PRZEGLĄD PRAWA ADMINISTRACYJNEGO
(6)2023 • DOI: 10.17951/ppa.2023.6.51-70

UNIVERSITY OF LIFE SCIENCES IN LUBLIN
KAMIL DRABIK
kamil.drabik@up.lublin.pl
ORCID ID: https://orcid.org/0000-0002-1195-8439

MARIA CURIE-SKŁODOWSKA UNIVERSITY IN LUBLIN
HANNA SPASOWSKA-CZARNY
hanna.spasowska-czarny@mail.umcs.pl
ORCID ID: https://orcid.org/0000-0003-4000-5837

UNIVERSITY OF LIFE SCIENCES IN LUBLIN
JUSTYNA BATKOWSKA
justyna.batkowska@up.lublin.pl
ORCID ID: https://orcid.org/0000-0002-0587-3690

The Freshness and Quality Indicators of Table Eggs During Their Storage on the Background of Existing Legislation

Wskaźniki świeżości i jakości konsumpcyjnych jaj kurzych w czasie ich przechowywania w świetle obowiązującego ustawodawstwa

Introduction

Due to the fact that bird eggs are one of the most popular animal-derived raw materials in the diet of modern societies, many scientific papers address the topic of their quality in the context of dietary use. This quality is seen as the interaction of many elements, such as the age[1] and genotype of the birds,[2] the production flock management, the laying hens rearing system,[3] or the nutritional additives used.[4] Knowledge about the factors shaping egg characteristics allows to produce raw materials in line with the preferences of consumers, for whom freshness is also a priority. It is important to note that, unlike many other food products, including those of animal origin, eggs are not always consumed immediately after harvesting and can be stored at all stages of the trading chain. However, there remains the question of the legislation in force, which should regulate precisely not only the commercial marketing of raw egg but also how it is stored and possibly preserved.

Legal basis for the table eggs trading and Polish Standards (PN)

Until 28 November 2023, the standards for the marketing of table eggs in the EU, i.e. the detailed rules for the implementation of Council Regulation (EC) No. 1234/2007 on marketing standards for eggs, were Commission Regulation (EC) No. 589/2008 of 23 June 2008.[5] The current standards are clarified by Commission Delegated Regulation (EU) 2023/2465 of 17 August 2023, supplementing Regulation (EU) No. 1308/2013 of the European Parliament and of the Council as regards marketing standards for eggs and repealing Commission Regulation (EC) No. 589/2008;[6] Commission Implementing Regulation (EU) 2023/2466 of 17 August 2023 laying down rules for the application of Regulation (EU) No.

[1] Y.F. Gu, Y.P. Chen, R. Jin, C. Wang, C. Wen, Y.M. Zhou, *A comparison of intestinal integrity, digestive function, and egg quality in laying hens with different ages*, "Poultry Science" 2021, vol. 100(3), p. 100949.

[2] Z. Sokołowicz, M. Kačániová, M. Dykiel, A. Augustyńska-Prejsnar, J. Topczewska, *Influence of storage packaging type on the microbiological and sensory quality of free-range table eggs*, "Animals" 2023, vol. 13(12), p. 1899.

[3] P.G.S. Pires, C. Bavaresco, B.S. Prato, M.L. Wirth, P. de Oliveira Moraes, *The relationship between egg quality and hen housing systems – a systematic review*, "Livestock Science" 2021, vol. 250(7), p. 104597.

[4] J. Wang, H. Yue, S. Wu, H. Zhang, G. Qi, *Nutritional modulation of health, egg quality and environmental pollution of the layers*, "Animal Nutrition" 2017, vol. 3(2), pp. 91–96.

[5] OJ L 163/6, 24.6.2008.

[6] OJ L 2023/2465/1, 8.11.2023.

1308/2013 of the European Parliament and of the Council as regards marketing standards for eggs;[7] and Commission Delegated Regulation (EU) 2023/2464 amending Regulation (EU) No. 1308/2013 of the European Parliament and of the Council as regards marketing standards for eggs.[8]

In the explanation of Delegated Regulation 2023/2465, the Commission indicates that the modification of the existing marketing standards for eggs is justified, *inter alia*, by technical progress and consumer demand and the evolution of avian influenza as a risk factor for free-range egg producers. In addition, the Commission considered it reasonable and advisable to keep the provisions on marketing standards for eggs in the form of a coherent set, leading to their inclusion in a single delegated act mentioned above.

In a supplement to the general obligation imposed by Regulation (EC) No. 178/2002 of the European Parliament and of the Council to ensure the traceability of food, feed, food-producing animals and any other substance intended to be, or expected to be, incorporated into food or feed at all stages of production, processing and distribution, for control purposes, Implementing Regulation 2023/2465 introduces the obligation to display specific information on transport packaging containing eggs and on accompanying documents. With regard to the provisions of Regulation (EU) No. 1169/2011, which lays down rules of a general nature applicable to all foodstuffs placed on the market, it introduces specific labelling requirements for egg packs. In addition, the Implementing Regulation supplements Regulation (EU) No. 1308/2013 with provisions on marketing standards for eggs of hens of the species *Gallus gallus*, with the exception of hatching eggs, in particular with regard to grading criteria; preservation and handling of eggs; labelling and packaging requirements; use of optional reserved terms; tolerance levels and import and export conditions.[9]

Executive Regulation 2023/2465, in addition to the general hygiene requirements for wrapping and packaging of foodstuffs, identifies UN/ECE Standard 42 as the basis for introducing additional regulations to minimise the risk of deterioration or contamination of eggs during storage and transport.

In addition, the provisions of Regulation (EC) No. 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs[10] and Regulation (EC) No. 853/2004 of the European Parliament and of the Council

[7] OJ L 2023/2466, 8.11.2023. The Regulation regulates, among other things, the operation of packing centres and the keeping of records by producers, purchasers and packing centres.

[8] OJ L 2023/2464, 8.11.2023. The Regulation lays down rules for the marking of eggs with the producer code at the place of production or packing centres. Article 2 specifies that the Regulation will apply from 8 November 2024.

[9] Article 1 Delegated Regulation (EU) 2023/2465.

[10] OJ L 139/1, 30.4.2004.

of 29 April 2004 laying down specific hygiene rules for food of animal origin continue to apply to eggs[11] (the EU legislator recommends referring to these horizontal regulations as much as possible) and Directive 1999/74/EC laying down minimum standards of protection for laying hens.[12] Additional voluntary labelling of eggs was allowed subject to compliance with Directive 2000/13/EC of the European Parliament and of the Council of 20 March 2000 on the approximation of the laws of the Member States relating to the labelling, presentation and advertising of foodstuffs.[13]

Commission Regulation (EC) No. 589/2008 imposed restrictions on the time that table eggs may remain on the market (28 days after laying)[14] as well as on the quality requirements for grade A eggs.[15] Implementing Regulation 2023/2465 does not introduce such restrictions. However, as the EC prescribes in point (4) a reference to the horizontal Regulations 852/2004 and 853/2004, it should be assumed that the date of minimum durability of eggs is set at not more than 28 days after laying or, if a laying period is indicated, the date is set from the first day of that period.[16]

Unfortunately, neither Regulation 589/2008 nor Regulation 2023/2465 corresponds to most of the recommendations and requirements provided for in the previously applicable Polish Standards (PN-86-A-86504:1986 and PN-A-86503:1998) regarding the conditions related to the storage of eggs at the stage of storage, packaging and distribution. Only the necessity to protect the raw material from exposure to sudden changes in environmental conditions was specified. The restriction of the regulation of storage conditions for commercial table eggs meant that refrigerated storage (below 6°C) was reserved exclusively for the final consumer.

A Polish Standard (PN) is a document adopted by consensus and approved by an authorized organizational unit (the Polish Committee for Standardization[17]).[18] It is a rule, guideline or characteristic, formulated for universal and repeated use, relating to various activities or their results, the purpose of which is to achieve

[11] OJ L 139/55, 30.4.2004. Regulation amended by Commission Regulation (EC) No. 1243/2007 (OJ L 281/8, 25.10.2007).

[12] OJ L 203/53, 3.8.1999.

[13] OJ L 109/29, 6.5.2000. Directive amended by Commission Directive 2007/68/EC (OJ L 310/11, 28.11.2007).

[14] Article 13 Commission Regulation (EC) No. 589/2008.

[15] Article 2 Commission Regulation (EC) No. 589/2008.

[16] See: Annex III, Section 10 Regulation (EC) No. 853/2004, p. 77.

[17] See: Articles 9–22 of the Act of 12 September 2002 on standardisation, consolidated text, Journal of Laws 2015, item 1483.

[18] See: Article 5(1) Act on standardisation.

an optimum degree of order in a specific area.[19] All national standardization is carried out to rationalize production and services through the application of recognized technical rules or organizational solutions; to remove and prevent technical trade barriers; to ensure the protection of life, health, the environment and the interests of consumers and occupational safety; to improve the functionality, compatibility and interchangeability of products, processes and services and to regulate their diversity; to ensure the quality and reliability of products, processes and services; to work for the inclusion of national interests in European and international standardization; to facilitate communication by defining terms, definitions, designations and symbols for general use.[20]

The Polish Standard for eggs for sale (PN-86 A-86504) was notified for the first time by the Ministry of Agriculture, Forestry and Food Economy and established by the Polish Committee for Standardization, Measurement and Quality on October 1, 1986 as a standard in force from July 1, 1987.[21] Subsequently, the quality parameters of eggs were regulated in 1994 by the Regulation of the Minister of Agriculture and Food Management of 18 March 1994 on the obligation to apply Polish Standards.[22] Based on Article 19(2) of the Standardization Act of 3 April 1993,[23] § 1 introduced the obligation to apply the Polish Standards listed in the Annex to the Regulation (Chapter 12: Food products; Class 121: Meat, meat and dairy products; Group 1216: "Poultry meat. Eggs. Preparations and by-products"; under No. 37: PN-85/A-86503).

The regulation of the Minister of Agriculture and Food of 27 June 1997[24] on the obligatory use of Polish Standards, again issued on the aforementioned legal basis, provided for a standard for hen eggs (PN-85/A-86503) under No. 35 and for hen eggs for collection (PN-85/A-86504) under No. 36 in the annex entitled "List of Polish Standards for obligatory use". Another "List of Polish Standards for obligatory use" was annexed to the regulation of the Minister of Agriculture and Food Economy of 20 October 1998 amending the regulation on the obligatory use of Polish Standards,[25] it classified under No. 135 the standard PN-85-A86503 for poultry eggs.

Until 1993, the use of PNs was mandatory. The provision of Article 19(1) of the Standardization Act of 3 April 1993[26] made the application of standards voluntary,

[19] See: Article 2(4) Act on standardisation.
[20] See: Article 3(1–7) Act on standardisation.
[21] Journal of Standardisation and Measurements No. 15/1986, item 29.
[22] Journal of Laws 1994, No. 40, item 152.
[23] Journal of Laws No. 55, item 251.
[24] Journal of Laws No. 83, item 535.
[25] Journal of Laws No. 139, item 901.
[26] Journal of Laws 1993, No. 55, item 251, as amended.

but Article 19(2) gave a mandate to the ministers to create lists of mandatory standards within their scope of action, while the norm of § 3 mandated their application if they were referred to in legal acts. Now, from 1 January 2003, the use of PNs is voluntary, as is clear from Article 5(3) of the 2002 Standardization Act.[27]

In relation to doubts arising in the interpretation of the provisions of Article 5 of the Standardization Act, at its meeting of 28 October 2010, the Standardization Council of PKN (Polish Committee for Standardization) adopted the following proposal. The Standardization Council of PKN accepted a request for the President of PKN to take an official stand on the issue of voluntary use of standards, especially in relation to the stipulation of Article 5(4) of the Standardization Act of September 12, 2002. From the published position of the President of the PKN, it is clear that the legislator intended to introduce a voluntary standardization system in Poland, to which Poland had committed itself in the association agreement with the EU. It would be a fundamental inconsistency on the part of the legislator if the provisions of Article 5(3) were to be limited in § 4 by universally permitting the imposition of the obligation to use PN in legal regulations. Thus, the provision of § 4 should be understood as allowing the citation of PN in legislation, with the legislator not referring to the provision of § 3, but, taking into account the wording of § 2, wanting to ensure that citizens have access to the content of PN in Polish. The legislator was reasonably concerned that there may be cases of reference in legislation to PNs published in the original language.[28] Interpreting § 4 as a delegation to impose an obligation to apply PNs is therefore completely wrong. If the legislator had intended to permit the imposition of an obligation to apply PNs by acts of a lower order than laws, he would have made a corresponding reservation to the provisions of § 3, as he did in Article 19 of the Standardisation Act of 3 April 1993.[29]

Beyond any doubt, the above position was supported by the Polish Supreme Administrative Court in its judgment of 10 April 2019.[30] The court ruled that the use of PNs is voluntary and they are not sources of universally binding law. Referring to the PNs is only justified when a provision of a law or regulation directly refers to the requirement to apply them. Furthermore, in a judgment of 21 March 2013,[31] the Supreme Administrative Court emphasised that PNs cannot

[27] Journal of Laws 2002, No. 169, item 1386.

[28] https://wiedza.pkn.pl/web/wiedza-normalizacyjna/stanowisko-pkn-w-sprawie-dobrowolnosci-pn (access: 2.11.2023).

[29] Journal of Laws 1993, No. 55, item 251.

[30] Judgment of the Supreme Administrative Court of 10 April 2019, II OSK 1486/17, LEX No. 2650511; see also: judgment of the Supreme Administrative Court in Kielce of 19 May 2009, II SA/Ke 183/09, LEX No. 558425.

[31] II OSK 2244/11, LEX No. 1332678.

be described as independent legal norms due to the copyright protection afforded to them. However, contracts between the relevant partners may introduce an obligation to provide a service or product in accordance with the requirements set out in the standard. This is an obligation binding only on the contracting sides, independent of the general principle of voluntary application of standards, and the provisions of the Civil Code apply in this case. The use of PNs is voluntary but brings benefits. Standards guarantee safety, and entrepreneurs who use standards are safe and reliable business partners. Standards offer practical knowledge to SMEs, so using them means relying on reliable and market-proven knowledge. Entrepreneurs using standards can be sure that their products and services meet the requirements of the Polish and European markets. It should be emphasised that entrepreneurs who use them thus prove that their products and services have reached a certain level of quality, safety and reliability.

The analysis of changes in eggs during storage as indicators of their quality

Currently, based on Commission Regulation (EC) No. 2023/2465, eggs are classified into 2 quality classes with fairly strict Class A designations. Eggs which do not have these characteristics are classified as Class B eggs and are only intended for food and non-food uses. Class A eggs which no longer have these characteristics may be reclassified as Class B eggs.[32] In addition, Class B eggs become unmarked eggs within 10 days of laying.[33] Class A eggs shall have a normal shape, a clean and undamaged shell and cuticle, the air cell shall be stationary and its height (depth) shall not exceed 6 mm.[34] In A Class eggs to be marketed as "extra" or "extra fresh" (within 9 days of laying), the height must not exceed 4 mm. On candling, the yolk is visible as a shadow, without a clear outline, moving slightly when the egg is rotated and returning to a central position. The white should be clear. Visible embryonic development, the presence of foreign bodies and a non-specific odour are unacceptable. In addition, such eggs must not have been washed cleaned or subjected to preservation or refrigeration.[35]

However, in eggs, as in any food commodity destined for the market, a number of different qualitative changes take place, and their beginning is the moment of

[32] Article 2(4) Commission Regulation No. 589/2008.
[33] Article 3(2) Delegated Regulation (EU) No. 2023/2465.
[34] Article 3(1) Delegated Regulation (EU) No. 2023/2465.
[35] Article 2 (2 and 3) Commission Regulation No. 589/2008.

laying. Originally, the egg is a generative cell[36] provided with the nutrients necessary for the potential development of the embryo (yolk) and protective layers (albumen, shell membranes, shell, mucin). Thus, metabolic processes take place inside the eggs, contributing to a gradual deterioration of their quality until they become completely unfit for consumption and technological use.[37] The intensity of egg "ageing", as one aspect of egg quality, also depends on many factors, e.g. the age of the laying hen,[38] the breed,[39] the rearing method of laying flocks,[40] the hygiene of the raw material,[41] the storage conditions,[42] or, finally, the physical characteristics of the eggs themselves, e.g. their initial weight.[43]

Some of these characteristics are controlled during trading. The Office of Competition and Consumer Protection, as well as the Agricultural and Food Quality Inspection, during inspections of egg retail stores, analyze the compliance of the labelling of packages with their contents in terms of, among other things, the weight of the raw material. In 2022, 143 batches of eggs were checked, of which 12.6% were questioned due to irregularities regarding weight class (missing or incorrect weight class, two weight classes given instead of one correct one), date of minimum durability (incorrect format, illegible writing, incorrect information regarding its indication on the package), missing or illegible producer code, as well as missing labelling, packing plant number, explanation of the producer code meaning, quality class. The use of a graphic design suggesting

[36] P.A. Johnson, C.S. Stephens, J.R. Giles, *The domestic chicken: Causes and consequences of an egg a day*, "Poultry Science" 2015, vol. 94(4), pp. 816–820.

[37] K. Drabik, J. Batkowska, T. Próchniak, B. Horecka, *Citric acid as a factor limiting changes in the quality of table eggs during their storage*, "Poultry Science" 2021, vol. 100(4), p. 100995.

[38] A. Marzec, K. Damaziak, H. Kowalska, J. Riedel, M. Michalczuk, E. Koczywąs, F. Cisneros, A. Lenart, J. Niemiec, *Effect of hens age and storage time on functional and physiochemical properties of eggs*, "Journal of Applied Poultry Research" 2019, vol. 28(2), pp. 290–300.

[39] J. Krawczyk, Z. Sokołowicz, *Effect of chicken breed and storage conditions of eggs on their quality*, "Acta Scientiarum Polonorum. Zootechnica" 2015, vol. 14(4), pp. 109–118.

[40] J. Batkowska, A. Brodacki, M. Gryzińska, *Effects of laying hen husbandry system and storage on egg quality*, "Archiv für Geflügelkunde" 2016, vol. 80(158).

[41] K.K. Chousalkar, S. Khan, A.R. McWhorter, *Microbial quality, safety and storage of eggs*, "Current Opinion in Food Science" 2021, vol. 38, pp. 91–95.

[42] A. Brodacki, J. Batkowska, K. Drabik, P. Chabroszewska, P. Łuczkiewicz, *Selected quality traits of table eggs depending on storage time and temperature*, "British Food Journal" 2019, vol. 121(9), pp. 2016–2026.

[43] M. Gryzińska, M. Niespodziewański, P. Widomski, *Wpływ warunków przechowywania kurzych jaj konsumpcyjnych różniących się wielkością na ich cechy jakościowe*, „Żywność. Nauka. Technologia. Jakość. Suplement" 2003, nr 10(4), pp. 113–121; J. Batkowska, A. Brodacki, S. Knaga, *Quality of laying hen eggs during storage depending on egg weight and type of cage system (conventional vs. furnished cages)*, "Annals of Animal Science" 2014, vol. 14(3), pp. 707–719.

other than cage rearing and the use of the term "rural" for caged eggs were also considered to be misleading.[44]

The weight of the egg is the one most often verified in the context of correct food labelling. The weight grades of Class A eggs shall be indicated by the corresponding letters and/or specific names and may be supplemented by the corresponding weight ranges XL (extra-large, ≥73 g), L (large, 73–63 g), M (medium, 63–53 g), S (small, <53 g), while it is permissible to sell packed eggs of different sizes with the indication, e.g. "Eggs of different sizes" and the weight of the smallest egg. During the control of batches of grade A eggs, tolerances with respect of unit weight shall be permitted. Such batches may contain not more than 10% of eggs of weight grades bordering on that marked on the pack, but not more than 5% of eggs of the next lower weight grade. Where a batch inspected contains fewer than 180 eggs, these margins shall be doubled.[45]

In the case of eggs, the primary change over time is weight loss. This change is continuous and linear[46] and, more importantly, it is recorded regardless of the storage temperature changes applied[47,48] or the protective substances used.[49,50,51] The rate at which water evaporates from the egg depends on air humidity, temperature and the quality of the cuticle. The cuticle is a glycoprotein layer composed mainly of mucin; its function is to reduce the passage of the shell pores, which not only limits their permeability to water vapor but also the possibility of penetration of the egg contents by microorganisms such as proteolytic ones. However, the effect of this barrier is limited to a few days after laying due to its desiccation.[52] According to the legislator, it is the eggs with damaged cuticles that

[44] IJHARS (Inspekcja Jakości Handlowej Artykułów Rolno-Spożywczych), 2022, https://www.gov.pl/web/ijhars/znakowanie-jaj-w-2022-r (access: 4.11.2023).

[45] Article 19 (1 and 2) Delegated Regulation (EU) 2023/2465.

[46] L. Ragni, P. Gradari, A. Berardinelli, A. Giunchi, A. Guarnieri, *Predicting quality parameters of shell eggs using a simple technique based on the dielectric properties*, "Biosystems Engineering" 2006, vol. 94(2), pp. 255–262.

[47] D.R. Jones, G.E. Ward, P. Regmi, D.M. Karcher, *Impact of egg handling and conditions during extended storage on egg quality*, "Poultry Science" 2018, vol. 97(2), pp. 716–723.

[48] A. Brodacki, J. Batkowska, K. Drabik, P. Chabroszewska, P. Łuczkiewicz, *op. cit.*

[49] G.D.S. Oliveira, V.M. Dos Santos, J.C. Rodrigues, Â.P. Santana, *Conservation of the internal quality of eggs using a biodegradable coating*, "Poultry Science" 2020, vol. 99(12), pp. 7207–7213.

[50] K. Drabik, T. Próchniak, D. Spustek, K. Wengerska, J. Batkowska, *The impact of package type and temperature on the changes in quality and fatty acids profile of table eggs during their storage*, "Foods" 2021, vol. 10(9), p. 2047.

[51] Z. Sokołowicz, M. Kačániová, M. Dykiel, A. Augustyńska-Prejsnar, J. Topczewska, *op. cit.*

[52] A.B. Rodríguez-Navarro, N. Domínguez-Gasca, A. Muñoz, M. Ortega-Huertas, *Change in the chicken eggshell cuticle with hen age and egg freshness*, "Poultry Science" 2013, vol. 92(11), pp. 3026–3035.

lose water in the shortest time, hence the ban on washing eggs for consumption.[53] However, the alternative to cage-rearing systems for laying hens raises the problem of so-called litter eggs, laid outside the nest and thus, exposed to bacterial contamination. Such eggs should be destined for processing (as Class B) and sold at a much lower price. The financial rationale, as well as the impossibility of simply verifying cuticle continuity,[54] may favor adulteration in this respect. In addition, real differences in the storage quality of washed versus unwashed eggs are detectable at the level of accurate laboratory analyses, while they are not large enough to be visible to the consumer,[55] especially with the recommendation to store purchased eggs at refrigeration temperature.[56] Importantly, in many countries (Japan, USA) egg washing is recommended as a hygienic element of the egg production process.[57]

The loss of egg weight with a simultaneously enlarged air cell is a natural change of the raw material during storage[58] resulting from the penetration of water from the albumen into the yolk and its evaporation through the shell pores, resulting in, among other things, a reduction in egg albumen weight.[59] Air cell depth is considered one of the main indicators of egg freshness. It seems to provide a simple way to verify the "age of the egg", but this is not a linear dependency.[60] The air cell, a stratification of the membranes filled with air, is formed when the egg is laid due to the difference in temperature and pressure inside and outside the hen's body, and its depth depends directly on this temperature contrast. In many cases, eggs from laying hens from outdoor systems (e.g. organic), laid in the colder seasons, may already show the presence of an air cell 2–3 mm

[53] Point 7 Delegated Regulation (EU) 2023/2465.

[54] S. Leleu, W. Messens, K. De Reu, S. De Preter, L. Herman, M. Heyndrickx, J. De Baerdemaeker, C.W. Michiels, M. Bain, *Effect of egg washing on the cuticle quality of brown and white table eggs*, "Journal of Food Protection" 2011, vol. 74(10), pp. 1649–1654.

[55] J. Batkowska, A. Brodacki, *Wpływ mycia skorupy na wybrane cechy jakości jaj kurzych w czasie przechowywania*, „Żywność. Nauka. Technologia. Jakość" 2014, nr 2(93), pp. 204–213.

[56] Y.C. Liu, T.H. Chen, Y.C. Wu, Y.C. Lee, F.J. Tan, *Effects of egg washing and storage temperature on the quality of eggshell cuticle and eggs*, "Food Chemistry" 2016, vol. 211, pp. 687–693.

[57] M.L. Hutchison, J. Gittins, A. Walker, A. Moore, C. Burton, N. Sparks, *Washing table eggs: A review of the scientific and engineering issues*, "World's Poultry Science Journal" 2003, vol. 59(2), pp. 233–248.

[58] H.E. Samli, A. Agma, N. Senkoylu, *Effects of storage time and temperature on egg quality in old laying hens*, "Journal of Applied Poultry Research" 2005, vol. 14(3), pp. 548–553.

[59] B. Biesiada-Drzazga, D. Banaszewska, A. Wereszczyńska, Ł. Olędzki, *Wpływ warunków przechowywania na wybrane cechy jaj pochodzących od kur rasy zielononóżka kuropatwiana*, „Żywność. Nauka. Technologia. Jakość" 2016, nr 1(104), pp. 79–87.

[60] K. Drabik, T. Próchniak, K. Kasperek, J. Batkowska, *The use of the dynamics of changes in table eggs during storage to predict the age of eggs based on selected quality traits*, "Animals" 2021, vol. 11(11), p. 3192.

deep on the first day. The rearing system of the laying hens therefore becomes a factor modifying both the quality of the eggs and the intensity of its changes during the storage. It seems that the more stable the environmental conditions (regulated parameters of microclimate, feeding, etc.), the more uniformly and slowly the quality of the egg content deteriorates.[61,62] The depth of the air cell is also closely correlated with the initial weight of the egg, i.e. its weight class. It deepens most rapidly in XL-class eggs, which may be due to the largest evaporative surface area of such large eggs.[63]

The loss of volume of the egg parts increases the concentration of chemical components, which has a direct effect on the reduction of water activity. The cause of the alkalinisation of the albumen is the loss of carbon dioxide and the change in the concentration of sodium and potassium bicarbonates that occur in the egg contents. The pH of the albumen, which depends on the buffer system of the egg, increases as carbon dioxide gradually diffuses through the pores in the shell over time and its loss disrupts the balance of the system.[64] The loss of carbon dioxide from the egg depends on the ambient temperature. It is faster at higher temperatures and continues until equilibrium is reached between the CO_2 content of the egg albumen and the ambient air. The acidity of the albumen is important for its functional properties, and here the stability of the resulting foam. Albumen with a pH of about 6.5–7 is the best to whip up, while those with a pH of 5 and in the range of 7.5 to 8.5, which is where the pH value of the egg most often falls,[65,66] are the worst. The height of the dense albumen depends on the degree of binding of the ovomucin-lysozyme complex, for the maintenance of which the optimum pH value is 8. With significant ageing, the albumen pH increases up to 9.5 and, consequently, the dense albumen changes from a stable gel form to a more dilute one.[67] Increasing alkalinisation of the environment brings the pH closer to the isoelectric point of lysozyme (pH = 11), resulting in a weakening of the gel structure and a dilution of the dense albumen, a decrease in its height and a decrease in the Haugh's units.

---

[61] J. Batkowska, A. Brodacki, M. Gryzińska, *op. cit.*

[62] K. Drabik, T. Próchniak, K. Kasperek, J. Batkowska, *op. cit.*

[63] J. Batkowska, A. Brodacki, S. Knaga, *op. cit.*

[64] J.L. Heath, *Chemical and related osmotic changes in egg albumen during storage*, "Poultry Science" 1977, vol. 56(3), pp. 822–828.

[65] P.C.D. Menezes, E.R.D. Lima, J.P.D. Medeiros, W.N.K.D. Oliveira, J. Evêncio-Neto, *Egg quality of laying hens in different conditions of storage, ages and housing densities*, "Revista Brasileira de Zootecnia" 2012, vol. 41(9), pp. 2064–2069.

[66] H. Bovšková, K. Míková, *Factors influencing egg white foam quality*, "Czech Journal of Food Sciences" 2011, vol. 29(4), pp. 322–327.

[67] K. Drabik, T. Próchniak, K. Kasperek, J. Batkowska, *op. cit.*

The quality of the yolk is characterised by 3 very practical features: its weight, colour and the strength of the vitelline membrane so that it can be separated from the albumen. These also change over time. First of all, there is an increase in the mass of the yolk, due to the movement of water between the albumen and yolk. These changes entail further changes, i.e. a decrease in the shape index value[68] and an apparent change in colour due to the stretching and tension of the vitelline membrane. In addition to water vapor and carbon dioxide, the egg emits small amounts of ammonia and hydrogen sulphide, produced by the enzymatic breakdown of proteins and fats. Under the influence of proteolytic enzymes, the aforementioned gradual loosening of the structure of the membrane surrounding the yolk takes place, resulting in a significant reduction in its strength, while at the same time, it becomes more permeable to water.[69] Eventually, as a result of the increasing volume of the yolk ball, the membrane may be disrupted and the morphological elements of the contents mixed together. The yolk in the fresh egg is round, located in the centre of the egg, and its pH is around 6.0 and increases with storage time.[70] At the same time as the pH of the protein increases, the elasticity of the chalaza decreases, while the yolk becomes more mobile, swimming under the shell and even coming into contact with the shell membranes. As the pH increases, iron ions penetrate towards the protein with water, while calcium, magnesium and sodium ions penetrate the yolk. This continues until the osmotic balance between protein and yolk is equalized. In an aging egg, the vitelline membrane weakens and the yolk flattens.[71,72] Invisible embryonic development is also cited as an indicator of the quality of Class A eggs, which does not exclude fertilized eggs, which can occur in eggs from alternative laying systems,[73] especially free-range and organic. In intensive rearing (cage, barn) roosters are not kept.

The most important factor determining the storage quality of eggs is the storage temperature. It affects the evaporation rate of water, the stability of the

[68] J. Li, S. Zhu, S. Jiang, J. Wang, *Prediction of egg storage time and yolk index based on electronic nose combined with chemometric methods*, "LWT-Food Science and Technology" 2017, vol. 82, pp. 369–376.

[69] J. Calik, *Zmiany cech jakościowych jaj pochodzących od kur nieśnych żółtonóżka kuropatwiana (Ż-33), w zależności od warunków ich przechowywania*, „Żywność. Nauka. Technologia. Jakość" 2013, nr 2(87), pp. 73–79.

[70] K. Drabik, T. Próchniak, K. Kasperek, J. Batkowska, *op. cit*.

[71] D.R. Jones, *Egg functionality and quality during long-term storage*, "International Journal of Poultry Science"2007, vol. 6(3), pp. 157–162.

[72] Z. Kralik, G. Kralik, M. Grcević, A. Galović, *Effect of storage period on the quality of table eggs*, "Acta Agraria Kaposváriensis" 2014, vol. 18(Suppl. 1), pp. 200–206.

[73] Council Directive 1999/74/EC of 19 July 1999 laying down minimum standards for the protection of laying hens, OJ L 203/53, 3.8.1999.

carbonic acid contained in the eggs and its solubility. As the temperature rises, the carbonic acid decomposes to form carbon dioxide, which is released through the pores in the shell, with a significant effect on reducing the weight of the eggs.[74] Class A egg raw material should not be stored at a temperature lower than 5°C. Raw material may also not be refrigerated if it is transported for more than 24 h and intended for marketing for less than 72 h, or if it is stored at a temperature lower than 5°C.[75] Leaving cold eggs at room temperature can lead to water condensation on the shell, which encourages the growth of micro-organisms that can then enter the egg contents. Eggs must therefore be stored and transported as far as possible at a constant temperature and should generally not be refrigerated before sale to the final consumer. However, it is refrigeration temperature (4–6°C) that has the best effect in reducing the adverse effects of egg ageing.[76] Due to current legislation, it is not possible to collect, store and sell eggs at what are termed refrigerated temperatures, so packing plants and stores provide a stable temperature maintained at 15–17°C (own observation). Some shops store eggs in refrigerators, with the lower temperature limit considered non-refrigerated. Even so, there is no guarantee that the temperature range provided to the eggs before sale, during transport to the shop, or after purchase will not contribute to the dewing of the eggshell surface. The keeping of eggs at refrigeration temperatures is such an important fact that producers are obliged to indicate this on the packaging of their products, a procedure which applies only to retail sales in the French overseas departments, to which, by derogation, eggs may be dispatched under refrigeration.[77]

The minimum shelf life date for Class A eggs is set at 28 days after laying. EU regulation[78] specify the marking of eggs intended for marketing in such a way that their origin and freshness can be determined. Eggs of Class A placed on the market are to be graded, marked and packed within 10 days of being laid.[79] Packs intended for storing eggs shall be dry, undamaged, free of dirt and free of extraneous odours. Packs intended for transport shall be marked with producer's details (name and address, the producer code), the number of eggs and/or their weight, the laying date or period and the date of dispatch.[80] The standards

[74] C. Caner, *The effect of edible eggshell coatings on egg quality and consumer perception*, "Journal of the Science of Food and Agriculture" 2005, vol. 85(11), pp. 1897–1902.

[75] Article 4(2) Delegated Regulation (EU) 2023/2465.

[76] T.A. Scott, F.G. Silversides, *The effect of storage and strain of hen on egg quality*, "Poultry Science" 2000, vol. 79, pp. 1725–1729; H.E. Samli, A. Agma, N. Senkoylu, *op. cit.*; A. Brodacki, J. Batkowska, K. Drabik, P. Chabroszewska, P. Łuczkiewicz, *op. cit*.

[77] Article 23 Delegated Regulation (EU) 2023/2465.

[78] Article 6 Delegated Regulation (EU) 2023/2465.

[79] Article 6(1) Delegated Regulation (EU) 2023/2465.

[80] Article 7 Delegated Regulation (EU) 2023/2465.

for the transport and storage of eggs are laid down in Annex III to Regulation (EC) No. 853/2004 of 29 April 2004. Eggs on the producer's premises and until delivery to the final consumer must remain clean, dry, free of extraneous odour and effectively protected from shocks and direct sunlight. They must be stored and transported at a constant temperature that ensures optimal conservation of their hygiene properties. Eggs must be delivered to the consumer within a maximum of 28 days of laying.[81]

Based on the above analysis, it is difficult to determine unequivocally how eggs should be stored properly, as the recommendations regarding humidity and temperature are very general. It is recommended to avoid direct sunlight on the raw material, exposure to sudden temperature fluctuations and the use of refrigeration conditions (<5°C). The multiplicity of suppliers, as well as the need to maintain the quality parameters of eggs and, above all, to ensure food safety, has led to the introduction of regulatory and standardisation systems throughout the animal raw material chain. Before Poland acceded to the European Union, the Polish Standard of 1986 (PN-86-A-86503) strictly regulated the parameters of eggs accepted for marketing and food processing, classifying them by external characteristics of structure into basic groups: valuable eggs, less valuable eggs and waste. The basic aspects of evaluation included the general appearance of the shell, i.e. dirtiness, defects or cracks in the shell, the depth of the air cell, examination of the egg content for the presence of meat or blood spots, but above all typical organoleptic characteristics such as, in addition to the above-mentioned external appearance, taste or smell. In the remainder of the aforementioned standard, we also find very clear indications for the packaging, transport and storage of table eggs.

The definition of the packaging parameters ensures control of both the multipacks, which are primarily intended for wholesale or transport (extruded packs of 30 eggs), taking into account both the positioning of the eggs (blunt end upwards) and the egg packs in the transport packaging. The necessary minimum description of the producer on the packaging is also specified. The exclusion of extraneous odours from the surroundings of the eggs, both during storage and transport, is repeatedly mentioned, which makes sense in view of their easy penetration through the shell. The most important storage conditions for table eggs from the point of view of our work are also included in the standard. A temperature range of 8–15°C, as well as a relative humidity of 65–80%, are intended to guarantee the preservation of freshness and quality of the stored raw material. Despite the generally good evaluation of the 1986 standard, a change was made in the form of Polish Standard PN-A-86503 "Poultry products – table eggs" in

[81] Annex III: Specific requirements; Section X: Eggs; Chapter 1: "Eggs", § 3, p. 67.

1998. It introduced, in particular, a clear distinction into classes A, B and C. The division criteria were enriched with tolerance ranges for most parameters, allowing eggs to be more accurately assigned to particular quality groups. In addition, for the first time, Class A-extra was distinguished by a shallow (up to 4 mm) air cell characteristic of very fresh eggs; this depth is maintained for a maximum of seven days after laying under optimal storage conditions. In Class A, the grading of table eggs according to egg weight was introduced to allow better adjustment of collection and retail packaging to the size of the eggs sold. The sorting of eggs by weight was reflected in the packaging system. In addition to the address of the supplier and the packing date, which has also been standardized, a weight grade, quality grade and number of eggs per pack have been introduced. The standardization of weight parameters also made it possible to separate egg prices in the retail trade. Also, the now widely known labelling of each egg has its roots in this very standard. Although the labelling system has changed, it was an important step towards standardization of the raw material. The storage conditions did not change, but a shelf life was introduced. It was set at 14 days, which was later significantly extended. Transport conditions were significantly tightened: protection from sunlight, shocks and sudden temperature changes was introduced. Despite the high degree of accuracy in defining the marketing parameters for table eggs, both standards were withdrawn and replaced by Commission Regulation (EC) No. 589/2008 of 23 June 2008 and currently by Commission Delegated Regulation (EU) 2023/2465. The labelling provisions were tightened by introducing the current system of individual egg labelling, as well as precise requirements for sales packages and their labelling in view of the possibility of international trade. Weight classes have been retained, and it has been made possible to wash eggs and distribute them as washed eggs but only in those member countries where such authorisations have been granted.[82]

[82] Article 4 Delegated Regulation (EU) 2023/2465.

Table 1. Comparison of regulations relating to the storage of table eggs

Item	Act of law		
	Polish Standards		European Union Regulations
	PN-86-A-86504 (retracted)	PN-A-86503 (retracted)	Commission Regulation (EC) 589/2008 (retracted) Commission Delegated Regulation (EU) 2023/2465 (in force) Regulation (EC) No. 853/2004 of the European Parliament and of the Council (in force) Regulation (EC) No. 852/2004 of the European Parliament and of the Council (in force) Regulation (EU) No. 1308/2013 of the European Parliament and of the Council (in force) Commission Implementing Regulation (EU) 2023/2464 (in force) Commission Implementing Regulation (EU) 2023/2466 (in force)
Quality classes	A. table eggs B. eggs for processing and waste	A. table eggs, "extra" grade introduced B. class II eggs C. eggs for processing only	A. table eggs; separate "extra" and "extra fresh" grades B. eggs for processing
Quality parameters	– appearance and structure of the shell – air cell height of not more than 6 mm – no foreign smell or taste – absence of blood spots and foreign bodies in the protein – absence of blood and foreign bodies in the albumen – minimum weight (minimum 45 g) – definition of the number of less valuable eggs in the batch	– shell appearance (shape, cleanliness, damage) – depth of air cell (A – 6mm; A-extra – 4 mm) – albumen (clear, no foreign bodies) – appearance and mobility of yolk – absence of germinal disc – absence of foreign odours	– the appearance of the shells (shape, cleanliness, damage) – depth of air cell (A – 6 mm; A-extra – 4 mm) – albumen (clear, no foreign bodies) – appearance and mobility of yolk – unacceptable embryo development – absence of extraneous odours
Weight grades	Only the setting of a minimum weight	XL (>73 g) L (63–73 g) M (53–62 g) S (48–52 g)	XL – extra large: egg weight ≥73 g L – large: 73 g > egg weight ≥63 g M – medium: 63 g > egg weight ≥53 g S – small: egg weight <53 g

Item	Act of law		
Egg marking	No guidelines	Class A eggs may be marked individually Classes B and C mandatory except for deliveries direct to the processor Class A – a circle of at least 12 mm Ø with the class symbol and the indication of weight grades	Marking with producer code, explanatory notes on packaging On eggs sold loose, indication of: best-before date, quality and weight class, farming system and explanation of producer code Other information on sales packaging Rearing system: – free range system – barn eggs – enriched cages (mandatory)
Packaging	General packaging parameters (cleanliness, absence of foreign odours) were discussed	General parameters for protection against external conditions, non-reusable small packs, blunt end upward positioning of eggs	Detailed information related to: – packaging of "extra" and Class A – quality of packaging – packing centres and marking on packagings – inspections of packing centres
Transport	The type of collective packaging (30-piece extruder), the number of eggs in the transport container, the arrangement of eggs on the extruders and the extruders themselves, the marking parameters of the transport packaging, a description of winter transport	The need for protection from the weather, ensuring the temperature remains as constant as possible	Only general principles are mentioned The descriptions of transport packaging have been made more specific
Storage	Determination of hygienic conditions in the storage room, storage temperature 8–13°C, humidity 65–80%	Determination of hygienic conditions in the storage room, storage temperature 8–13°C, avoidance of sudden temperature changes	Only mentioned not exposing eggs to temperature changes
Minimum shelf life date	Not available	14 days	28 days

Source: Authors' own study.

Unfortunately, due to the climatic differences in the EU Member States, the aforementioned regulations do not specifically define storage conditions, their place being taken by only the general issues of transport and packaging to ensure shock resistance and general cleanliness. Table 1 shows a comparison of the regulations of the relevant PNs and the applicable regulations.

Conclusions

Regardless of environmental conditions or the use of protective methods, changes in the quality of table eggs during storage are natural and continuous, and it is not possible to eliminate this phenomenon. Proper storage not only preserves the freshness parameters of eggs for a longer period, but also protects food from microbiological changes. Due to its layered structure, the egg is partially protected from environmental factors and external pathogen contamination. However, with the passage of time, changing the parameters of eggs not only deteriorates their food value but can also expose consumers to microbial risks. Fresh eggs, thanks to the presence of a bacteriostatic complex, are largely protected against bacterial infections. Nevertheless, with the use of improper washing or drying, as well as temperature fluctuations during storage and transport, infections can occur due to bacterial growth in water droplets on the shell.

Changes in legal regulations over the years have had a positive impact on the quality of table eggs available on the market and have allowed consumers to make an informed choice of products meeting their requirements. Unfortunately, the issue of egg storage, despite the important role it plays in the marketing of this animal raw material, has been treated far too superficially.

References

Batkowska J., Brodacki A., *Wpływ mycia skorupy na wybrane cechy jakości jaj kurzych w czasie przechowywania*, „Żywność. Nauka. Technologia. Jakość" 2014, nr 2(93).

Batkowska J., Brodacki A., Gryzińska M., *Effects of laying hen husbandry system and storage on egg quality*, "Archiv für Geflügelkunde" 2016, vol. 80(158).

Batkowska J., Brodacki A., Knaga S., *Quality of laying hen eggs during storage depending on egg weight and type of cage system (conventional vs. furnished cages)*, "Annals of Animal Science" 2014, vol. 14(3).

Biesiada-Drzazga B., Banaszewska D., Wereszczyńska A., Olędzki Ł., *Wpływ warunków przechowywania na wybrane cechy jaj pochodzących od kur rasy zielononóżka kuropatwiana*, „Żywność. Nauka. Technologia. Jakość" 2016, nr 1(104).

Bovšková H., Míková K., *Factors influencing egg white foam quality*, "Czech Journal of Food Sciences" 2011, vol. 29(4).

Brodacki A., Batkowska J., Drabik K., Chabroszewska P., Łuczkiewicz P., *Selected quality traits of table eggs depending on storage time and temperature*, "British Food Journal" 2019, vol. 121(9).

Calik J., *Zmiany cech jakościowych jaj pochodzących od kur nieśnych żółtonóżka kuropatwiana (Ż-33), w zależności od warunków ich przechowywania*, „Żywność. Nauka. Technologia. Jakość" 2013, nr 2(87).

Caner C., *The effect of edible eggshell coatings on egg quality and consumer perception*, "Journal of the Science of Food and Agriculture" 2005, vol. 85(11).

Chousalkar K.K., Khan S., McWhorter A.R., *Microbial quality, safety and storage of eggs*, "Current Opinion in Food Science" 2021, vol. 38.

Drabik K., Batkowska J., Próchniak T., Horecka B., *Citric acid as a factor limiting changes in the quality of table eggs during their storage*, "Poultry Science" 2021, vol. 100(4).

Drabik K., Próchniak T., Kasperek K., Batkowska J., *The use of the dynamics of changes in table eggs during storage to predict the age of eggs based on selected quality traits*, "Animals" 2021, vol. 11(11).

Drabik K., Próchniak T., Spustek D., Wengerska K., Batkowska J., *The impact of package type and temperature on the changes in quality and fatty acids profile of table eggs during their storage*, "Foods" 2021, vol. 10(9).

Gryzińska M., Niespodziewański M., Widomski P., *Wpływ warunków przechowywania kurzych jaj konsumpcyjnych różniących się wielkością na ich cechy jakościowe*, „Żywność. Nauka. Technologia. Jakość. Suplement" 2003, nr 10(4).

Gu Y.F., Chen Y.P., Jin R., Wang C., Wen C., Zhou Y.M., *A comparison of intestinal integrity, digestive function, and egg quality in laying hens with different ages*, "Poultry Science" 2021, vol. 100(3).

Heath J.L., *Chemical and related osmotic changes in egg albumen during storage*, "Poultry Science" 1977, vol. 56(3).

Hutchison M.L., Gittins J., Walker A., Moore A., Burton C., Sparks N., *Washing table eggs: A review of the scientific and engineering issues*, "World's Poultry Science Journal" 2003, vol. 59(2).

Jones D.R., *Egg functionality and quality during long-term storage*, "International Journal of Poultry Science" 2007, vol. 6(3).

Jones D.R., Ward G.E., Regmi P., Karcher D.M., *Impact of egg handling and conditions during extended storage on egg quality*, "Poultry Science" 2018, vol. 97(2).

Kralik Z., Kralik G., Grcević M., Galović A., *Effect of storage period on the quality of table eggs*, "Acta Agraria Kaposváriensis" 2014, vol. 18(Suppl. 1).

Krawczyk J., Sokołowicz Z., *Effect of chicken breed and storage conditions of eggs on their quality*, "Acta Scientiarum Polonorum. Zootechnica" 2015, vol. 14(4).

Leleu S., Messens W., De Reu K., De Preter S., Herman L., Heyndrickx M., De Baerdemaeker J., Michiels C.W., Bain, M., *Effect of egg washing on the cuticle quality of brown and white table eggs*, "Journal of Food Protection" 2011, vol. 74(10).

Li J., Zhu S., Jiang S., Wang J., *Prediction of egg storage time and yolk index based on electronic nose combined with chemometric methods*, "LWT-Food Science and Technology" 2017, vol. 82.

Liu Y.C., Chen T.H., Wu Y.C., Lee Y.C., Tan F.J., *Effects of egg washing and storage temperature on the quality of eggshell cuticle and eggs*, "Food Chemistry" 2016, vol. 211.

Marzec A., Damaziak K., Kowalska H., Riedel J., Michalczuk M., Koczywąs E., Cisneros F., Lenart A., Niemiec J., *Effect of hens age and storage time on functional and physiochemical properties of eggs*, "Journal of Applied Poultry Research" 2019, vol. 28(2).

Menezes P.C.D., Lima E.R.D., Medeiros J.P.D., Oliveira W.N.K.D., Evêncio-Neto J., *Egg quality of laying hens in different conditions of storage, ages and housing densities*, "Revista Brasileira de Zootecnia" 2012, vol. 41(9).

Oliveira G.D.S., Dos Santos V.M., Rodrigues J.C., Santana Â.P., *Conservation of the internal quality of eggs using a biodegradable coating*, "Poultry Science" 2020, vol. 99(12).

Pires P.G.S., Bavaresco C., Prato B.S., Wirth M.L., Oliveira Moraes P. de, *The relationship between egg quality and hen housing systems – a systematic review*, "Livestock Science" 2021, vol. 250(7).

Ragni L., Gradari P., Berardinelli A., Giunchi A., Guarnieri A., *Predicting quality parameters of shell eggs using a simple technique based on the dielectric properties*, "Biosystems Engineering" 2006, vol. 94(2).

Rodríguez-Navarro A.B., Domínguez-Gasca N., Muñoz A., Ortega-Huertas M., *Change in the chicken eggshell cuticle with hen age and egg freshness*, "Poultry Science" 2013, vol. 92(11).

Samli H.E., Agma A., Senkoylu N., *Effects of storage time and temperature on egg quality in old laying hens*, "Journal of Applied Poultry Research" 2005, vol. 14(3).

Scott T.A., Silversides F.G., *The effect of storage and strain of hen on egg quality*, "Poultry Science" 2000, vol. 79.

Sokołowicz Z., Kačániová M., Dykiel M., Augustyńska-Prejsnar A., Topczewska J., *Influence of storage packaging type on the microbiological and sensory quality of free-range table eggs*, "Animals" 2023, vol. 13(12).

Wang J., Yue H., Wu S., Zhang H., Qi G., *Nutritional modulation of health, egg quality and environmental pollution of the layers*, "Animal Nutrition" 2017, vol. 3(2).

Abstract: From the moment of laying, physico-chemical changes occur in eggs, known as "ageing". Their intensity is modified by many factors such as the age of the laying hens, the system of birds' rearing, the method of egg packaging, their storage conditions, the preservation methods or the physical characteristics of the eggs. Also, packaging and marketing operations affect the freshness and suitability of table eggs. The study brings into focus the type of changes, also in terms of consumer preferences and the possibility of deterioration of the quality of raw material against the background of the legal acts in force. Particular attention is paid to legislative changes specifying (or not) the storage conditions for eggs.

Keywords: table eggs; egg quality changes; egg storage

Abstrakt: Od momentu zniesienia w jajach zachodzą zmiany fizyko-chemiczne, określane jako „starzenie się". Ich intensywność modyfikowana jest przez wiele czynników, takich jak wiek niosek, system chowu ptaków, sposób pakowania, warunki przechowywania, metody konserwacji czy cechy fizyczne jaj. Również czynności związane z konfekcjonowaniem i wprowadzaniem surowca na rynek wpływają na zachowanie świeżości i przydatności jaj konsumpcyjnych. W artykule opisano rodzaj zmian, również w aspekcie preferencji konsumenta i możliwości pogorszenia jakości surowca, na tle obowiązujących aktów prawnych. Szczególną uwagę zwrócono na zmiany legislacyjne precyzujące (lub nie) warunki przechowywania jaj.

Słowa kluczowe: jaja konsumpcyjne; zmiany jakości jaj; przechowywanie jaj