

13th
INTERNATIONAL
SYMPOSIUM

MODERN
TRENDS
IN LIVESTOCK
PRODUCTION



P R O C E E D I N G S

6 - 8 October 2021, Belgrade, Serbia

Institute for Animal Husbandry
Belgrade - Zemun, SERBIA

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THE IMPORTANCE OF EGGS IN THE DIET, CONSUMER PREFERENCES, THE PRODUCTION AND MARKET OF TABLE EGGS IN SERBIA

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Invited paper

Abstract: Nutrition is very important for maintaining the good health of people at all stages of life and as such should be the subject of interest not only for nutritionists, but also for each individual. The choice of food stuffs in the diet is significantly influenced by habits, and in recent decades it has been noticed that consumers are increasingly concerned about the way food is produced, its safety and harmlessness. Although eggs, as a food, have an excellent nutritional composition, they have had a bad reputation for decades due to the high content of cholesterol, which was considered bad, which is why many consumers avoided them or ate only egg whites. The results of research indicating that cholesterol in food such as eggs has an insignificant effect on blood cholesterol have contributed to solving the problem of cholestophobia, so that official nutrition organizations, around year 2000, recommended the abolition of restrictions on egg consumption. Egg consumption and method of preparation vary significantly among different countries, which may be related to dietary traditions and consumer preferences. During the last decades, the attitudes of consumers are gaining in importance and are being studied in relation to the characteristics of egg quality, according to production systems, the welfare of chickens, etc. A comprehensive view of consumers' perceptions, their habits and understanding of the role of eggs in the diet requires a systematic approach, at the level of the entire social community, including education, which is especially important for younger populations. The aim of this paper is to point out the importance of eggs in the diet, to show the situation in the sector of table egg production in Serbia, with reference to EU countries, including expected changes caused by changes in the legislation, which may have far-reaching consequences for this sector, consumers and the market situation.

Key words: nutrition, eggs, welfare, rearing systems, consumer preferences

Introduction

Eggs as a food stuff play a significant role in the diet from early childhood to old age. Although they are a high-value biological food, attitudes about the role of eggs in human nutrition have changed several times over the last decades. Egg confusion results from a cholesterol content of 200 to 300 mg per 100g (*Miranda et al., 2015*), or an average of 141 to 234 mg per egg, which is about two-thirds of the recommended daily limit of cholesterol intake, which several a decade ago was 300 mg/day (*Clayton et al., 2017*). Cholesterophobia, at one time, was primarily related to consumer fear that consuming eggs could lead to coronary heart disease, which could be linked to a decline in egg consumption (*Ruxton et al., 2010; Kuang et al., 2018*). Only after scientific studies established that cholesterol in foods such as eggs had only a small and clinically insignificant effect on blood cholesterol, and that egg consumption was not associated with an increased risk of cardiovascular diseases (*Qureshi et al., 2007; Gray and Griffin, 2009*), official nutrition organizations have recommended lifting restrictions on egg consumption. In 2002, the American Heart Association (AHA) withdrew a recommendation to limit egg consumption to 3 to 4 per week. In 2015, the Dietary Guidelines Advisory Committee (DGAC) officially withdrew its recommendation to limit cholesterol intake to 300 mg per day, as there was no evidence of a link between dietary cholesterol and blood serum cholesterol (*Carson et al., 2020*). However, as the dietary recommendations for Americans for the period 2015-2020 are such that it is recommended to consume as little cholesterol as possible, while respecting healthy eating habits, but that cholesterol is not an ingredient that, if consumed excessively, does represent a concern, one gets the impression that confusion related to cholesterol intake to some extent still remains (*Zhuang et al., 2021*).

Egg production and consumption vary significantly and from country to country. Production in the last few years, at the world level, according to FAO data, has recorded a steady increase (*FAOSTAT, 2015, 2016, 2017, 2018, 2019*). After China, the European Union is the world's largest producer of table eggs (*Augère Granier, 2019*). Among the largest producers in Europe are the Russian Federation, Ukraine, France, Spain, Germany, the United Kingdom, Italy, the Netherlands and Poland, and of the surrounding countries Romania, Hungary and Bulgaria. Serbia is on the first place among the countries of the Western Balkans in terms of egg production, and in 2019 it was 17th in Europe (*FAOSTAT, 2017, 2018, 2019*). In Serbia, egg production in 2019 amounted to 7,600 tons, or 1,775,000 pieces, according to the Statistical Yearbook (*Statistical Office of the Republic of Serbia, 2020*). Egg consumption per capita on an annual basis,

according to IEC (2018) data, is the highest in Mexico (368) and Japan (337), followed by China (255), Spain (273) and Denmark (248). The average consumption of eggs in EU countries in 2018 was 210, and in the USA 287.5 eggs per capita (IEC, 2018; Shahbandeh, 2021).

Egg consumption in Serbia in 2007 was about 8 kg, or 135 eggs, while in the same year in Europe it was 12 kg or 200 eggs per capita, and in the United States 14 kg or 240 eggs (Milošević and Perić, 2011). In Serbia, egg consumption recorded a slight increase in 2013 (Zlatanović, 2015) and amounted to 222 eggs per household member, which is more compared to countries in the region, in Macedonia 168, in Croatia 153 and in Slovenia 76 eggs. According to the Household Budget Survey for the period from 2015 to 2019, the average consumption of eggs per capita in Serbia was 219.4 (Statistical Office of the Republic of Serbia, 2015, 2016, 2017, 2018, 2019). The reason for the still lower consumption of eggs in Serbia compared to some developed countries may be the continued presence of cholesterol phobia, given that according to a survey by Tolimir *et al.* (2016), 18.66 % of consumers cite fear of high cholesterol as an egg deficiency, which opened the question, i.e. the need for better information of consumers. In the coming period, poultry meat and eggs are recognized as the leading foods in the diet, since their production is up to 50% cheaper compared to the same amount of protein from the meat of other domestic animals, which makes them available to the population, regardless of material status (Milošević and Perić, 2011).

The table egg production sector, in the last two decades, is facing various challenges due to changes in legislation and numerous regulations in the field of food safety, ecology, poultry welfare, sustainability of production, as well as socio-economic changes. Major changes in this sector have been brought about by the EU Directive 1999/74/EC, which has banned, starting from 2012, the rearing of laying hens in classic conventional cages. This complex process is influenced by a large number of factors and takes place differently in individual EU countries. Serbia has a legal framework harmonized with EU regulations, and the process of transition from conventional cage systems for raising chickens to permitted systems is slow. According to the research of Tolimir *et al.* (2020), in the transition period (2014-2020), about 85% of producers failed to harmonize their production with regulations, which led to the extension of the deadline.

Increased consideration of consumer attitudes has led to an increase in research, mainly surveys and studies focused on consumer preferences of table eggs (Guyonnet, 2012; Mizrak *et al.*, 2012, Kralik *et al.*, 2014, Tolimir *et al.*, 2016, Zelić *et al.*, 2016). Also, changes in the egg production sector, conditioned by legislation, have opened up a number of questions regarding consumer attitudes about animal welfare (Verbeke, 2009; European Commission, 2007; de Roest *et*

al., 2010; *Hansstein*, 2011). Research indicates that European consumers generally have similar attitudes towards domestic animal welfare and agree that welfare needs to be raised to a higher level (*Blokhuis et al.*, 2008; *Alonso et al.*, 2020). However, there are differences between individual countries (*European Commission*, 2005; *Martelli*, 2009) which are a consequence of different levels of knowledge and awareness of consumers about animal welfare, i.e. about farming systems and different willingness to allocate more funds for purchasing products obtained by welfare principles. The contribution to raising awareness of the importance of food production according to the welfare principles and the impact of animal welfare on the quality of animal products could be achieved through better information and education of consumers (*Autio et al.*, 2017).

The aim of this paper is to point out the very important role of eggs in the diet and to contribute to overcoming the problem of cholestephobia, to show the situation in the sector of egg production in Serbia and EU countries, caused by changes in legislation related to poultry welfare, including consumer preferences and the situation on the market in Serbia.

The importance of eggs as food stuff

The human nutrition has always been important - Hippocrates, a Greek philosopher and physician, who is considered the founder of medicine as a science, said: "Let food be your medicine, and medicine be your food". Eggs, as a food stuff, have a wide application, due to their great nutritional value and numerous possibilities of use in the preparation of various salty and sweet dishes. In addition to differences among countries in the consumption of eggs as food stuff (*Magdelaine*, 2011), there are also differences in the way of preparation, i.e. consumption of eggs, which are most often conditioned by the tradition of diet and habits in preparing eggs. *Tolimir et al.* (2016) indicate a certain similarity between Serbia and the surrounding countries, i.e. Croatia, and differences in relation to Turkey. In order to fully understand the importance of eggs as a food stuff in the diet, which could affect the increase in egg consumption in Serbia, which is lower compared to some developed countries, it is necessary to educate consumers in several different areas, i.e. the nutritional value of eggs, the role eggs within a balanced, healthy diet, the importance of properly combining eggs with other foods, as well as the impact of heat treatment on nutritive value (*Farjami et al.*, 2021).

The egg contains almost all the nutrients needed by man and as such is considered important in the diet, during all life stages. It has the same ratio of egg yolks, egg whites and shells, as the basic parts, regardless of the breed, age of the hens and nutrition (*Milošević and Perić*, 2011). The egg has a high protein content,

as the basic building blocks necessary for the growth and regeneration of all living cells in the body (*Pal and Molnar, 2021*). The egg proteins are among the most biologically valuable because they are easily digestible and therefore serve as a standard for measuring the quality of protein in food (*Sakanaka et al., 2000*). The amino acid composition of egg proteins is favourable, i.e. they contain all the essential amino acids necessary for the organism (*Lesnierowski and Stangierski, 2018; Wang et al., 2018*). In addition to being an excellent source of first-class proteins, eggs contain significant amounts of vitamin A, D, E, K and B complexes, especially riboflavin, biotin, vitamin B12, folic and pantothenic acid, minerals, especially iron, zinc, calcium, phosphorus and sodium (*Anton et al., 2005; López-Fandino, 2007*), also bioactive and antimicrobial compounds, such as phospholipids, immunoglobulin, fosvitin, lysozyme and cystatin (*Lesnierowski and Stangierski, 2018*). Also, eggs are foods of moderate caloric value (about 150 kcal/100 g) and their regular use is a healthy eating habit, because they provide satiety and can contribute to weight loss (*Bertechini and Mazzuco, 2013; Miranda et al., 2015*).

The role of eggs, as high-value food stuff, in maintaining good health is indicated by a large number of researches. Eggs are one of the best sources of lutein, a pigment that enables better vision, and is especially important for slowing down some degenerative processes that can affect the eyes, i.e. reduce the risk of cataracts and macular degeneration (*Goodrow et al., 2006*). In terms of vision, eggs are also rich in vitamin A, which, according to the World Health Organization (WHO), is a public health problem, especially in developing countries, where it is the most common cause of blindness in children (*Mendonça Jr et al., 2002; WHO, 2009*). Also, egg is an excellent source of choline, one egg contains more than 100 mg of this very important nutrient used to build cell membranes and plays a role in the production of signalling molecules in the brain (*Penry and Manore, 2008; Caudill, 2010*). Eggs contain LDL or "bad" cholesterol, but also HDL or "good" cholesterol, which provides strong protection against LDL cholesterol in the arteries, i.e. from oxidative damage induced by free radicals (*Kosmas et al., 2018*). According to one study, consuming 2 eggs a day for 6 weeks resulted in a 10% increase in HDL levels (*Scänohr et al., 1994*). Although recent research indicates the unfounded fear of cholesterol, and opinion that eggs can be a key element of a healthy diet, a number of consumers still view eggs with suspicion (*Tolimir et al. 2016; Ahnen and Slavin, 2019*). It is crucial to inform consumers that according to research, dietary cholesterol and blood cholesterol are only weakly related (*McNamara, 2000*) and that based on these studies, recommendations are given by official health organizations to remove restrictions on egg consumption in healthy people, except in people with diabetes (*Carson et al., 2020; Qureshi et al., 2007*;

Guo et al., 2018). According to *Lopez-Sobaler and Gonzalez-Rodriguez (2015)*, omitting eggs in the diet would be unnecessary and undesirable.

So called „enriched eggs“, which belong to functional foods, can have particularly positive impact on human health, and even in the treatment of some diseases, (*Perić et al., 2011*), and which, in addition to their basic nutritional function, have some additional substance or some substances that are normally contained in the egg are increased to levels that can have a positive effect on health. The goal of increasing the levels of omega 3 fatty acids in eggs is to meet the daily human requirements for this ingredient by eating one egg (*Grashorn, 2005*). Studies indicate that the consumption of omega - 3 eggs can lead to improved lipid status, i.e. lowering levels of triglycerides, total and LDL cholesterol, and increasing HDL cholesterol levels in the blood, and thus to protection against atherosclerosis and lower blood pressure (*Yannakopoulos et al., 2005; Bovet et al., 2007; Shakoob et al., 2020*). Selenium-enriched eggs, which also belong to functional foods, are also important in the diet (*Perić et al., 2009, Tolimir et al., 2012*), especially bearing in mind that there is a selenium deficiency in the soil. The addition of selenium must be carefully dosed, because this element in higher concentrations is harmful to human health (*Surai, 2002*), and when enriching eggs, it is recommended to use organic forms of selenium, which are better absorbed (*Tolimir et al., 2012*). It is recommended that eggs enriched with selenium contain no more than half of the recommended human daily needs, i.e. 35 µg Se (*Yaroshenko et al., 2004*), which according to *Fisinin et al. (2008)* can be achieved by introducing 0.3 to 0.5 ppm of organically bound selenium into feed for layer hens.

Situation in the production of table eggs and expected changes

According to FAO data, egg production, worldwide, is growing steadily and in 2019 amounted to over 83 million tons of eggs (*FAOSTAT, 2019*). In recent decades, the egg production sector has faced a number of challenges, among which changes in legislation related to poultry welfare, food safety and the environment protection have a major impact, to which the growing demands of consumers can be added. In the European Union, the implementation of legislation, i.e. EU Directive 1999/74/EC which has banned the rearing of laying hens in classic conventional cages in all EU countries since 2012, has varied in individual countries, under the direct influence or consequence of interaction between producers, retailers, consumers, lawmakers, the media, and public pressure in general (*Appleby, 2003; Frewer et al., 2005*). By looking into the structure of production, and depending on the rearing system, it can be stated that out of the

total 365 million laying hens in the European Union in 2019, the largest share of poultry is still in the cage system, i.e. in "enriched" cages about 49.50%, approx. 32.5% in the floor system, 11.8% in the so-called "Free range" or free keeping system and the least is in the organic production system, about 6.20% (*European Commission, 2020*), with a tendency to increase the percentage of individuals from "non-caged" systems (*Committee for the Common Organization of the Agricultural Markets, 2017*). Enriched cages are still dominant in EU Member States from Eastern, Central and Southern Europe, while they are very underrepresented in Northern and Western European countries (*Kollenda et al., 2020*).

The abolition of cage systems proceeded with different dynamics in the EU countries. Some countries, such as Belgium, which had a deadline of 2012, have been slow to adopt alternative chicken farming systems (*Tuytens et al., 2011*), while some members have decided to go beyond EU standards by introducing stricter national or regional laws (*Van Horne and Bondt, 2017*). Strategies for waiting and producer requests for extensions, in some countries, have proven to be a poorer choice in relation to acceptance and quicker adaptation to new conditions, and *Rodić et al. (2014)* indicate that it is not realistic that the rules for Serbia could be different, if we take into account how the process took place in EU countries and considering the persistence of decision makers.

In Serbia, adaptation to European standards (*Directive 1999/74/EC*) is related to the Law on Animal Welfare (*Official Gazette of the Republic of Serbia No. 41/2009*) and the Rulebook on rearing conditions (*Official Gazette of the Republic of Serbia No. 6/10; Official Gazette of the Republic Of Serbia No. 57/2014-27*). The process of abandoning the conventional battery system and switching to permitted systems is slow, with extensions of deadlines on several occasions, and given that the changes are major, with high costs, they can be considered a danger to the egg production sector in Serbia. In the last two decades, it can be stated that the number of laying hens has decreased, which according to the data from 2019 is lower by 11.11% compared to the 2008-2017 average. The negative trend can also be related to the inability of producers to meet the new high requirements of regulations in Serbia, harmonized with EU regulations (*Krnjaić, 2019*). According to the results of *Tolimir et al. (2020)*, until the fall of 2020, when the previous deadline for abandoning of production in conventional cages was, only 16.3% of producers switched to permitted systems, of which 2% in full and 14.3% in part. Similar results are part of a study conducted in 2019, according to which it is estimated that only about 15% of conventional cage equipment has been replaced in Serbia (*Krnjaić, 2019*). This situation resulted in a new extension of the deadline for abandoning of the conventional cage system, until the end of 2023, at the request of the producer, i.e. the Group for the production of poultry meat and eggs.

In the coming years, major changes are expected in the egg production sector in Serbia, with a far-reaching impact on the primary production of table eggs, which will be reflected in the market. The threat to the self-sufficiency of production, i.e. the danger of a deficit of table eggs in Serbia may be, on the one hand due to the reduction in the number of hens, caused by the transition to systems complying with poultry welfare, and on the other hand due to producers forced to leave production, mainly due to high initial cost for the procurement of equipment, which according to the research of *Tolimir et al. (2020)* accounts for about 20%. Knowledge of the attitudes of manufacturers is important for monitoring and directing the entire process of implementing regulations. According to the research in 2020 (*Tolimir et al., 2020*), all surveyed producers in Serbia (100%) have enriched cages as a choice when switching from conventional cages, with 65.11% of them believing that switching to enriched cages will not affect the welfare of layer hens. The same authors, during the survey, got the impression that producers would not switch from the classic cage system, if they were not forced due to legal regulations, which was also established by *Stadig et al. (2016)*, who state that only 8.2% of the surveyed egg producers would switch from a battery system to one of the alternative systems of laying laying hens if it was not required by law. *Tuytens (2011)* indicates that the problem of non-acceptance was more pronounced in older farmers. In Serbia, the age structure of surveyed producers, based on surveys in 2020, is as follows: 50% are aged 56 to 65, 26.09% are 46 to 55, 15.22% are 36 to 45 and 8.7% of the youngest category, with about 50% of producers stating that they have a successor in their business (*Tolimir et al., 2020*).

One of the key issues in the implementation of regulations, i.e. for further production of table eggs in Serbia, is decision of the producer on the rearing system, from the group of permitted systems - enriched cages, alternative systems, free range and organic production. The choice of producers in Serbia may also be influenced by the outcome of a civic initiative launched in Europe, called "End the Cage Age", which calls for the abolition of cage systems for keeping laying hens, for which over a million signatures have been collected, presented to the European Parliament in 2019 and discussed in the European Parliament in 2021 (*European Parliament, 2021*). According to the research of *Tolimir et al. (2020)*, 61.7% of producers in Serbia were aware of this initiative, while the awareness of producers with smaller farm capacities was lower. Also, for the choice of rearing system, the experience of producers who have already implemented legislation is important, based on which it can be determined whether legally imposed changes in the rearing environment really result in improving the welfare of laying hens in practice (*Tuytens et al., 2011*).

It is important to consider the research results to make a decision on the choice of rearing system, and according to the available literature, some scientists

are not convinced that the welfare of laying hens is better in alternative systems compared to battery/tier system (Duncan, 2001), but the fact is that both systems have advantages and disadvantages. The results of the research indicate that laying hens in non-cage systems have a greater possibility to show their natural behavior, but also increased risk of injuries, parasites, diseases, predators in relation to cage systems (Laing, 1988). Since the adoption of regulations in Serbia, scientists have repeatedly (Pavlovski et al., 2011; Rakonjac, 2016) pointed out the importance and need, for more efficient implementation of expected changes in the egg production sector, to focus attention to scientific research and application of new, alternative poultry farming systems, for laying hens and poultry welfare. Đoković et al. (2018) indicate that in Serbia, for the process of implementing legislation related to the transition from conventional cages to permitted systems of hen rearing, a synergistic action of the state through financial support programs would be necessary, on the one hand and scientific institutions on the other hand, through scientific-professional teams in several fields, including investment design, development of solutions for the construction of new and reconstruction of existing farms and monitoring of production performance indicators from several aspects. In Serbia, the government, as one of the measures to support producers, for the transition of production to permitted systems, has enabled the use of IPARD funds, since 2020 (IPARD program, Serbia, 2021).

Consumer preferences and market conditions

Studies with consumers of table eggs are mainly surveys/questionnaires and refer to consumer preferences regarding certain characteristics of egg quality, as well as factors that influence consumer choice when buying (Kralik et al., 2014; Mizrak et al., 2012; Tolimir et al., 2016; Zelić et al., 2016). The research results indicate that consumers are more and more demanding, with specific requirements in terms of production of eggs with special properties (functional food), welfare of domestic animals, food safety, etc. Research on consumer preferences indicates that in relation to the characteristics of egg quality, attention is primarily on egg weight, shell colour and yolk colour, egg white quality and the absence of meat and blood stains (Tolimir et al., 2016), contrary to producers who primarily focus on egg mass and shell quality, as prerequisites for good prices and placement. According to the study by Tolimir et al. (2017), freshness of eggs is very important to consumers in Serbia (73.28%), they prefer to buy larger eggs (classes SS, S and A are the choice for 69.82%) and prefer eggs of extremely yellow colour (62.76%). In the previous period, consumers in Serbia preferred eggs of a more intense yellow colour, i.e. (56.5%) prefer the yellow colour of the yolk (up to 9 Roche units), and 27% prefer a dark yellow color (more than 9 Roche units) (Pavlovski

and Mašić, 1994). Also, in most EU countries, a more intense (darker) yellow colour is valued (Parrott *et al.*, 2013; Hernandez *et al.*, 2005). Consumer interest in egg safety and quality is on the rise and the literature indicates that in a number of European countries (France, Germany, Italy, UK, Spain, Poland and Greece), consumer safety and egg freshness are the most important factors, and from the point of sensory traits of egg quality, strong shell, egg white consistency and yolk colour are characteristics that are especially appreciated by consumers (Hernandez *et al.*, 2005; Hernandez, 2006).

Examining consumer attitudes about the production system in obtaining products of animal origin is of great importance because together with sensory characteristics, impact on human health and ease of preparation, they are among the four most relevant criteria in consumer choice for products (Grunert *et al.*, 2000). Stadig *et al.* (2016) points out the significant influence of consumers attitudes when producers are deciding on rearing systems. Analysing the results of consumer surveys on the welfare of laying hens (Bejaei, 2009; Vecchio and Annunziata, 2011; Kehlbacher *et al.*, 2012; Heng *et al.*, 2013; Mulder and Zomer, 2017), differences between respondents can be found depending on gender, education, regions in which they live, i.e. whether it is an urban and rural environment, and other socio-demographic differences. According to the *European Commission* (2005), there are differences between countries and in the north of Europe greater importance is attached to welfare compared to the countries of the south and the newly acceded EU member states, which may be due to differences in levels of knowledge and willingness to allocate more resources to products obtained according to welfare principles. In Serbia, there are, but few studies on the attitudes of consumers of table eggs on the welfare of poultry/laying hens (Rodić *et al.* 2010; Stojanović *et al.*, 2014, Tolimir *et al.*, 2019a). Comparing data with research in earlier periods in Serbia (Pavlovski *et al.*, 2011), there is a decrease in the share of consumers for whom the cage system is acceptable in egg production, from 70.6% to 35.6% in the period from 1981 to 2001, which is in favour of changing consumer attitudes. The attitude of consumers of table eggs in Serbia differed depending on the influence of gender, education, age and number of children in the family (Stojanović *et al.*, 2014; Tolimir *et al.*, 2019a).

Welfare and rearing systems are closely related, and according to Tactacan *et al.* (2009) one of the factors that led to the development of improved production systems is the concern for welfare and the desire for laying hens to show their natural behaviour. According to the research of Tolimir *et al.* (2019a), the same group of respondents attach greater importance to the welfare of domestic animals (50.77%) compared to the rearing system (39.49%), which raises the question of whether consumers associate the rearing system with the welfare of laying hens and understand their connection. Also, some authors who have examined consumer

attitudes about welfare point to a lack of consumer knowledge about welfare standards and its relationship to product quality (Nocella et al., 2010). Autio et al. (2017) also point to the need for consumers to be better informed and educated about the importance of welfare of domestic animals, which would also include rearing systems. Also, Binnekamp and Ingenbleek (2006) point to the lack of consumers' full understanding of the concept of animal welfare and the lack of information on the quality of these products, and recognize this as market barriers for products produced according to welfare standards.

One of the issues related to the production of food of animal origin in accordance with welfare standards is the willingness of consumers to allocate more funds for products obtained with respect to welfare. According to a large number of studies, consumers have expressed this readiness (Nocella et al., 2010; Heng et al., 2013; Stojanović et al. 2014), which is of great importance given that the application of welfare standards results in increased production costs, also, as stated by Rodić et al. (2010), eggs from non-caged systems can be competitive only if there is a willingness of consumers to pay a higher price for eggs produced in this way. The publication *European Commission (2005)* it is stated that 81% of consumers in the EU express their readiness to allocate more funds for eggs produced according to the principles of welfare, for a price higher than 5 to 10%. According to the results of research in Serbia, Pavlovski et al. (2011) indicate that the share of consumers who are willing to pay a higher price for eggs from non-battery systems increased from 46 to 71.5%, and Rodić et al. (2010) state that the willingness of consumers to pay more for eggs from non-cage systems exists, but it is up to 20% more money. According to the research by Tolimir et al. (2019a), the share of consumers in Serbia who expressed readiness to allocate more funds for eggs produced with respect to welfare compared to eggs from conventional production was 78.53%, and differed between regions, from 69.9% in Southern and Eastern Serbia up to 86.76% in the region of Western Serbia and Šumadija. It is also important to what extent the consumers are willing to pay more and according to the research of Tolimir et al. (2019b) in Serbia, 71.2% expressed readiness to allocate more funds for eggs from organic production, however 58.8% consumers would pay up to 30% higher price, and only 12.4% of them price higher by more than 30%. *The European Commission (2009)* states that although there is a willingness of consumers to pay a higher price, they do not always implement it in practice. In the research of Tolimir et al. (2019a), producers were surveyed about the readiness of consumers to allocate more money for eggs from permitted systems, who, when asked: "How much are consumers willing to pay a higher price for eggs from non-battery systems", expressed skepticism and stated that for consumers in Serbia, the most important thing is the lowest possible price of eggs, except for a very small number of consumers, mainly in the city of Belgrade. The

authors of this study noted the differences between producers and consumers in terms of consumer willingness to pay more for eggs from alternative systems and concluded that in the coming period, attention should be paid to their better communication and consumer education.

For the table egg production sector, it is important to know the consumer's commitment to purchase, i.e. their choice of place of purchase, as well as the choice of egg type depending on the producer and production system - conventional production, alternative systems in accordance with animal welfare or functional food programs. The supply of table eggs in Serbia, based on market insights by the authors, is in line with current production, in terms of representation of individual systems, i.e. mostly present are eggs from conventional cage systems, and eggs from free systems, from free range systems, as well as organic, and eggs from the functional food program, these are eggs enriched with omega acids and selenium. Also, it can be noticed that the supply of the market is different, with the supply from one to five producers, within one market, with eggs being sold in special sections on markets and specialized shops with organic products. In European countries, supermarket supply is given a lot of attention, and market chains are considered factors that drive the product market, which results in the effort provide for consumers a larger range of specific, targeted products, such as organic products (*Rader, 2018*). The market for table eggs in Serbia is very important, as indicated by the research of *Tolimir et al. (2017)*, according to which in the Belgrade market, the majority of respondents (39.62%) stated that they buy eggs in supermarkets/hypermarkets, similar to neighbouring countries, where supermarkets are locations of purchase of eggs for 38.78% of respondents (*Kralik et al., 2014*). Markets should be observed through the impact on egg quality, through the aspect of conditions in the facility and the time from supply to sale of eggs, given that the initial quality of eggs, at the time of laying is the highest and subsequently the internal quality of eggs begins to decline depending on further manipulation (*Jin et al., 2011*). Examination of egg quality in retail establishments is research subject of a number of authors, mainly with the aim of determining egg quality characteristics, i.e. egg age, weight, egg white height, Haugh units, yolk colour, number of cracked eggs (*Bell et al., 2001; Burley and Johnson, 2013*). Studies also indicate the dependence of egg quality on producers (*Škrbić et al., 2006*), and according to the results of market research in the City of Belgrade, between supermarkets/hypermarkets there is a difference in supply and quality of eggs (*Tolimir et al., 2017*), number brands/producers within the market varied from 1 to 5, and the analysis of eggs of all producers, aged up to 1 to 10 days, according to the values of egg quality parameters, a satisfactory quality of eggs was recorded.

Conclusion

A balanced diet is the key to good health, within which eggs as a high-value biological food are of great importance for all age groups. If the eggs are enriched, by adding certain nutrients, vitamins, antioxidants and omega 3 acids to food for laying hens, which are converted into eggs, they are considered to be functional foods, of special importance for maintaining health or treating certain diseases.

The increase in egg consumption in Serbia should be paid attention to, given that it is significantly lower compared to some developed countries, and in that regard, educational and better information measures should be taken at the level of the entire community, through a systematic approach. Special emphasis should be placed on eliminating the unfounded fear of an increase in blood cholesterol due to egg consumption, given that some consumers in Serbia still have misconceptions on this issue.

The egg production sector in Serbia is under strong pressure aimed at harmonizing production with international regulations, i.e. the implementation of welfare laws, which will cause major changes in the coming years, often considered as a potential threat to this sector. At the same time, consumers are increasingly demanding in terms of welfare, rearing systems, egg quality, food safety, but there is a need to better inform them, as well as increase their awareness of the importance of welfare and the relationship between welfare and product quality.

The willingness of more than three quarters of surveyed consumers in Serbia to pay more money for eggs produced in systems that are based on the principle of welfare of poultry, can be a guideline for producers who are obliged to establish a system of rearing standards according to welfare standards, as well as other actors in market chains in Serbia. However, the conflicting position of producers in Serbia regarding the expressed readiness of consumers to actually do so imposes the need to establish better communication between them.

Značaj jaja u ishrani, preference potrošača, stanje u proizvodnji konzumnih jaja i na tržištu u Srbiji

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Rezime

Ishrana je veoma važna za održavanje dobrog zdravlja ljudi u svim životnim fazama i kao takva ne bi trebala da bude predmet interesovanja samo nutricionista, već i svakog pojedinca. Na odabir namirnica u ishrani značajno utiču navike, a u poslednjim decenijama zapaža se da potrošači sve više brinu i o načinu na koji je hrana proizvedena, o njoj bezbednosti i neškodljivosti. Iako se jaja, kao namirnica, odlikuju odličnim nutritivnim sastavom decenijama su imala lošu reputaciju zbog visokog sadržaja holesterola koji se smatrao lošim, zbog čega su ih mnogi potrošači izbegavali ili su jeli samo belance. Rešavanju problema holesterofobije doprineli su rezultati istraživanja koja ukazuju da holesterol u hrani kao što su jaja ima beznačajan uticaj na holesterol u krvi, tako da su i zvanične organizacije za ishranu, oko 2000. godine, dale preporuku za ukidanje ograničenja u konzumiranju jaja. Potrošnja jaja i način pripreme u velikoj meri variraju među različitim zemljama, što se može povezati sa tradicijom ishrane i preferencama potrošača. Tokom poslednjih decenija, stavovi potrošača dobijaju na značaju i proučavaju se u odnosu na osobine kvaliteta jaja, prema sistemima proizvodnje, dobrobiti kokoši i dr. Celovito sagledavanje percepcije potrošača, njihovih navika i shvatanja o ulozi jaja u ishrani zahteva sistemski pristup, na nivu celokupne društvene zajednice, uključujući i edukaciju, posebno važnu za mlađe populacije. Cilj ovog rada je da ukaže na značaj jaja u ishrani, da prikaže stanje u sektoru proizvodnje konzumnih jaja u Srbiji, sa osvrtom na zemlje EU, uključujući i očekivane promene uslovljene zakonskom regulativom, koje mogu imati dalekosežne posledice po ovaj sektor, sa osvrtom na preference potrošača i situaciji na tržištu.

Key words: ishrana, jaja, dobrobit, sistemi gajenja, preference potrošača

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References

- AHNEN R. T., SLAVIN J. L. (2019): Eggs as part of a healthy eating pattern. In: Eggs as Functional Foods and Nutraceuticals for Human Health. Ed Ju W. The Royal Society of Chemistry, Croydon, UK, 1-21.
- ALONSO M. E., GONZÁLEZ-MONTAÑA J. R., LOMILLOS J. M. (2020): Consumers' Concerns and Perceptions of Farm Animal Welfare. *Animals* 10, 3, 385.
- ANTON M., NAU F., NYS Y. (2005): Bioactive egg components and their potential uses. Proceedings of the XIth European Symposium on the Quality of Eggs and Egg Products, May 23-26, Doorwerth, Netherlands, 237-244.
- APPLEBY M. C. (2003): The European Union ban on conventional cages for laying hens: History and prospects. *Journal of Applied Animal Welfare Science* 6, 2, 103-121.
- AUGÈRE-GRANIER M.L. (2019): The EU poultry meat and egg sector - Main features, challenges and prospects (In depth analysis), PE 644.195, EPRS - European Parliamentary Research Service, European Parliament, retrieved from [https://www.europarl.europa.eu/RegData/etudes/IDAN/2019/644195/EPRS_IDA\(2019\)644195_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/IDAN/2019/644195/EPRS_IDA(2019)644195_EN.pdf), on 20.06.2021
- AUTIO M., AUTIO A., KUISMIN A., RAMSINGH B., KYLKILAHTI E., VALROS A. (2017): Bringing Farm Animal Welfare to the Consumer's Plate – The Quest for Food Business to Enhance Transparency, Labelling and Consumer Education. In: *The Business of Farm Animal Welfare*. Eds Amos N. and Sullivan R. Greenleaf Publishing, Taylor & Francis / Routledge, 120-136.
- BEJAEI (2009): Attitudes and preferences of consumers/purchasers toward different types of table eggs. Master of Science Thesis, University of British Columbia.
- BELL D. D., PATTERSON P. H., KOELKEBECK K. W., ANDERSON K. E., DARRE M. J., CAREY J. B., KUNEY D. R., ZEIDLER G. (2001): Egg marketing in national supermarkets: Egg quality—Part 1. *Poultry Science* 80, 383-389.
- BERTECHINI A. G., MAZZUCO H. (2013): The table egg: a review. *Ciência e Agrotecnologia*, 37, 2, 115-122.
- BINNEKAMP M. H. A., INGENBLEEK P. T. M. (2006): Market barriers for welfare product innovations. *NJAS - Wageningen Journal of Life Sciences* 54, 2, 169-178.
- BLOKHUIS H. J., KEELING L. J., GAVINELLI A., SERRATOSA J. (2008): Animal welfare's impact on the food chain. *Trends in Food Science & Technology*, 19, 1, S79-S87.
- BOVET P., FAEH D., MADELEINE G., VISWANATHAN B., PACCAUD F. (2007): Decrease in blood triglycerides associated with the consumption of eggs of

hens fed with food supplemented with fish oil. *Nutrition, Metabolism and Cardiovascular Diseases* 17, 4, 280-287.

BURLEY H. K., JOHNSON C. L. (2013): Market survey of quality and freshness of eggs produced under an enhanced hen nutrition and egg production program. *The Journal of Applied Poultry Research* 22, 929-933.

CARSON J. A. S., LICHTENSTEIN A. H., ANDERSON C. A. M., LAWRENCE J. A., PENNY M. K. E., MEYER K. A., PETERSEN K., POLONSKY T., VAN HORN L. (2020): Dietary cholesterol and cardiovascular risk; A science advisory from the American Heart Association. *Circulation*, 141, e39-e53.

CAUDILL M. A. (2010): Pre- and postnatal health: Evidence of increased choline needs. *Journal of the American Dietetic Association* 110, 1198-1206.

CLAYTON Z.S., FUSCO E., KERN M. (2017): Egg Consumption and Heart Health: A Review. *Nutrition*, 37, 79-85.

COMMITTEE FOR THE COMMON ORGANISATION OF THE AGRICULTURAL MARKETS 2017. (Ed.): EU Market Situation for Eggs. Brussels, August 27th, retrieved from: https://circabc.europa.eu/sd/a/18f7766e-e9a9-46a4-bbec-94d4c181183f/23.03.2017_eggs_Europa.pdf, on 25.05.2021.

DE ROEST K., FERRARI P., MONTANARI C., BOKMA M., HEUTINCK L., VAN REENEN K., et al. (2010): Report on consumers' attitudes towards animal welfare standards based on the main findings of EU and national research projects. Resource document, retrieved from https://www.researchgate.net/publication/314153758_Report_on_consumers'_attitudes_towards_animal_welfare_standards_based_on_the_main_findings_of_EU_and_national_research_projects/citations, on 16.07.2021.

DIRECTIVE 1999/74/EC of 19 July 1999 laying down minimum standards for the protection of laying hens. European Union, retrieved from <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31999L0074&from=EN>, on 05.07.2021.

ĐOKOVIĆ J., MUNČAN M., PAUNOVIĆ T. (2018): Proizvodnja konzumnih jaja u Srbiji – sadašnje stanje, aktuelni problemi i mogućnosti unapređenja. *Agroekonomika*, 47, 81, 49-57.

DUNCAN I. J. H. (2001): The pros and cons of cages. *World's Poultry Science Journal* 57, 4, 381-390.

EUROPEAN COMMISSION (2005): Attitudes of Consumers towards the Welfare of Farmed Animals. *Special Eurobarometer*, 229, 1-138.

EUROPEAN COMMISSION (2007): Attitudes of EU citizens towards animal welfare. *Special Eurobarometer* 270, Wave 66.1.TNS Opinion and Social.

EUROPEAN COMMISSION (2009): Feasibility study on animal welfare labeling and establishing a Community Reference Centre for Animal Protection and Welfare, DG SANCO, Brussels.

- EUROPEAN COMMISSION (2020): DG Agriculture and Rural Development, EU Market Situation for Eggs, retrieved from: https://ec.europa.eu/info/food-farming-fisheries/animals-and-animal-products/animal-products/eggs_en, on 17.07.2021
- EUROPEAN PARLIAMENT (2021): European Citizens' Initiative "End the cage age", retrieved from https://www.europarl.europa.eu/doceo/document/TA-9-2021-0295_EN.html, on 10.07.2021.
- FAOSTAT (2015, 2016, 2017, 2018, 2019): Crops and livestock products, retrieved from <http://www.fao.org/faostat/en/#data/QCL>, on 08.05.2021.
- FAOSTAT (2017, 2018, 2019): Crops and livestock products, retrieved from <http://www.fao.org/faostat/en/#data/QCL>, on 03.06.2021.
- FARJAMI T., BABAEI J., NAU F., DUPONT D., MADADLOU A. (2021): Effects of thermal, non-thermal and emulsification processes on the gastrointestinal digestibility of egg white proteins, *Trends in Food Science & Technology* 107, 45-56.
- FISININ V. I., PAPAZYAN T. T. SURAI P.F. (2008): Producing specialist poultry products to meet human nutrition requirements: selenium enriched eggs. *World's Poultry Science Journal* 64, 85-98.
- FREWER L. J., KOLE A., VAN DE KROON S. M. A., DE LAUWERE C. (2005): Consumer Attitudes Towards the Development of Animal-Friendly Husbandry Systems. *Journal of Agricultural and Environmental Ethics* 18, 345-367.
- GOODROW E. F., WILSON T. A., HOUDE S. C., VISHWANATHAN R., SCOLLIN P. A., HANDELMAN G., NICOLOSI R. J. (2006): Consumption of one egg per day increases serum lutein and zeaxanthin concentrations in older adults without altering serum lipid and lipoprotein cholesterol concentrations. *The Journal of Nutrition* 136, 2519–2524.
- GRASHORN M.A. (2005): Enrichment of eggs and poultry meat with biologically active substances by feed modifications and effects on the final quality of the product. *Polish Journal of Food and Nutritional Science* 14/55, 1, 15-20.
- GRAY J., GRIFFIN B. (2009): Eggs and dietary cholesterol – dispelling the myth. *Nutrition Bulletin*, 34, 66-70.
- GRUNERT K.G., BECH-LARSEN T., BREDAL L. (2000): Three issues in consumer quality perception and acceptance of dairy products. *International Dairy Journal* 10, 575-584.
- GUO J., HOBBS D. A., COCKCROFT J. R., ELWOOD P. C., PICKERING J. E., LOVEGROVE J. A., GIVENS D. I. (2018): Association between egg consumption and cardiovascular disease events, diabetes and all-cause mortality. *European Journal of Nutrition* 57, 2943–2952.
- GUYONNET V. (2012): Eggs and egg products: Consumers' attitudes, perceptions and behaviours. Proceedings of the XXIV World's Poultry Congress, August 5 –

9, Salvador, Brazil, retrieved from http://www.facta.org.br/wpc2012-cd/pdfs/plenary/Vincent_Guyonnet.pdf, on 01.05.2021.

HANSSTEIN F. (2011): Profiling the egg consumer: attitudes, perceptions and behaviours. In: Woodhead Publishing Series in Food Science, Technology and Nutrition, Improving the Safety and Quality of Eggs and Egg Products. Eds Y. Nys, M. Bain and F. Van Immerseel, Woodhead Publishing, Cambridge, UK, 39-61.

HENG Y., PETERSON H. H., LI X. (2013): Consumer Attitudes toward Farm-Animal Welfare: The Case of Laying Hens. *Journal of Agricultural and Resource Economics* 38, 418–434.

HERNANDEZ H. M., BEARDSWORTH P., WEBER G. (2005): Egg quality – meeting consumer expectations. *International Poultry Production* 13, 3, 20-23.

HERNANDEZ J. M. (2006). European consumer perspectives on egg quality. *Proceedings of the 18th Australian Poultry Science Symposium*, February 20-22, Sydney, 261-268.

INTERNATIONAL EGG COMMISSION – IEC (2018). Annual Review, retrieved from <https://www.internationalegg.com/resource/global-egg-production-continues-to-grow/> on 01.07.2021.

IPARD PROGRAMME, SERBIA (2021): Measure 1 - Investments in physical assets of agricultural holdings, retrieved from <https://ipard.co.rs/>, on 23.06.2021.

JIN Y. H., LEE K. T., LEE W. I., HAN Y. K. (2011): Effects of storage temperature and time on the quality of eggs from laying hens at peak production. *Asian-Australasian Journal of Animal Sciences* 24, 2, 279-284.

KEHLBACHER A., BENNETT R., BALCOMBE K. (2012): Measuring the consumer benefits of improving farm animal welfare to inform welfare labelling. *Food Policy* 37, 627–633

KOLLEND A., BALDOCK D., HILLER N., LORANT A. (2020): Transitioning towards cage-free farming in the EU: Assessment of environmental and socio-economic impacts of increased animal welfare standards. Policy report by the Institute for European Environmental Policy, Brussels & London.

KOSMAS C. E., MARTINEZ I., SOURLAS A., BOUZA K. V., CAMPOS F. N., TORRES V., MONTAN P. D., GUZMAN E. (2018): High-density lipoprotein (HDL) functionality and its relevance to atherosclerotic cardiovascular disease. *Drugs Context* 7, 212525.

KRALIK I., KRALIK Z., ZELIĆ S. (2014): Preferencije potrošača konzumnih jaja. *Proceedings of the 49th Croatian & 9th International Symposium on Agriculture*, February 16 – 21, Dubrovnik, Croatia, 156-160.

KRNJAČIĆ S. (2019): Egg production and processing sector analysis in the Republic of Serbia *Sektorska analiza proizvodnje i prerade jaja u Republici Srbiji* (in Serbian), retrieved from <http://www.minpolj.gov.rs/wp->

[content/uploads/datoteke/IPARD/01%2004%202019%20Sektorska%20analiza%20proizvodnje%20i%20prerade%20jaja%20u%20Srbiji.pdf](https://www.ipard.gov.rs/content/uploads/datoteke/IPARD/01%2004%202019%20Sektorska%20analiza%20proizvodnje%20i%20prerade%20jaja%20u%20Srbiji.pdf), on 28.06.2021.

KUANG H., YANG F., ZHANG Y., WANG T., CHEN G. (2018): The Impact of Egg Nutrient Composition and Its Consumption on Cholesterol Homeostasis. Cholesterol, Article ID 6303810

LAING P. M. (1988): Diseases of free range birds. *World's Poultry Science Journal* 44, 72-75.

LESNIEROWSKI G., STANGIERSKI J. (2018): What's new in chicken egg research and technology for human health promotion? - A review. *Trends in Food Science and Technology* 71, 46-51.

LOPÉZ-FANDINO R. (2007): Use of egg compounds for human nutrition. In: *Bioactive Egg Compounds*, Eds Huopalahti R., Lopéz-Fandino R., Anton M. and Schade R. Springer, Berlin, Heidelberg, Germany, 117-190.

LÓPEZ-SOBALER A. M., GONZÁLEZ-RODRÍGUEZ L. G. (2015): Role of eggs consumption in women at different life stages. *Nutrición Hospitalaria* 1, 35-40.

MAGDELAINE P. (2011): Egg and egg product production and consumption in Europe and the rest of the world. In: *Improving the Safety and Quality of Eggs and Egg Products-Egg Chemistry, Production and Consumption* Eds Y. Nys, M. Bain and F. Van Immerseel, Woodhead Publishing, Cambridge, UK, 3–16.

MARTELLI G. (2009): Consumers' perception of farm animal welfare: An Italian and European perspective. *Italian Journal of Animal Science* 8, 1, 31-41.

McNAMARA D.J. (2000): Dietary cholesterol and atherosclerosis. *Biochimica et Biophysica Acta* 1529, 310–320.

MENDONÇA JR. C. X., ALMEIDA C. R. M., MORI A. V., WATANABE C. (2002): Effect of dietary vitamin A on egg yolk retinol and tocopherol levels. *Journal of Applied Poultry Research*, 11, 373-378.

MILOŠEVIĆ N., PERIĆ L. (2011): Technology of poultry production / Tehnologija živinarske proizvodnje (in Serbian). University of Novi Sad, Faculty of Agriculture, Novi Sad.

MIRANDA J. M., ANTON X., REDONDO-VALBUENA C., ROCA-SAAVEDRA P., RODRIGUEZ J. A., LAMAS A., FRANCO C. M., CEPEDA A. (2015): Egg and Egg-Derived Foods: Effects on Human Health and Use as Functional Foods. *Nutrients*, 7, 706-729.

MIZRAK C., DURMUS I., KAMANLI S., ERDOGAN DEMIRTAS S. KALEBASI S., KARADEMIR E., DOGU M. (2012): Determination of egg consumption and consumer habits in Turkey. *Turkish Journal of Veterinary and Animal Sciences* 36, 6, 592-601.

MULDER M., ZOMER S. (2017): Dutch consumers' willingness to pay for broiler welfare. *Journal of Applied Animal Welfare Science* 20, 2, 1-18.

NOCELLA G., HUBBARD L., SCARPA R. (2010): Farm Animal Welfare, Consumer Willingness to Pay, and Trust: Results of a Cross-National Survey. *Applied Economic Perspectives and Policy* 32, 2, 275-297.

OFFICIAL GAZETTE OF THE REPUBLIC OF SERBIA NO. 41/2009. (2009): Law on animal welfare / *Zakon o dobrobiti životinja* (in Serbian).

OFFICIAL GAZETTE OF THE REPUBLIC OF SERBIA NO. 6/10; OFFICIAL GAZETTE OF THE REPUBLIC OF SERBIA NO. 57/2014-27 (2010, 2014): Rulebook on conditions for animal welfare in terms of animal housing, rooms and equipment in facilities where animals for production purposes are kept, reared and placed on the market, the manner of keeping, breeding and trade of certain species and categories of animals, as well as the content and management of animal records' keeping / *Pravilnik o uslovima za dobrobit životinja u pogledu prostora za životinje, prostorija i opreme u objektima u kojima se drže, uzgajaju i stavljaju u promet životinje u proizvodne svrhe, načinu držanja, uzgajanja i prometa pojedinih vrsta i kategorija životinja, kao i sadržini i načinu vođenja evidencije o životinjama* (in Serbian).

PAL M., MOLNÁR J. (2021): The role of eggs as an important source of nutrition in human health. *International Journal of Food Science and Agriculture*, 5, 1, 180-182.

PARROTT P., WALLEY K., CUSTANCE P. (2013): Consumer defined dimensions of egg quality. *EggMeat Symposia 2013*, September 15-19, Bergamo; *World's Poultry Science Journal*, 69 Supplement.

PAVLOVSKI Z., MAŠIĆ B. (1994): Odnos potrošača prema živinskim proizvodima. *Živinarstvo* 7-9, 77-82. (in Serbian)

PAVLOVSKI L., ŠKRBIĆ Z., LUKIĆ M. (2011): Free systems of laying of chickens and layer hens: quality of meat and eggs. *Tehnologija mesa* 52 1, 160-166.

PENRY J., MANORE M. (2008): Choline: an important micronutrient for maximal endurance-exercise performance? *International Journal of Sport Nutrition and Exercise Metabolism* 18, 191-203.

PERIĆ L., MILOŠEVIĆ N., ŽIKIĆ D., KANAČKI, Z., DŽINIĆ N., NOLLET L., SPRING P. (2009): Effect of selenium sources on performance and meat characteristics of broiler chickens. *Journal of Applied Poultry Research* 18, 403-409.

PERIĆ L., RODIĆ V., MILOŠEVIĆ N. (2011): Production of poultry meat and eggs as functional food - challenges and opportunities. *Biotechnology in Animal Husbandry* 27 3, 511-520.

QURESHI A. I., SURI F. K., AHMED S. NASAR A., DIVANI A. A., KIRMANI J. F. (2007): Regular egg consumption does not increase the risk of stroke and cardiovascular diseases. *Medical Science Monitor*, 13, CR1-CR18.

- RADER L., FAS Europe Specialists (2018): EU Organic Boom Brings Opportunities for U.S. Exporters, retrieved from https://globalorganictrade.com/sites/default/files/general_file/file/eu_organic_boom_brings_opportunities_for_u.s._exporters_berlin_germany_2-6-2018.pdf, on 20.06.2021.
- RAKONJAC S. (2016): Production and quality of products from laying hens in alternative rearing systems / Proizvodnja i kvalitet proizvoda kokoši nosilja iz alternativnih sistema gajenja (in Serbian) Ph.D. Dissertation, Faculty of Agronomy Čacak, University of Kragujevac.
- RODIĆ V., PERIĆ L., PAVLOVSKI Z., MILOŠEVIĆ N. (2010): Competitiveness of table eggs from non-cage housing systems. *Biotechnology in Animal Husbandry*, 26, 1-2, 117-128.
- RODIĆ V., PERIĆ L., PAVLOVSKI, Z. (2014): Stavovi proizvođača konzumnih jaja prema regulativi za obezbeđenje dobrobiti nosilja (in Serbian) / Attitudes of table eggs producers towards regulations for ensuring the welfare of laying hens. *Agroekonomika* 43, 63-64, 125-135.
- RUXTON C. H. S, DERBZSHIRE E., GIBSON S. (2010): The nutritional properties and health benefits of eggs. *Nutrition & Food Science*, 40, 3, 263-279.
- SAKANAKA S., KITAHATA K., MITSUYA T., GUTIERREZ M. A., JUNEJA L. R. (2000): Protein Quality Determination of Delipidated Egg-yolk. *Journal of Food Composition and Analysis*, 13, 5, 773-781.
- SCÄNHR P., THOMSEN O. O, HANSEN R., BOBERG-ANS G., LAWAETZ H., WEEKE T. (1994): Egg consumption and high-density-lipoprotein cholesterol. *Journal of Internal Medicine* 235, 3, 249-51.
- SHAHBANDEH M. (2021): Per capita consumption of eggs in the U.S. 2000-2021. *Food & Nutrition, Consumer Goods and FMCG*, retrieved from <https://www.statista.com/statistics/183678/per-capita-consumption-of-eggs-in-the-us-since-2000/> on 28.06.2021.
- SHAKOOR H., KHAN M. I., SAHAR A., KHAN M.K. I., FAIZ F., BASHEER AHMAD H. (2020): Development of omega-3 rich eggs through dietary flaxseed and bio-evaluation in metabolic syndrome. *Food Science Nutrition* 8, 6, 2619-2626.
- ŠKRBIĆ Z., PAVLOVSKI Z., MITROVIĆ S., LUKIĆ M., TOMAŠEVIĆ D. (2006): Variability of certain table egg quality traits depending on the producer and investigation year. *Biotechnology in Animal Husbandry* 22, 5-6, 21-31.
- STADIG L. M., AMPE B. A., VAN GANSBEKE S., VAN DEN BOGAERT T., D'HAENENS E., HEERKENS J. L. T., TUYTTENS F. A. M. (2016): Survey of egg farmers regarding the ban on conventional cages in the EU and their opinion of alternative layer housing systems in Flanders, Belgium. *Poultry Science* 95, 3, 715-725.

STATISTICAL OFFICE OF THE REPUBLIC OF SERBIA (2015, 2016, 2017, 2018, 2019): Household budget survey. Statistical Office of the Republic of Serbia, Belgrade.

STATISTICAL OFFICE OF THE REPUBLIC OF SERBIA (2020): Statistical Yearbook of the Republic of Serbia, Belgrade.

STOJANOVIĆ T., GLIGORIJEVIĆ M., OGNJANOV G., VELJKOVIĆ S., MITIĆ S., FILIPOVIĆ J., ILIĆ J., BURAZEROVIĆ J., BURAZEROVIĆ E. (2014): Attitudes of consumers in Serbia on animal welfare / Stavovi potrošača u Srbiji o dobrobiti životinja (in Serbian), Organizacija za poštovanje i brigu o životinjama – ORCA, Belgrade.

SURAI P.F. (2002): Selenium in poultry nutrition 1. Antioxidant properties, deficiency and toxicity. *Worlds Poultry Science Journal* 58, 333-347.

TACTACAN G. B., GUENTER W., LEWIS N. J., RODRIGUEZ-LECOMPTE J. C., HOUSE J. D. (2009): Performance and welfare of laying hens in conventional and enriched cages. *Poultry Science* 88, 698-707.

TOLIMIR N., JOVANOVIĆ R., MASLOVARIĆ M., VUKIĆ-VRANJEŠ M., DRINIĆ M. (2012): Testing concentrate feed mixtures with increased selenium concentration in order to produce eggs as functional food. *Proceedings of the XV International Feed Technology Symposium Feed-to Food / Cost Feed for Health Joint Workshop*, October 3 – 5, Institute of Food Technology, Novi Sad (Serbia), pp: 217-222.

TOLIMIR N., MASLOVARIĆ M., ŠKRBIĆ Z., LUKIĆ M., BUDIMOVIĆ N., MILIĆ D., RADIŠIĆ R. (2020): Attitudes of Serbian producers and consumers of table eggs on the ban on conventional batteries and the transition to enriched cages and alternative production systems. *Biotechnology in Animal Husbandry* 36, 4, 463-476.

TOLIMIR N., MASLOVARIĆ M., ŠKRBIĆ Z., LUKIĆ M., RAJKOVIĆ B., RADIŠIĆ R. (2017): Consumer criteria for purchasing eggs and the quality of eggs in the markets of the city of Belgrade. *Biotechnology in Animal Husbandry* 33, 4, 425-437.

TOLIMIR N., MASLOVARIĆ M., ŠKRBIĆ Z., RADIŠIĆ R., LUKIĆ M., RAJKOVIĆ B. (2019a): The attitudes of table egg consumers in Serbia on the welfare of laying hens. *Biotechnology in Animal Husbandry* 35 4, 387-398.

TOLIMIR N., MASLOVARIĆ M., ŠKRBIĆ Z., RAJKOVIĆ B., RADIŠIĆ R., LUKIĆ M. (2019b): Preferences of consumers/customers from Serbia toward organic eggs. *Proceedings of the 12th International symposium „Modern trends in Livestock Production”*, October 9 – 11, Belgrade, 633-642.

TOLIMIR N., ŠKRBIĆ Z., RAJKOVIĆ B., TRAILOVIĆ J., MASLOVARIĆ M. (2016). Attitudes of consumers in Serbia towards the importance of a balanced diet and table eggs as foodstuff. *Biotechnology in Animal Husbandry* 32, 2, 205-218.

- TUYTTENS F. A. M., SONCK B., STAES M., VAN GANSBEKE S., VAN DEN BOGAERT T., AMPE B. (2011): Survey of egg producers on the introduction of alternative housing systems for laying hens in Flanders, Belgium. *Poultry Science* 90, 941-950.
- VAN HORNE P.L.M., BONDT N. (2017): Competitiveness of the EU egg sector, base year 2015. Wageningen Economic Research. Wageningen, Netherlands, pp 46.
- VECCHIO R., ANNUNZIATA A. (2011): Italian consumer awareness of layer hens' welfare standards: a cluster analysis. *International Journal of Consumer Studies* 36, 6, 647-655.
- VELJKOVIĆ S., STOJANOVIĆ T., FILIPOVIĆ J. (2015): Attitudes toward farm animals' welfare and consumers' buying intentions - case of Serbia. *Economics of Agriculture* 62, 1, 53-71.
- VERBEKE W. (2009): Stakeholder, citizen and consumer interests in farm animal welfare. *Animal Welfare* 18, 325-333.
- WANG J., CHI Y., CHENG Y., ZHAO Y. (2018): Physicochemical properties, *in vitro* digestibility and antioxidant activity of dry-heated egg white protein. *Food Chemistry* 246, 18-25.
- WHO (2009). Vitamin A deficiency, retrieved from <https://www.who.int/data/nutrition/nlis/info/vitamin-a-deficiency>, on 25.06.2021.
- YANNAKOPOULOS A. L., TSERVENI-GOUSHI A. S., CRISTAKI E., FORTMARIS P., AVRAMIDIS A., DELAROUDIS E. (2005): Enhanced egg production in practice: the case of bio-omega-3 egg. *International Journal of Poultry Science* 4, 8, 531-535.
- YAROSHENKO F. O., SURAI P. F., YAROSHENKO Y. F., KARADAS F., SPARKS N. H. C. (2004): Theoretical background and commercial application of production of Se-enriched chicken. Proceedings of the XXII WPC, June 8-13, Istanbul, Turkey.
- ZELIĆ A., KRALIK Z., KRALIK I., MAHMUTOVIĆ H. (2016): Consumer preferences when purchasing table eggs in the area of Tuzla city in Bosnia and Herzegovina. *Krmiva* 57, 2, 74-79.
- ZHUANG P., WU F., MAO L., ZHU F., ZHANG Y. (2021): Egg and cholesterol consumption and mortality from cardiovascular and different causes in the United States: A population-based cohort study. *PLOS Medicine* 18, 2, e1003508.
- ZLATANOVIĆ V. (2015): Porodični budžet prosečnog domaćinstva u Republici Srbiji / Family budget of the average household in the Republic of Serbia. *Ekonomija-teorija i praksa*, 8 (3): 78-101.

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