was realised with a syringe needle and the testicle visualised. We applied the loop of the tonsilectomy instrument on the testicular pedicle and sectioned it by pressure. Through the same incision the contralateral testicle was removed. The surgical wound was cleaned and sutured after with resorbable material. A healing powder with antibiotic was applied (Germostop). In the finger squeezing procedure the same intervention steps were respected.

The survival rate was 100 %. After gonadectomy the experimental group (caponised) and the control group (intact) chickens, composed of nine individual each, were raised in the same environment and feeding conditions, more exactly an extensive husbandry system in a 400 m² open air pen and fed *ad libitum* with a feed ration composed of maize 50%, grain flour 30%, sunflower flour 20%, green alfalfa and boiled potatoes. The individuals were slaughtered at thirty weeks, the obtained carcasses weighed and visually examined. In order of evaluating the main parameters which imply the poultry meat quality (in particular color), we brought 18 samples at the meat hygiene laboratory Faculty of Veterinary Medicine Cluj-Napoca, 9 carcasses of caponised chickens and 9 of intact ones.

For meat color appreciation of the 2 types of carcasses the classic sensorial method and the HunterLab Mini Scan EZ (HunterLab, USA) spectrophotometer was used at 5 hours after slaughtering.

Sensory examination aimed appreciation of aspect, colour and smell. Sensory analysis of the meat was conducted by a panel of seven tasters, and the visual exam was done five hours after slaughtering. Samples of chicken breast, capon breast, chicken drumstick and capon drumstick were analysed. Attributes to be assessed were colour, odour. Each variable was scored on a scale of 1 to 10.

The Hunter Lab spectrophotometer measures meat colour, by precise determination of the brightness (L*), shades of red/green (a*), respectively yellow/blue (b*).

- L* scale determines in the 0-100 interval, the light shades between 0-50, respectively dark shades between 51-100.

- a* scale determines red versus green shades, with the positive values indicating red shades and the negative values green shades.
- b* scale determines the yellow versus blue shades, in which the positive values indicate yellowish shades and negative values blue shades.

RESULTS AND DISCUSSIONS

Aspects encountered during growth: After incubation a 79% hatching rate was obtained.

These autosexed hybrid presents a quick coating with plumage so that at 1 week the feathers from the wings are grown, an important aspect because helps in thermoregulation thus the chickens have a reduced feed intake and don't require any more energy consumption with regulation of the body temperature.

In females we identified a phenotypic characteristic which has not been described yet in other research, respectively a dark skin on the legs. Whereas in males the skin color of the legs is yellow, an important aspect in obtaining a capon carcass with commercial appearance.

The chickens have a quick growth compared to chickens from the pure dual-purpose breeds from which they come from. The heterosis phenomenon was encountered, thus at 21 days the chickens from the pure dual-purpose breeds, had a mean weight of 380 g while the mean weight of the autosexed hybrids was 450 g, a noticeable difference and an important economic aspect. At 45 days the hybrids have a mean weight of 1400 g, with 200 g more than the pure breed chickens. Both gonadectomy methods took the same intervention time and the recuperation time after the intervention was the same.

After 16 weeks in which the intact chickens had the same environmental and feeding conditions with caponised cockerels, at slaughtering (thirty weeks), it was noticed that the mean weight of the capons was higher than the mean weight of the control group of intact chickens. The capons mean weight was 3,3 kg and the intact roosters of 3,0 kg. This also influenced the mean weight of the obtained carcasses that were heavier in the case of the capons than in the intact group (i.e. 2,5 kg vs. 2,2 kg).

According to Muriel Duran (2004), after stress of the caponisation procedure passed, caponisation had a positive effect regarding growing in weight and Mahmud et al. (2013) reports a decrease of the androgen levels after caponisation that can be associated with a higher increase in body weight of the capons.

Sensory examination aimed appreciation of color. At visual examination of the carcass, it was observed that the skin of the capons has a more intense yellow (i.e. score 8/10 vs. 6/10) (Figure 1) and on the section of the drumstick muscles from the capons has a lighter colour opposite to the muscles of the drumstick of the intact chickens which is more darkish (i.e. light red vs. dark red) scoring 8,4/10 vs 6,2/10 (Figure 2).



Figure 1. Carcass differences:
1-capon; 2-intact chicken

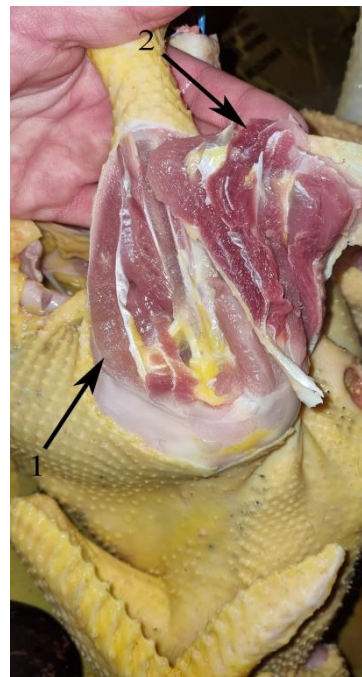


Figure 2. Differences in color of the drumstick muscles: 1-capon; 2-intact chicken

According to Calik (2014) the increased quantity of fat in capons compared to the intact chickens might be a cause in the difference of skin colour and according to other authors (Chen et al., 2007; Rikimaru et al., 2009), carotenoids from the feed are stocked in the subcutaneous fat and can influence the skin colour.

Table 2. Assesment of muscle colour at 5 hours after slaughter (mean values)

Sample	Capons			Sample	Intact chickens		
	L	a	b		L	a	b
Drumstick	73,57±0,69	6,55±0,48	37,85±0,32	Drumstick	69,34±0,51	8,12±0,52	31,54±1,09
Breast	74,26±1,02	5,94±0,44	33,98±1,93	Breast	73,38±0,55	5,01±0,28	25,39±0,67

The chicken carcasses presented on the skin a moist aspect, without being tacky, on section the muscles are slightly wet, without any impurities, with shiny and elastic tendons, clear synovial liquid.

From the results analysis there have been noticed significant differences in luminosity (L*) measured from the drumstick of the capons, consisting in a mean value significantly higher than in the intact chickens mean value (i.e. 73,57 vs. 69,34). Regarding the a* scale for red, the mean value of the capon's drumstick muscles is significantly lower than the mean value of the intact chicken's drumstick (i.e. 6,55 vs. 8,12). Regarding the b* scale associated with the yellow shades, both mean values of the drumstick and breast muscles of the capons (i.e. 37,85&33,98) are significantly higher than the mean values of the drumstick and breast muscles from the intact chickens (i.e. 31,54&25,39).

According to Lyon & Cason (1995) and Troutt et al. (1992) the color of the muscles is influenced mainly by the muscle myoglobin and the quantity of intramuscular fat, thus an increase in the quantity of intramuscular fat resulted in a decrease in muscle myoglobin. Capons have a lower level of myoglobin compared with the intact chickens according to the data reported by Sirri et al. (2009).

Jacob & Mather (2000) stated that capons need less oxygen in the muscle fibers due to abolition of fighting and protecting territory instinct. According to Hillebrand et al. (1996) the red colour of the meat is influenced by the concentration of myoglobin, thus worked muscles have a more darkish colour. In the scientific literature a decrease in muscles the red color intensity in capons was also reported by Miguel et al. (2008).

Other authors (Hsu&Lin, 2003; Calik, 2014) mention that the capon carcasses presented increased values of the L* and b* waves and decreased values of the a* wave compared to the intact cockerels of the control group.

CONCLUSIONS

It was proved that obtaining of an autosexed chicken hybrid is important in order to prepare the individuals for caponisation, thus the obtained hybrid has a significantly better growth than the chickens from the dual-purpose breeds from which they were obtained. The fact that the hybrid is autosex helped is to group the male chickens from the first day of life in order to prepare them an early caponisation. Another fact which we aimed was the skin yellow skin colour of the autosexed male hybrid with commercial aspect, examined by the sensorial method. Our study demonstrated a positive effect of caponisation regarding the weight of the carcasses in the capons compared to the intact chickens. The aspects of the two types of chicken carcasses revealed at the sensory examination were also proved through the determinations made with the HunterLab Mini Scan EZ (HunterLab, USA) spectrophotometer, thus we highlighted increased values of luminosity (L* waves) and of the yellow shades (b* waves) in the meat of the capon's drumsticks and breast compared to the meat of the intact chickens.

Muscles of the drumstick in the hybrid capons was of a light red colour which is an quality indicator. Muscles of the drumstick in the hybrid intact chickens is more darkish, noticing increased values of the a* waves compared to the meat obtained from the capons. Finally, caponisation influences the colour of the meat, thus the capons have muscles colour which is lighter (L*), more yellowish (b*) and of a lighter red (a*).

Author Contributions: A.S. G. Conceived the analysis and collected the data; S.D.D. Contributed data and analysis tools; L.R. M. Collected the data; M.F. C. Collected the data; A. F. Contributed with analysis tools; R. M. Performed the analysis; M. M. Wrote the paper.

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Conflicts of Interest

The authors declare that they do not have any conflict of interest.

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