

ISBN 978-86-82431-73-2



11th
INTERNATIONAL
SYMPOSIUM

MODERN
TRENDS
IN LIVESTOCK
PRODUCTION

P R O C E E D I N G S

11th - 13th October 2017 - Belgrade, Serbia

ISBN 978-86-82431-73-2



INSTITUTE FOR ANIMAL HUSBANDRY
BELGRADE - SERBIA

11th
INTERNATIONAL
SYMPOSIUM

MODERN
TRENDS
IN LIVESTOCK
PRODUCTION

P R O C E E D I N G S

11th - 13th October 2017 - Belgrade, Serbia

EDITORIAL COUNCIL

Prof. Dr. Martin Wähler, Faculty of Applied Sciences,
Bernburg, Germany
Dr. Milan P. Petrović, Institute for Animal Husbandry,
Belgrade-Zemun, Serbia
Dr. Zorica Tomić, Institute for Animal Husbandry,
Belgrade-Zemun, Serbia
Prof. Dr. Milica Petrović, Faculty of Agriculture,
University of Belgrade, Serbia
Prof. Dr. Lidija Perić, Faculty of Agriculture,
University of Novi Sad, Serbia
Dr Maya Ignatova, Institute of Animal Science,
Kostinbrod, Bulgaria
Prof. Dr. Kazutaka Umetsu, Obihiro University of
Agriculture and Veterinary Medicine, Obihiro, Japan
Prof. Dr. Dragan Glamočić, Faculty of Agriculture,
University of Novi Sad, Serbia
Prof. Dr. Vigilijus Jukna, Institute of Energy and
Biotechnology Engineering, Aleksandras Stulginskis
University, Kaunas, Lithuania
Dr. Elena Kistanova, Institute of Biology and
Immunology of Reproduction „Kiril Bratanov“, Sofia,
Bulgaria
Prof. Dr. Pero Mijić, Faculty of Agriculture, University
of Osijek, Croatia

Prof. Dr. Marjeta Čandek-Potokar, Agricultural Institute
of Slovenia, Ljubljana, Slovenia
Prof. Dr. Peter Dovč, Department of Animal Science,
Biotechnical Faculty, University of Ljubljana, Slovenia
Dr. Marjeta Čandek-Potokar, Agricultural Institute of
Slovenia, Ljubljana, Slovenia
Prof. Dr. Wladyslaw Migdal, University of Agriculture,
Krakow, Poland
Dr Ivan Bahelka, National Agricultural and Food
Centre – Research Institute for Animal Production,
Lužianky, Slovakia
Prof. Dr. Colin Whitehead, Roslin Institute, University
of Edinburgh, United Kingdom
Prof. Dr. Sandra Edwards, School of Agriculture, Food
and Rural Development, University of Newcastle,
United Kingdom
Prof. Dr. Giacomo Biagi, Faculty of Veterinary
Medicine, University of Bologna, Italy
Prof. Dr. Stelios Deligeorgis, Aristotle University,
Thessaloniki, Greece
Prof. Dr. Hasan Ulker, Turkey
Dr. Catalin Dragomir, National Research and
Development Institute for Animal Biology and
Nutrition (IBNA Balotesti), Balotesti, Ilfov, Romania

Publisher

Institute for Animal Husbandry, Belgrade-Zemun, Serbia

Editor-in-Chief

Milan M. Petrović, PhD, Principal Research Fellow
Director of the Institute for Animal Husbandry, Belgrade-Zemun

EDITORIAL BOARD

Editor

Zdenka Škrbić, PhD, Senior Research Associate
Institute for Animal Husbandry, Belgrade-Zemun

Section Editors

Animal Science

Vlada Pantelić, PhD, Senior Research Associate
Miloš Lukić, PhD, Senior Research Associate
Dragana Ružić-Muslić, PhD, Senior Research Associate
Dušica Ostojić-Andrić, PhD, Research Associate
Čedomir Radović, PhD, Research Associate

Feed Science

Zorica Bijelić, PhD, Senior Research Associate
Violeta Mandić, PhD, Research Associate

Technology and Quality of Animal Products

Prof. Dr. Marjeta Čandek-Potokar, Agricultural Institute of Slovenia, Ljubljana, Slovenia
Nikola Stanišić, PhD, Research Associate

Food safety and Veterinary Medicine Science

Aleksandar Stanojković, PhD, Research Associate

Language editor

Olga Devečerski

MEAT QUALITY OF REDBRO CHICKENS REARED EXTENSIVE INDOORS AFFECTED BY DURATION OF FATTENING PERIOD

Zdenka Škrbić¹, Miloš Lukić¹, Veselin Petričević¹, Snežana Bogosavljević-Bošković², Vladimir Dusković², Simeon Rakonjac²

¹Institute for Animal Husbandry, 11080, Belgrade-Zemun, Republic of Serbia

²Faculty of Agronomy, University of Kragujevac, Cara Dušana 34, 32000 Čačak

Corresponding author: zdkrbic@gmail.com

Original scientific paper

Abstract: In the development of alternative production systems in the production of poultry meat, the set goals are related to market demands, product quality and production efficiency. In addition to pure and autochthonous breeds of poultry, production in these systems can also be based on more productive hybrids of moderate growth in order to realize higher yields of meat. For the quality of meat from alternative production, the key is the slaughter age of chickens that approaches full maturity. However, slaughtering of older chickens leads to some unfavorable changes in meat quality. The aim of this study was to determine the importance of the duration of fattening period for the quality of chickens of moderate growth of Redbro provenance, grown indoors, based on the chemical composition and individual physical characteristics of the meat. A total of 300 one day old chickens were grown indoors, 12 birds/m². The chickens of the first group were reared to the age of 42 days and the chickens of the second group, up to 84 days. Meat quality parameters were studied on samples of white (pectoral muscles) and dark meat (thigh and drumstick muscles) of 12 broilers per treatment, with equal sex representation. The basic chemical composition and parameters of the technological quality of meat were determined (cooking loss, grilling loss, water holding capacity, objective tenderness). Meat of 84 days old Redbro chickens had poorer water holding capacity compared to 42 days old chickens, which is also associated with determined greater cooking loss or grilling loss on the 84th day. The effect of the duration of fattening period on the water holding capacity did not adversely affect the tenderness of the meat, since the meat cutting force was at the same level on the 42nd and 84th day. Chickens aged 84 days, as expected, had higher fat content in meat. A positive aspect of the established higher fat content, especially in white meat, is the possible improvement in the sensory quality of the meat.

Key words: meat quality, Redbro chickens, extensive indoor, slaughtering age

Introduction

Market demands for quality and safe food have initiated the development of alternative breeding systems in poultry production. Commission Regulation 543/2008 sets standards for the production of chicken meat from the system of free range and extensive indoors in the EU countries. In France, the production system and the market for chickens from unconventional systems have been fully developed and standardized, thus providing a standardized quality standard. In our conditions, when the development of market-oriented alternative systems of rearing is initially present in all its forms, it is important that market requirements, product quality and production efficiency are included as criteria for selection. In addition to pure and autochthonous breeds of poultry, adapted to the rearing conditions in these systems, production can also be based on more productive hybrids of moderate growth in order to realize higher body weight and higher meat yield. One of them is the Redbro provenance of chickens, which in previous studies showed good adaptation to systems of production of different intensity. Depending on the nutritional conditions in free range systems, Redbro chickens can reach body weight of 1759 g at the age of 91 days (*Blagojević et al., 2009*), to 3382 g at the age of 84 days (*Škrbić et al., 2013*). In accordance with the above-mentioned body weights are also the relative carcass yields „ready to grill“, which in these studies amounted to 66.43%, and 73.93%, respectively, while the share of abdominal fat ranged from 2.71 to 2.55%. Data on meat quality of Redbro chickens from various unconventional production systems are scarce. The duration of fattening period, in addition to genotypes, breeding systems, nutrition (*Fanatico et al., 2007; Ristić et al., 2007*), is also important for the meat quality properties. Intensive growth and development of breast muscles of fast growing hybrids is associated with an increase in the size of muscle fibers and reduced deposition of fat, which negatively affects the quality of meat (*Duclos et al., 2007*). According to *Fanatico et al. (2007)*, for the quality of meat from alternative production, of crucial importance is the age of slow-growing slaughter chickens approaching full maturity. Some authors report of a different character of meat quality changes with slaughtering age, depending on the genetic predisposition of broilers for intensity of growth (*Owens et al., 2006; Fanatico et al., 2006*).

The aim of this study was to determine the importance of the duration of fattening period for the meat quality of chickens of moderate growth, of Redbro

provenance, reared extensive indoors, based on the chemical composition and individual physical characteristics of the meat.

Material and methods

A total of 300 one day old chickens were grown indoors, 12 birds/m². The first group was reared to the age of 42 days and the second group, up to 84 days. The chickens were reared in pens on a deep straw litter, with three repetitions per each treatment. During the first seven days of age, the light program was continuous with 23 hours of light. Subsequently, a lighting program was implemented in accordance with legal norms, which included six hours of darkness in blocks of 4 and 2 hours. Nutrition to day 42 was with three mixtures based on maize/soybean: starter 22% CP, 12.7 MJ ME; grower 19% CP, 13.0 MJ ME; finisher 17% CP, 13.3 MJ ME. The chickens of the second group, after 42 days, until the end of the fattening period, were fed with a finisher mixture (17% CP; 13.3 MJ ME). The availability of food and water was *ad libitum*. Meat quality parameters were studied on samples of white (breast meat) and dark meat (thigh and drumstick muscles) of 12 broilers per treatment, with equal sex representation. The basic chemical composition of meat was determined by reference methods for moisture, fat, protein and ash content according to AOAC (*Association of Official Analytical Chemists, 2011*). Cooking and grilling losses were determined based on the difference in the mass of white and/or dark meat before and after thermal treatment. Thermal processing by boiling was for 10 minutes in boiling water and thermal processing by baking for 25 minutes at 250°C. Water holding capacity (WHC) was tested using the compression method according to *Grau and Hamm (1952)*. The resistance to cutting or tenderness of meat was determined on meat subsamples (1×0.5 cm) after thermal treatment, on warm meat, by the action of the blade (Warner-Bratzler Shear) perpendicular to the muscle fibers and by multiplying the obtained value by a coefficient of 0.25.

Statistical data processing was done by analyzing variance with the One-way ANOVA using the statistical software package STATISTICA, version 8, StatSoft, Inc. (www.statsoft.com).

Results and Discussion

The chemical composition of white meat (breast meat) and dark meat (thigh and drumstick meat) of the average mixed-sex sample of Redbro slaughter chickens of 42 and 84 days of age is shown in Table 1. Identified changes in the chemical composition of meat of Redbro chickens as an effect of slaughter age, refer to the mineral component, the content of fat and water. Ash content was

significantly lower in meat of chickens aged 84 days compared to chicken meat at the age of 42 days. Determined changes were the same in samples of white and dark meat. The content of intramuscular fat was significantly increased in white meat of broilers at the age of 84 days, and in dark meat, the water content and fat content were under the significant influence of chicken age. Expectedly, the water content decreased and the fat content increased with the age of Redbro slaughter chickens.

Contrary to this, with respect to the same indoors rearing system, the greater slaughter age of Ross broilers did not lead to significant changes in the chemical composition of white or dark meat in the study of *Castellini et al. (2002)*. However, by comparing the chemical composition of white meat of Ross broilers in the same research, grown indoors for up to 56 days and in the system with the possibility of using the range to the slaughter age of 83 days, greater fat content in the group of broilers grown for 56 days in the facility is established. These results indicate that, in conditions of the same genotype, the rearing system may have a more important role for the fat content of the meat than the slaughter age of chickens. The absence of differences in the content of water, protein and fat in white meat of the same slow-growing hybrid reared in two systems, at the same slaughter age, is determined by *Wang et al. (2009)*.

Analysis of the chemical composition of white meat of Redbro broilers reared in the facility up to 67 days of slaughter, *Fanatico et al. (2005)* determined dry matter content of 27.83%, fat content expressed in the percentage of DM 4.70% and ash 3.93%, which are significantly higher values compared to our results. The explanation is probably in the effect of nutrition. The differences in the chemical composition of white meat between slow, moderate and fast-growing broilers reared in the object, at different slaughter ages (81, 67 or 53 days, respectively), in the same study, were not determined.

Table 1. Chemical composition of the breast meat and legs (drumstick+thigh) meat Redbro broilers

Chemical composition, %	Age, day				p-value
	42		84		
	Mean	SD	Mean	SD	
Breast meat					
Moisture	74.20	0.76	73.85	0.69	0.263
Protein	24.21	1.04	24.45	0.99	0.565
Lipids	0.59	0.27	0.83	0.25	0.029
Ash	1.21	0.04	1.04	0.06	<0.001
Legs meat					
Moisture	75.86	0.84	74.37	1.03	<0.01
Protein	20.20	0.63	20.60	0.59	0.120
Lipids	2.79	0.63	4.04	0.85	<0.001
Ash	1.14	0.05	1.03	0.05	<0.001

Table 2. Physical characteristics of the breast meat and legs (drumstick+thigh) meat Redbro broilers

Physical characteristics	Age, day				p-value
	42		84		
	Mean	SD	Mean	SD	
Breast meat					
Cooking loos, %	18.46	1.21	15.92	1.82	<0.01
Grilling loos, %	27.80	1.20	26.75	2.05	0.139
Tenderness	2.22	0.70	2.18	0.41	0.861
Water holding capacity (WHC), %	11.24	0.56	10.19	0.59	<0.01
Legs meat					
Cooking loos, %	25.01	2.06	26.40	2.02	0.109
Grilling loos, %	35.59	3.13	32.07	1.64	<0.01
Tenderness	2.01	1.01	1.98	0.19	0.92
Water holding capacity (WHC), %	13.09	0.52	11.56	0.86	<0.001

Physical characteristics of white and dark meat of Redbro broilers, shown in Table 2, indicate significant differences in losses in thermal processing of meat, where differences in cooking loos were found in white meat (18.46% vs 15.92%), and differences in grilling loos in dark meat (35.59% vs. 32.07%). Both parameters are related to the established significant reduction in water holding capacity with the extension of the fattening period. The difference in the water holding capacity in the meat between the Redbro broilers reared 42 and 84 days, was more pronounced in dark meat samples compared to breast meat, which can be related to the size of muscle fibers and glycogen reserves (*Duclos et al., 2007*). The increased locomotor activity of chickens in conditions of extensive indoor rearing increases the glycogen content in muscle fibers and, consequently, the anaerobic glycolytic potential in muscles, especially in the thigh, which results in lower pH post mortem (*Lawrie and Ledward, 2006*) and leads to denaturation and loss of functionality of numerous proteins responsible for binding of water.

The effect of the duration of fattening period on the water holding capacity did not adversely affect the tenderness of the meat, since the cutting force of the meat remained at the same level, despite the partial negative correlation between the ability to hold water and the meat tenderness (*Lee et al., 2008*). The obtained results are in concordance with the findings that the slaughter age is not the decisive for tenderness of meat, as indicated by previous research (*Castellini et al., 2008*). *Horsted et al. (2010)* point out the significant role of the genotype, that is, the breed of chickens for the character of changes in the tenderness of meat with the slaughter age. In concordance are the results of the study by *Wang et al. (2009)* showing no differences in the objective texture of white meat of slow-growing broilers reared in the facility and on free range. The opposite effects of slaughter age on meat tenderness are found in fast growing hybrids in relation to slow

growing hybrids. Meat of fast-growing hybrids has the tendency of reducing tenderness with extension of the fattening period and weight gain, while in slow-growing races the opposite is determined (*Owens et al., 2006*). The explanation is in the muscle mass and differences in the proteolytic potential associated with the tenderness of the meat. In accordance with the above is a higher degree of tenderness of the Redbro broilers reared until the age of 67 days compared to Cobb broilers reared to the age of 53 days, in the study of *Fanatico et al. (2006)*. Extensive rearing systems, especially with the access to range, due to the higher degree of activity of chickens, can result in hard meat in relation to the rearing systems indoors (*Castellini et al., 2002*), while in the study of *Owens et al. (2006)* this effect is related to the slow-growing chicken genotype.

Conclusion

Extensive rearing of Redbro chickens in the facility up to the age of 42 and 84 days resulted in changes in the chemical composition and physical characteristics of the meat. Slaughtering at the age of 84 days reduces the technological quality of meat due to poor water holding capacity, but on the other hand, the acceptability of meat for consumers, based on the determined target tenderness, has remained unchanged. Redbro chickens aged 84 days, as expected, have higher fat content in meat.

A positive aspect of the established higher fat content, especially in white meat, is the possible improvement in the sensory quality of the meat.

Efekat dužine tovnog perioda na kvalitet mesa Redbro pilića gajenih ekstenzivno u objektu

Zdenka Škrbić, Miloš Lukić, Veselin Petričević, Snežana Bogosavljević-Bošković, Vladimir Dusković, Simeon Rakonjac

Rezime

U razvoju alternativnih sistema gajenja u proizvodnji pilećeg mesa postavljani ciljevi vezani su za zahteve tržišta, kvalitet proizvoda i efikasnost proizvodnje. Pored čistih i autohtonih rasa živine, proizvodnja u ovim sistemima se može zasnovati i na produktivnijim hibridima umerenog porasta u cilju dostizanja većih prinosa mesa. Za kvalitet mesa iz alternativne proizvodnje je

ključna starost pilića za klanje koja se približava polnoj zrelosti. Međutim, klanje u starijem uzrastu pilića vodi i određenim nepovoljnim promjenama kvaliteta mesa. Cilj ovog istraživanja je bio da se utvrdi značaj dužine tovnog perioda za kvalitet mesa pilića umerenog porasta, Redbro provenijence, gajenih extensive indoor, na osnovu hemijskog sastava i pojedinih fizičkih karakteristika mesa. Ukupno 300 Redbro jednodnevnih pilića je gajeno extensive indoor, 12 birds/m². Prva grupa je gajena do uzrasta 42 dana a druga, do 84 dana. Parametri kvaliteta mesa su ispitani na uzorcima belog (pectoralni mišići) i tamnog mesa (mišići bataka i karabataka) od 12 brojlera po tretmanu, sa jednakim učešćem polova. Utvrđen je osnovni hemijski sastav i parametri tehnološkog kvaliteta mesa (kalo kuvanja, kalo pečenja, water holding capacity, objective tenderness). Meso Redbro pilića starosti 84 dana je imalo lošiji water holding capacity u odnosu na uzrast 42 dana, koji je povezan i sa utvrđenim većim cooking loss or grilling loss 84. dana. Efekat dužine tovnog perioda na water holding capacity se nije negativno odrazio na tenderness mesa, s obzirom da je sila sečenja mesa bila na istom nivou 42. i 84. dana. Pilići starosti 84 dana su, očekivano, imali veći sadržaj masti u mesu. Razlike između 42 i 84 dana tovnog perioda u sadržaju masti su bile na nižem nivou signifikantnosti za belo meso, što može dovesti i do izvesnih poboljšanja u proceni senzornog kvaliteta belog mesa.

Ključne reči: kvalitet mesa, Redbro pilići, ekstenzivan sistem u objektu, starost za klanje

Acknowledgment

This research is part of the Project EVB: TR-31033 financially supported by Ministry of Education, Science and Technological Development of the Republic of Serbia.

References

- AOAC. (2011): Official Methods of Analysis. 18th ed. Association of Official Analytical Chemists, Washington, DC.
- BLAGOJEVIĆ M., PAVLOVSKI Z., ŠKRBIĆ Z., LUKIĆ M., MILOŠEVIĆ N., PERIĆ L. (2009): The effect of genotype of broiler chickens on carcass quality in extensive rearing system. *Acta Veterinaria*, 59, 1, 91-97.

- CASTELLINI C., BERRI C., LE BIHAN-DUVAL E., MARTINO G. (2008): Qualitative attributes and consumer perception of organic and free-range poultry meat. *World's Poultry Science Journal*, 64, 500-512.
- CASTELLINI C., MUGNAI C., DAL BOSCO A. (2002): Effect of organic production system on broiler carcass and meat quality. *Meat Science*, 60, 219–225.
- DUCLOS M. J., BERRI C., LE BIHAN-DUVAL E. (2007): Muscle Growth and Meat Quality. *Journal of Applied Poultry Research*, 16:107–112.
- FANATICO A. C., CAVITT L. C., PILLAI P. B., EMMERT J. L., OWENS C. M. (2005): Evaluation of Slower-Growing Broiler Genotypes Grown with and Without Outdoor Access: Meat Quality. *Poultry Science* 84:1785–1790.
- FANATICO A. C., PILLAI P. B., CAVITT L. C., EMMERT J. L., MEULLENET J. F., OWENS C. M. (2006): Evaluation of Slower-Growing Broiler Genotypes Grown with and Without Outdoor Access: Sensory Attributes. *Poultry Science* 85:337–343.
- FANATICO A. C., PILLAI P. B., EMMERT J. L., GBUR E. E., MEULLENET J. F., OWENS C. M. (2007): Sensory Attributes of Slow- and Fast-Growing Chicken Genotypes Raised Indoors or with Outdoor Access. *Poultry Science* 86:2441–2449.
- GRAU R., HAMM R. (1952): Eine einfache Methode zur Bestimmung der Wasserbildung im Fleisch. *Die Fleischwirtschaft*, 4, 295-297.
- HORSTED K., ALLESEN-HOLM B.H., HERMANSEN J.E. (2010): The effect of breed and feed-type on the sensory profile of breast meat in male broilers reared in an organic free-range system. *British Poultry Science*, 51: 515–524.
- LAWRIE R.A., LEDWARD D.A. (2006): *Lawrie's Meat Science*, 7th ed. Cambridge, England: Woodhead Publishing Limited.
- LEE Y.S., XIONG R., SAHA A., OWENS C.M., MEULLENET J.F. (2008): Changes in broiler breast fillet tenderness, water-holding capacity, and color attributes during long-term freezing. *Journal of Food Science*, 73: E162-E168.
- OWENS C., FANATICO A., PILLAI P., MEULLENET J., J. EMMERT (2006): Evaluation of alternative genotypes and production systems for natural and organic poultry markets in the U.S. *Proceedings XII European Poultry Conference*, Verona 10730.
- RISTIĆ M., FREUDENREICH P., WERNER R., SCHÜSSLER G., KÖSTNER U., EHRHARDT S. (2007): Hemijski sastav mesa brojlera u zavisnosti od porekla i godine proizvodnje. *Tehnologija mesa*, 48, 5-6, 203-207.
- Statistica-Stat Soft, Inc. version 8.0 (2008), www.statsoft.com
- ŠKRBIĆ Z., PAVLOVSKI Z., LUKIĆ M., PETRIĆEVIĆ V. (2013): Production performance and carcass quality of coloured broilers differentiated genetic potencial for growth. *Biotechnology in Animal Husbandry*, 29 (4), 615-624.

WANG K. H., SHI S. R., DOU T. C., SUN H. J.(2009):). Effect of a free-range raising system on growth performance, carcass yield, and meat quality of slow-growing chicken. *Poultry Science*, 88: 2219–2223.