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SELECTED FACTORS AFFECTING the table eggs quality

Анотація. ***The global egg market is experiencing significant growth, indicating a rising consumer interest in eggs as a valuable source of high-quality protein, fats, essential vitamins and minerals. Ensuring the quality of table eggs poses challenges for producers and researchers seeking to standardize quality and explore functional food opportunities. The study provides an overview of factors influencing table egg quality, focusing on pre- and post-laying determinants. Egg weight, trait crucial for consumer choice, is influenced by multigenerational breeding efforts and laying hen origin. It is also affected by the laying management practices and environmental conditions, with varying effects reported in scientific reports. The strength of eggshell, predominantly composed of calcium carbonate, is essential for protection but decreases with hen age, necessitating additional mineral supplementation. Shell cleanliness and colour (affected by genotype) influence consumer preferences regionally. Albumen, constituting over 60% of an egg's weight, serves as protection and hydration for the yolk and embryo. Its dense fraction indicates the egg freshness. Yolk, rich in essential nutrients, varies in proportion and colour, influenced by genotype, environmental factors, and dietary pigments. Consumer yolk colour preferences, often influenced by stereotypical beliefs, contribute to regional differences in selection. This drives research efforts aimed at improving egg quality, safety, and ethical production standards, while also addressing welfare concerns. With a growing emphasis on health and sustainability among consumers, future research is expected to prioritize meeting these expectations while catering to diverse preferences.***

Key words: *chickens, food eggs, protein, yolk, shell, egg quality, factors*

The global egg market was valued at $248.49 billion in 2022 with an expected growth of 8.7% in 2023 *(Bussiness Research Group, 2023)*, representing the production of 88 684 000 tonnes of eggs *(OECD-FAO Agricultural Outlook, 2023)*. The upward trend has continued for many years, and thus the eggs, mainly hen eggs, are becoming an object of consumer interest. Eggs in general are a valuable source of high-quality protein, and fat, containing significant amounts of polyunsaturated fatty acids, important for the organism's micro and macro elements (calcium, magnesium or selenium in organic combinations), and almost all vitamins, except for vitamin C. Ensuring the proper quality of raw egg material is a challenge for producers, but also for researchers looking for methods to standardise the quality of the table eggs obtained and the possibility of using them as functional foods, e.g. by enriching them with bioactive substances. **This study aims** to provide an overview of the main factors (acting before and after laying) determining the quality of table eggs.

Whole egg characteristics. The most important characteristic of the whole egg is undoubtedly its weight. Consumers most often choose large eggs; their classification in this respect is regulated in the EU by Commission Delegated Regulation (EU) 2023/2465. Multigenerational breeding work has made it possible to obtain hybrids with satisfactory

production traits, including those allowing them to obtain large eggs of satisfactory quality. The origin of the laying hens thus affects both egg quantity and quality, including its weight *(Calik, 2013; Batkowska and Brodacki, 2017)*. Egg weight also increases with stock age *(Zita et al., 2009)*. Laying management is also a determinant of egg consumer choice, but scientific reports are discrepant regarding its effect on egg weight. In studies by *Roll et al. (2009)* and *Lewko and Gornowicz (2011)*, caged eggs weighed more than barn ones, while *Ferrante et al. (2010)* observed that organic eggs weighed significantly more than barn eggs, and similarly *Castellini et al. (2006)* noted that extensification of environmental conditions can increase the egg weight by up to 9%.

Eggshell. The shell is an external, inorganic barrier protecting the egg content from external conditions. Its highly organised structure is composed of the vast majority of minerals, predominantly calcium carbonate (90-95%), but also calcium triphosphate, magnesium carbonate or much rarer elements such as aluminium or copper *(Drabik et al., 2021)*. It is perforated by numerous pores that allow gas exchange across the shell (Tsai et al., 2006). Shell strength is one of the most important indicators of egg quality, mainly due to losses during egg collection and marketing (packing, storage, transport), which can reach 13-20% *(Rolland, 1988; Hunton, 2005)*. With the age of the laying hens, there is a decrease in the strength of the eggshells, which may be due to structural changes in the shells or a decrease in the mineral absorption *(Rodrigez-Navarro et al., 2002)*, calcium and phosphorus, from the feed, as well as a slower mineralisation process *(Hunton, 2005)*. This is due to a lower efficiency of calcium absorption and use with the simultaneous increase in egg weight in older layers. Methods to reduce the intensity of the negative phenomenon are numerous, the most common being additional mineral supplementation *(Świątkiewicz et al., 2015)*.

For the producer, the cleanliness of the shell is important, as according to current legislation it is prohibited to wash table eggs, which may contribute to unsealing the pores, which are covered by a mucin layer on the outside, and increase evaporation of water from the egg content *(Batkowska and Brodacki, 2014)*. The level of hygiene of the collected raw egg material depends on the rearing system of the laying hens and the possibility for the eggs to come into contact with the litter or the ground of the runs, as is the case in barn and/or free-range or organic rearing. Nest hygiene is also important. Contamination of eggs with bird faeces or soil leads to an elevated risk of microbial contamination of the shells, the most commonly mentioned microorganisms are *E. Coli, Salmonella, Streptococcus, Staphylococcus* and *Yersenia (Jones et al., 2004)*. Eggs from floor/outdoor systems may have considerably higher levels of bacterial contamination than caged eggs *(Gondek et al., 2013)*.

The aforementioned cleanliness of the shell, but also its colour, are important determinants of purchasing choices. Eggshell colour is mainly affected by the genotype of laying birds *(Roberts, 2004)*, but colour intensity can also be influenced by flock age and health *(Aygun, 2014)*. There is also the possibility of a slight modification of shell colour through birds' nutrition *(Park et al,. 2009; Batkowska et al., 2021)* including due to the housing system used. Consumer preference for eggshell colour varies regionally, and in Poland, for example, eggs with dark-coloured shells are the most popular chosen, unfortunately often wrongly associated with egg quality and yolk colour *(Biesiada-Drzazga and Janocha, 2009)*. Similarly, in Italy, the United Kingdom, Portugal and Ireland, brown-shelled eggs are the most commonly preferred, in the United States white-shelled eggs are favoured, while in Germany or the Netherlands, white and brown eggs are chosen with similar frequency *(Aygun, 2014)*.

Albumen. Albumen constitutes more than 60% of an egg's weight and, from its biological function point of view, it is an additional protection of the yolk and the developing embryo against vibrations, as well as a reservoir of water necessary for proper embryogenesis. In the table egg, the most important feature of the albumen is the height of its density fraction, which indicates the egg's freshness. Changes in density, i.e. protein dilution, occur due to the dissociation of carbonic acid, the release of carbon dioxide, with subsequent alkalinisation of the environment and therefore an increase in protein pH *(Monira et al., 2003)*. The high hydration of the albumen translates into a greater susceptibility to water loss by evaporation through the shell membranes, as well as diffusion into the yolk through the vitelline membrane. These processes referred to as egg ageing, reflect the amount and stability of the obtained foam *(Mikova and Bovskova, 2009)*.

In general, in addition to the time elapsed since laying, albumen quality is conditioned, like eggshell quality, by genetic (breed, line, flock age), and non-genetic factors, such as the housing system, however, here it is considered in terms of the stability of microclimatic conditions, which contribute to the stability of changes in egg content characteristics during storage of the raw material. According to *Samiullah et al. (2017)*, in eggs from barn hens, the albumen height may be lower than in eggs from free-range hens, while *Lordelo et al. (2017)* reported no effect of rearing system (barn vs. free-range) on albumen quality. Using albumen traits as indicators of freshness, the best stability of quality traits during 28 days of storage was recorded for eggs obtained from a cage system, which may indicate their best suitability for storage *(Batkowska et al., 2016)*.

Yolk. The yolk is the most valuable part of the egg from a nutritional point of view. It contains all the essential amino

acids, minerals and fatty acids, which are intended as building material and nutrition for the developing embryo. However, from the consumer's point of view, the yolk's proportion in the egg weight and colour is the most important. The percentage of the yolk is 38% dependent on the genotype *(Hartman et al., 2010)* and the other part on environmental influences, including the rearing system of the layers. Larger values for this trait were reported in eggs from organic than in caged hens *(Küçükyılmaz et al., 2012)*, similarly, *Kralik et al. (2013)* found that eggs obtained from hens kept in a free-range system were characterised by a larger yolk than those from caged hens with a similar egg weight.

Yolk colour is another characteristic determining consumers' choice of eggs and, despite regional differences, they usually choose darker-coloured yolks *(Beardsworth and Hernandez, 2004)*, often this choice is dictated by stereotypical beliefs about the better taste, and higher nutritional value of dark yolks or the origin of laying hens from free-range systems. The latter thesis finds some support in research results as the intensity of yolk colouration depends directly on the amount of the pigment in the feed so eggs from birds kept with access to green forage may be characterised by a darker yolk *(Gornowicz et al., 2013)*, but in intensive rearing, it is not difficult to obtain a similarly saturated colour by adding synthetic pigments to the feed *(Spada et al., 2016)*. Furthermore, xanthophylls, which belong to the carotenoids, are not provitamins of vitamin A. It should also be noted that vegetable feeds, the main source of xanthophylls, in addition to yolk colour, can also affect the sensory evaluation of eggs from laying hens kept with access to runs. They are not always rated higher than eggs from conventionally kept birds *(Terčič et al., 2012),* and consumer preference in this respect depends rather on individual acceptance of taste and smell. In addition, the possibility of using open-air runs may result in the exposure of birds to additional stressors (noise, predators) and an increase in the frequency of blood-stained eggs *(Roll et al., 2009)*.

CONCLUSIONS

1. Regardless of the factors modifying the quality of the eggs obtained, it is important to produce raw eggs of good technological quality, which will also ensure the satisfaction of consumers.
2. When making a conscious choice, consumers are guided not only by the price and packaging of eggs but also by their quality characteristics or origin.
3. The issue of limiting the intensification of ways of keeping laying poultry is becoming extremely important in terms of the consumer's preferences, who are increasingly interested in the safety and health-promoting properties of poultry raw materials, as well as the welfare of the birds.
4. It seems, therefore, that consumers and the necessity of satisfying their requirements and needs will determine the direction of scientific research involving the production of animal raw materials.

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Деякі чинники, що впливають на якість харчових яєць

Анотація. ***Світовий ринок яєць переживає значне зростання, що свідчить про підвищення інтересу споживачів до яєць як цінного джерела високоякісного білка, жирів, необхідних вітамінів і мінералів. Забезпечення якості харчових яєць ставить перед виробниками та дослідниками завдання стандартизації якості та вивчення можливостей функціонального харчування. У дослідженні представлено огляд чинників, що впливають на якість харчових яєць, з акцентом на детермінанти до та після знесення. На масу яйця, яка є вирішальною для споживчого вибору, впливають багаторічна селекційна робота та походження курей-несучок. На неї також впливають практики управління несучістю та умови навколишнього середовища, при цьому в наукових звітах повідомляється про різний вплив цих чинників. Міцність яєчної шкаралупи, яка складається переважно з карбонату кальцію, має важливе значення для захисту, але зменшується з віком курей, що вимагає додаткового додавання мінеральних добавок. Чистота і колір шкаралупи (залежить від генотипу) також впливають на споживчі переваги. Білок, що становить понад 60% маси яйця, є захистом і зволожувачем жовтка. Його щільна фракція вказує на свіжість яйця. Жовток, багатий на основні поживні речовини, змінюється за пропорцією та кольором під впливом генотипу, чинників навколишнього середовища та харчових пігментів. Уподобання споживачів щодо кольору жовтка часто знаходяться під впливом стереотипних переконань. Однак це стимулює зусилля дослідників, спрямовані на покращення якості, безпечності та етичних стандартів виробництва яєць, а також на вирішення проблем добробуту несучок. Зважаючи на зростаючу увагу споживачів до питань здоров'я та сталого розвитку, очікується, що майбутні дослідження будуть спрямовані на задоволення цих очікувань, враховуючи при цьому різноманітні уподобання.***

Ключові слова: *кури, харчові яйця, білок, жовток, шкаралупа, якість яєць, чинники*

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