

Free systems of rearing of chickens and layer hens: quality of meat and eggs*

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Abstract: Conventional broiler and egg production are basis of modern production of poultry meat and table eggs in the World and in our country. Standing requirements and demands for more and better in poultry production have induced continuous work on improvement of technologies of broiler rearing and production of table eggs. Improvements in technologies of production of meat and eggs depend on country's natural resources, environment conditions and, certainly, on consumer opinion and demands. In addition to the quantity of products, considerable attention will be focused on poultry welfare, application of new rearing systems and, accordingly, on quality of the product. Positive effects of the free system of rearing of broilers and layer hens on quality of meat and eggs, which have been established in our many years of research, will be presented in this paper.

Key words: free system of rearing, quality, poultry meat, table eggs.

Introduction

Quality properties of poultry meat and table eggs are of very dynamic character and changeable depending on numerous factors. The quality of poultry products, among biological factors, is mostly influenced by genotype, gender and age, and the most important factors of zootechnical nature are housing system, nutrition and health condition of poultry. Presently, market offers plenty of poultry products (meat and eggs) and they are all competing to win, i.e. to realize the best marketing resulting in higher profit. For better marketing of product, in addition to competitive price, also special and guaranteed quality of the product for which consumers are prepared to pay higher price is important (Pavlovski *et al.*, 2001). Alternative, non-conventional poultry housing systems are introduced into production, on one hand because of the poultry welfare, and on the other because of the product quality, i.e. the connection between the quality of life of poultry

and quality of product is established in this way (Pavlovski *et al.*, 2010).

Only few researchers in Serbia have studied the rearing programs and quality of poultry products (meat and eggs) in special non-conventional housing systems as well as new methods in production of poultry products (Bogosavljić Bošković *et al.*, 2005; Milošević *et al.*, 2003; Milošević *et al.*, 2005.; Pavlovski and Mašić, 1994; Pavlovski *et al.*, 1992; Pavlovski *et al.*, 2002; Pavlovski and Mašić, 1986; Pavlovski *et al.*, 2009; Pavlovski *et al.*, 2010; Blagojević *et al.*, 2009).

Production of poultry meat and table eggs, due to intensive and interesting development in the last twenty years of the 20th century, has managed to provide to consumers products in large amounts throughout the year and at relatively low prices. However, this has had negative impact on opinion of consumers on quality of poultry products. Eggs were unjustly accused as products with high cholesterol content to be harmful to human health. Also, relative-

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ly poorer quality of poultry meat from intensive broiler production (watery meat, insufficiently expressed/distinct flavour and aroma, high percentage of subcutaneous fat and abdominal fat, weak and breakable bones, etc.), as well as development of consumer awareness of animal welfare and food safety, had induced the perception of poultry meat as unhealthy and unnatural. Poultry meat and eggs, as food products, are unjustly accused as harmful to human health and in, last few years, this injustice is slowly being corrected.

The fact that a new organism is created from the egg – chicken, is evidence confirming that the egg is food rich in nutrients. Egg is source of highly valuable proteins and it contains unique combination of fatty acids necessary in human diet and this fact is main argument in fight/struggle against cholesterol phobia, which has been present in the last 20 years and contributed significantly to drop in the egg consumption.

New housing systems for layer hens (enriched cages, extensive, semi-intensive system, deep litter, organic production) as well as new systems in broiler production (extensive, semi-intensive, rearing of broilers separated according to gender, extended fattening, new light regimes) have not only improved the poultry welfare, but have also provided to consumers new product range (table eggs and poultry meat) of different, better, guaranteed quality.

Increase of production costs in these alternative housing systems and at the same time increase of the price of the product on the market, surely has impact on the decision of consumer in purchasing of such products. The question is raised if the consumers are ready to pay higher price for product because of ensured welfare or because these products have special and guaranteed quality. Majority of buyers appreciate mainly the freshness and safety of eggs when purchasing this product (*Pavlovski and Mašić, 1986; Pavlovski and Mašić, 1993*). Production system is also the factor influencing the choice of consumers when purchasing this product, i.e. poultry housing system which includes farm conditions, nutrition, welfare, health condition of poultry, etc. Today, there are two categories of consumers: *global consumers*, who are willing to pay higher price for products of special and guaranteed quality, and the other group, so called *consumers* who are aware of the production system and take it into account, but at the same time are not willing to pay higher price for such product.

In this paper, significantly improved technologies for production of table eggs and poultry meat from poultry reared in free system will be presented,

as well as the opinion and attitude of consumers towards this type of products.

Rearing of chickens in free system

System features

Problem solved by introduction into practice of the technological procedure in production of poultry meat in rearing system with free range is organization of poultry meat production of special quality, according to principles of rationalized system and, in this way, added value for the poultry carcass is generated, as well as new market for poultry products. Considering specificities of the technological procedure, concerning provision of grazing/pasture surface, this would enable development of rural areas in our country.

After three weeks of fattening in intensive system, chickens are fattened in extensive system. Chickens can remain for further fattening on the holding of the same farmer who fattened them to mentioned age, or they can be transported to other producer who will rear the min extensive system to the slaughtering age (12 to 14 weeks).

Selection of chickens for fattening

Production of chickens in extensive systems is based on slow growing hybrids of coloured plumage, of domestic or imported origin. Chickens used in industrial production (broilers) are not used for this production, or white plumage chickens. In our conditions, domestic, native/autochthonous hens of more fattening type can be used, naked neck hens (with coloured plumage), New Hampshire, Amrock, Grey Plymouth Rock and similar chickens with no white plumage. Researches with chickens of New Hampshire and Amrock breeds were carried out by *Pavlovski et al. (1992)*.

Domestic naked neck chickens, reared on our territory for long time are considered as domestic hens. They originate from primitive hens crossed with various foreign breeds of which the influence of the Transylvanian naked neck is the most obvious, since this naked neck trait is transferred as dominant trait. Naked neck hen as autochthonous is present in all neighbouring countries, and differences among them are very small (*Grujić, 1928*). The most distinct exterior trait is naked neck, and plumage is of different colour. Quality of meat is good and the hen is very resistant.

Pavlovski et al. (2009) have initiated investigations which could contribute to better understanding and consideration of possibilities for production

of chicken meat based on mentioned Program, where naked neck chicken of different varieties would be used.

Facilities and equipment

In this production smaller facilities are used, different constructions, different types, stable (fixed) or mobile. Considering that they are used for housing of chickens over night and for protection from bad weather conditions during day, the construction of these buildings is very simple and made of cheap material, such as light eaves or shed. Within the facility feeders and waterers are placed and chickens are housed on natural light, so the facilities can be without electricity. Stable facility is place in the centre of the free range - pasture which is divided into rotations.

Free range – Pasture

Chickens for fattening are reared and kept on unlimited free range (pasture) and as protection from birds of prey and thieves, it is necessary to fence the free range and divide it into small parts – rotations. On free range feeders and waterers are placed. It is desirable to have within the pasture or at least on the edges, some trees, as protection from strong sun light. If there are not trees, it is necessary to provide some type of eaves. Pasture is for poultry the source of proteins, minerals and vitamins A, B, E and C. With additional nutrition using concentrated feeds, especially alfalfa meal supplemented with vitamin D, poultry can utilize the pasture extremely well.

Nutrition

Nutrition is process of digestion, adoption and transformation of food into tissues and energy in chickens' organisms. Therefore it is considered that nutrition as well as housing has decisive effect on production and quality of poultry meat. For the purpose of production of chicken meat of special and guaranteed quality it is necessary to provide special food and nutrition of poultry. Main nutrition principles are:

- grain/cereals as diet basis (minimal share 70% in complete mixtures, except in starter - min. 50%);
- without animal feeds, feeds produced from GMO and growth promoters, and
- with limited number of additives.

System of nutrition of chickens is realized in two phases: 1. nutrition in the facility (first 6 weeks) in general is not different from nutrition of chickens in conventional fattening, except in regard to selecti-

on of feeds and less concentrated mixtures; 2. nutrition on the free range/pasture with three separate feeds (energy, protein, mineral) in system of free choice. This system allows for chickens to balance their own diet.

Change of the housing system requires adequate nutrition based on grain mixture and mixture of concentrates with usual mineral and vitamin additives. In compliance with principles of production of natural food and certain demands of European market, these diets are supplemented with natural additives in order to improve production results and quality of chicken meat. The following are considered as new additives: enzymes, probiotics, prebiotics, phytobiotics (medicinal herbs) and mycotoxin adsorbents.

With application of *enzymes* in poultry nutrition better utilization of certain nutritious substances is achieved for the purpose of obtaining better production results (gain, feed conversion), better quality of meat with lower mortality. Special importance has enzyme phytase which improves utilization of phytine phosphorus (to 30%) and reduces pollution of environment.

Probiotics help development of useful to the detriment of harmful (pathogen) microorganisms in digestive tract. With application of probiotics the health condition is improved, also better production results and better quality of meat are realized.

Prebiotics are indigestible feed components (carbon hydrates, certain peptides or lipids) which have favourable effect on host through stimulation/promotion of development of desirable bacteria with simultaneous limiting of development of undesirable bacteria in digestive tract. With application of prebiotics optimal production results are achieved, utilization of food is improved as well as vitality of chickens.

Phytobiotics and their extracts have wide range of effect: they stimulate consumption of food and endogenous secretion of enzymes, they have anti-microbial and coccidiostatic effect, improve production results, poultry health and product quality. Medicinal herbs which can be used as additives are: camomile, lemon balm, mint, fennel, yarrow, thyme, sweet basil, etc.

Presence of mycotoxins in chicken food causes numerous problems, starting with the negative effect on production results to various health problems which often end in death. They can be generated in contaminated food during production process or storage. In the strategy for solving of the problem of mycotoxins in nutrition the best results were realized by different adsorbents. For all adsorbents it is important that they have high adsorbing specificity,

high affinity and adsorbance capacity and that they protect poultry from negative effect of mycotoxins. It is necessary to identify the mycotoxin and accordingly determine the most effective adsorbent which will eliminate or alleviate the negative effect of mycotoxin on production results in poultry.

Water is essential nutritious substance, main component of chicken organism and necessary for all functions in organism. Therefore, microbiologically and chemically proper water must at all times be available for chickens.

Environment and production conditions

In order to realize satisfactory production results in extensive poultry rearing system, certain requirements have to be fulfilled.

Temperature: Optimal and acceptable temperatures, depending on the age of chickens, are: 1. week 30–32°C; 2. week 28–30°C; 3. week 25–27°C; 4. week 23–24°C; 5. week 20–22°C. After the age of 5 weeks, chickens are reared in normal conditions without special heating on room temperature of 18–20°C.

Ventilation and air humidity: Relative humidity in the facility where chickens are kept in the initial period, when the facility is heated, should be at least 70%, and later 50%. Excessively dry air can lead to respiratory diseases, incidence of cannibalism, and litter gets dusty.

Light program: Extensive system of poultry rearing includes natural light and facility with windows, i.e. open sides. If there is need for it, the facility can have electric light of 5 W/m².

Floor surface and free range surface: Program anticipates not more than 11 chickens per m² of floor surface, max. 1.000 chickens in box and starting from 6. week of age to the end of fattening (min. 84 days) access to grass free range (surface of min. 2-10 m² per chicken).

Feeding surface: Total surface from which chickens are feeding should be 20% of the surface that is heated. From 2. to 5. week of age, chickens take food from cylindrical feeders (50 chickens per feeder). During the period of free range utilization, feeders are moved around free range in order to equally utilize pasture.

Watering surface: In the initial period of several days chickens are watered from plastic waterers of siphon type, and from the 10. days of age from automatic hanging waterers. One hanging waterer is sufficient for 125 chickens. Several waterers in the form of troughs of drip-waterers are placed also on free range neat feeders and also moved all around the free range.

Health protection

Chickens in extensive system, considering the open space where they spend most of the time, must have very solid and efficient protection. Health protection is provided through application of several protective measures and control of health condition of chickens, and it is divided into general and specific. *General protection* includes those measures carried out during the process of development of the farm project and construction on the farm; they contribute that infectants are not introduced to the farm or spread within the farm or from farm to the environment. *Specific protection* relates to protection from diseases which occur in our geographical origin and it is realized through vaccination program. *Control of the health condition* is realized through clinical monitoring of the chickens and laboratory analysis of deceased chickens, or of their organs, in order to determine the diagnosis and successfully treat affected flock.

Slaughtering of chickens

Minimal allowed age of chickens which are slaughtered in extensive rearing system is from 84 to 91 days. Packaged carcass must have adequate label containing following data: duration of fattening, share of grain in food, maximum period from slaughtering to sale, origin of product, producer name, rearing system, organization responsible for quality control, type of slaughter processing and storage conditions.

Quality control includes: control on the location of production, sale and in distribution chain. On fresh carcass the following is examined: conformation (Pavlovski and Mašić, 1983; Pavlovski et al., 2006), slaughtering quality, condition and colour of skin, processing quality and on roasted carcass: quality of carcass when it is cut, aroma, skin condition, general impression, tenderness and succulence of meat.

Rearing of layer hens in free system

In production of table eggs numerous strategies are implemented aimed at creation of product of distinct and guaranteed quality (brand egg). New production systems were first developed in European Union countries, and later in developing countries, to improve poultry welfare and meet the consumers' demand for eggs of distinct, known and guaranteed quality. This primarily applies to eggs produced in free systems (extensive), eggs from deep litter and from enriched cages, which provide minimum of poultry welfare.

In this paper, main principles of production of table eggs in free housing systems of layer hens will be presented.

Building and equipment

Segments of the grid floor are placed in the hen house and subsequently 2/3 of the floor is covered with dry litter in a layer of 30 cm. Then, hanging feeders and nests with clean litter are placed and functioning of the light and watering equipment is checked, in order to eliminate or rectify potential mistakes and omissions in operation of the equipment.

Selection of layer hens

For production of table eggs in this Program hybrids are used which are not common or used in industrial production. In our conditions domestic indigenous hens can be used, naked neck hen, domestic populations of Rhode Island, New Hampshire, Amrok, Plimoth rock hens and crosses obtained from crossing of these breeds.

Housing of hens into hen house is done at the age of 18 weeks. First, the distant parts of the hen house are housed and then parts closer to the door and finally, food and water consumption of birds is monitored. Two to three days after housing hens are released to free range – pasture. In the morning they are given food in feeders on the free range, and feeders are moved gradually away from the building and closer to the fence of free range.

Free range – pasture

At the age of 18-20 weeks, laying hens are placed on free feeders and drinkers until end of laying (not longer than 72 week of life). It is desirable to have trees within pasture or on its edges which would be used as shade for chickens to hide from hot Sun. If there are no trees it is necessary to make some kind of eaves. Pasture for poultry is source of protein, minerals and vitamins A, B, E and C. With additional nutrition using concentrated feeds, especially alfalfa meal with addition of vitamin D poultry can utilize free range exceptionally well.

Nutrition

Nutrition is process of digestion, adoption/absorption and conversion of food into tissues and energy in the hen organism. Therefore it is considered that nutrition, as well as housing, has decisive role and effect on production and quality of table eggs and poultry meat. For the purpose of production of table eggs of special and guaranteed quality it

is necessary to provide special nutrition of poultry. Main nutrition principles are:

- Cereals are basis of the diet (minimum share of 70% in full mixtures except in starter mixture - min. 50%);
- No animal additives, feeds produced from GMO ingredients;
- Limited number of additives;
- Green and juicy (root-tuberous) feeds.

Change of the housing system requires adequate nutrition based on mixture of cereals and concentrate mixture, with usual mineral and vitamin additives. In accordance to principles of production of natural food and some requirements of European market, natural additives are introduced to these diets which are used to improve production results and quality of table eggs. These new additives are enzymes, probiotics, prebiotics, phytobiotics (medicinal herbs) and mycotoxin adsorbents.

By application of *enzymes* in poultry nutrition better utilization of certain nutritious substances is achieved for the purpose of obtaining better production results (laying ability, number and mass of eggs), better quality of eggs and lower mortality. Special importance has enzyme phytase, which improves utilization of phytine phosphorus (up to 30%) and reduced environment pollution.

Probiotics help development of useful to contrary to harmful (pathogen) microorganisms in digestive tract. By application of probiotics the health condition is improved, better production results are realized as well as better quality of eggs.

Prebiotics are non-digestible feed components (carbon hydrates, some peptides or lipids) which have beneficial effect on host through stimulation of development of desirable bacteria with simultaneous limiting of development of undesirable bacteria in digestive tract of the poultry. By application of prebiotics optimal production results are achieved, the food utilization is improved as well as the vitality of poultry.

Phytobiotics and their extracts have wide spectrum of utilization: they stimulate the food consumption and endogenous enzyme secretion, they have antimicrobial and coccidiostatic effect, they improve production results, they have beneficial impact on health of poultry and quality of products. Medicinal herbs which can be used as additives are camomile, lemon balm, mint, anise, yarrow, thyme, basil, etc.

Presence of mycotoxins in food for layer hens causes numerous problems, from negative effect on production results to different health problems which often end in death. They can be generated in contaminated food during process of production or storage. In strategy against mycotoxins in poul-

try nutrition the best results were established when adsorbents were used. It is important for all adsorbents to have high specificity of absorbance, high affinity and adsorbing capacity and to protect as much as possible poultry from negative effect of mycotoxins. It is necessary to identify the mycotoxin and determine the most efficient adsorbent which would eliminate, or at least alleviate, the detrimental effect of mycotoxins on production results in poultry.

Light program

Extensive system of housing of layer hens anticipates for prolonging of natural day light with artificial light, but total duration can not exceed 16 hours. Natural light is provided through open sides of the hen house, i.e. windows made of plastic foil. Artificial light is provided by electric bulbs of power of 4.5 W per m².

Health protection

Layer hens in extensive system, considering the open space available to them, must have very thorough and efficient protection. Health care is provided by application of series of protective measures and control of the health condition of hens and it is divided into general and specific. *General protection* includes those measures which are considered during planning of the building and production facility, which contribute to safety and prevent introduction of infectants to the farm and their spreading within the farm or from farm to the surrounding environment. *Specific protection* relates to protection from diseases which occur on our geographical territory and it is realized through vaccination program. *Control of the health condition* is realized by clinical observation of hens and laboratory examination of died birds or their organs for the purpose of establishing of diagnosis and successful treatment of diseased flock.

Procedure with eggs

Eggs should be collected as often as possible, at least 4 times during laying period (from early morning to early afternoon). After collecting, eggs are placed in special storage room (chamber) with temperature of 10-15° C and relative air humidity of 70–75 %. Eggs with dirty or cracked shell, as well as eggs which are not for the market (below 45 g or above 75 g, of irregular shape, etc.) are consumed on the household or sold to local buyers. This Program determines minimum conditions in regard to quality of eggs. Eggs of guaranteed and special quality are

exclusively non-fertilized fresh eggs in egg shell that hasn't been washed or mechanically cleaned and categorized/sorted one day after production. In order for these eggs to have recognizable image, special packaging is designed in form of boxes or baskets. Beside adequate label, registered commercial name and all data issued by the Regulation, packaging should also contain information about the housing system of layer hens, composition of used food, max. period of time from laying to supply to the store, origin of eggs, minimum quality requirements, organization controlling the quality, storage conditions and shelf life at given conditions. In this Program it is determined that eggs have at the moment of delivery to the place of sale (average for entire package of eggs): minimum 70 Haugh units, egg yolk colour minimum 12 Roche units and egg shell thickness of at least 0.35 mm.

Marketing strategy and consumer attitudes

It is well known that in every production chain, the most important link is the final one – consumer. For each production, even production of table eggs, it is very important to know why consumers are purchasing specific product and what preferences consumers have in relation to that product. It is paradox that poultry production in many countries of the world, even in Serbia, over the period of several decades, has developed suddenly and become industrialized – revolution in livestock production, but almost no attention was directed to researches of consumer demands and marketing strategies. Even in countries with developed poultry production, first among few researches of the consumer relations to poultry products appeared in late sixties. However, in eighties these researches became very up-to-date and intensive. Today on poultry scientific meetings researches of consumer attitudes and marketing strategies are given outstanding position. Favourable circumstance is that in our country considerable attention was directed to researches of the consumer relation to poultry products. Numerous researches directed in various directions have been carried out (*Pavlovski and Mašić, 1986; Pavlovski et al., 1981; Pavlovski and Mašić, 1993; Pavlovski et al., 2002; Pingel and Jeroch, 1997; Rossi, 2007*). It is interesting to mention that in year 1981 70,6% of questioned consumers thought that battery system was acceptable as production method. One decade later this percentage was reduced to 54,6%, and two decades later to 35,6%. During this period the percentage of consumers in favour of banning of cage system almost doubled from 6,4% to 10,3% and 13,2%, respectively. In mentioned research

years number of consumers which were willing to pay higher price by 10% for eggs of guaranteed and controlled quality or from free-range system increased from 46% to 63% and 71,5%. Obviously, number of consumers adherent to the free-range and banning of battery system on Belgrade market increased considerably, which is in accordance with similar trends and new directives of EU.

At least, there is a need for traceability system that gives information on origin, production, retailing and final destination of products. Such system shall enhance consumer confidence in food, enable the regulatory authorities and to withdraw health hazardous and non- consumable products from the

markets. An animal product is an element in this “food-to-farm” approach to public health (*Schwägelke and Adrée, 2009*).

Conclusion

Proposed programs for production of table eggs and poultry meat will generate products of slightly lower cholesterol content and ideal ratio of unsaturated and saturated fatty acids, i.e. products of distinct, known and guaranteed quality, which will meet the demand of domestic and foreign consumers, fans of natural food.

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Slobodni sistemi gajenja pilića i kokoši: kvalitet mesa i jaja

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Rezime: Konvencionalna brojlerska proizvodnja i proizvodnja jaja je osnova današnje proizvodnje pilećeg mesa i konzumnih jaja u svetu i u našoj zemlji. Stalni zahtevi u živinarskoj proizvodnji za bolje i više doveli su do toga da se kontinuirano radi na poboljšanju tehnologija gajenja brojlera i proizvodnje konzumnih jaja. Poboljšanja u tehnologijama proizvodnje mesa i jaja zavise od prirodnih resursa određene zemlje, ambijetalnih uslova i svakako mišljenja i zahteva potrošača. Pored količine proizvoda značajna pažnja će se pridavati dobrobiti živine, primeni novih sistema gajenja i shodno tome kvalitetu proizvoda. U radu će biti prikazani pozitivni uticaji slobodnog sistema gajenja brojlera i kokoši nosilja na kvalitet mesa i jaja, koje smo ustanovili u našem dugogodišnjem radu.

Ključne reči: slobodan sistem gajenja, kvalitet, pileće meso, jaja za konzum.