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CHANGES IN VENISON QUALITY IMPORTANT TO THE CONSUMER DURING VENISON HARVESTING AND STORAGE

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Abstract. Food quality is a set of characteristics of the food product that can be evaluated for each kind of food. Several characteristics are identified for each of them: degree of freshness, energy value, amounts of protein, vitamins, micro- and macronutrients as well as various additives etc. However, the main characteristics of quality food of animal origin relate to its healthiness and safety for the consumer. From the perspective of a producer, quality represents specific characteristics to be achieved by the producer, and product quality is one of the basic elements of economic development to produce competitive products. Food production and processing, especially food of animal origin, is a complicated process that involves several stages and production process deviations affected by risk factors, and the elimination of the deviations is usually associated with significant financial expenses. Risk factors can appear at one or more stages and pass from one production stage to another, thereby negatively affecting the subsequent stages and the final product. In the production of venison, one of the groups of risk factors relates to venison harvesting, pre-processing and storage. Properly processed venison is usually clean and its microbiological contamination is not high, while non-compliance with venison storage requirements as well as bacterial contamination of venison in case of the non-compliance with storage requirements should be considered as a cause of possible materialization of some risks. Therefore, the present research aims to identify changes in venison quality important to the consumer during venison harvesting and storage. Microbiological control of venison is an important factor that affects the quality of the product, its shelf life and, in the long term, the competitiveness of the enterprise in the market. The research has found that venison could be stored for 45 to 50 days in vacuum packaging at a temperature of +3 to +4 ℃, provided that all the hygiene requirements are met during venison processing, which makes it possible not only to sell the product in the domestic market but also export the fresh venison.

Key words: deer farming, venison, quality, venison storage.
JEL code: Q22

Introduction

Global competition challenges and the need to increase the level of prosperity of the rural population set new objectives for food producers regarding the production of high-quality food commodities of animal origin. Quality becomes important when it comes to the competitiveness of a particular good or service, an industry and the national economy as a whole. The ongoing processes in the economy allow us to state with absolute certainty that the growth of the food industry in Latvia, just like the food industry in the world, is affected by the change in consumer demand for food products – the demand for healthy food as well as organically produced food tends to increase –, which is facilitated by the growing concern of consumers for the environment and their health. Public health issues are also stressed in national policy documents stating that one of the priorities of agriculture in Latvia is providing consumers with safe and high-quality food, which is also consistent with the goals set by the EU food safety policy, emphasizing that human health is. one of the basic values as well as the basis of life quality and personal and family prosperity. Therefore, one of the factors increasing the competitiveness of food production in the context of economic globalization is the production of high-quality food products.

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In the context of economic globalization, one of the factors increasing the competitiveness of livestock production is the production of high-quality food products. The need for research on it is determined by: the requirements of the common market of the European Union and the demand of the country's population for high-quality food that provides nutritional energy and guarantees human health preservation and improvement, as well as life extension. The population of the world continues to grow, currently exceeding 7 billion. This factor has contributed to the demand for animal products in human diets, as well as increasing the standard and quality of life in developing countries (Cawthorn, Hoffman, 2014). In 1961, meat consumption per capita did not exceed 23 kg, while in 2011 meat consumption had increased to 42 kg per capita (Sans et al., 2015). Since the demand for wild animal meat grew in the second half of the 20th century, the consumption of it increased worldwide to one million tonnes per year. As the demand continues to increase, today approximately 2 million tonnes of wild animal meat are sold for food every year (Costa et al., 2016).

Meat is considered to be the main source of fat in human diets. As health care evolves, there is an emphasis on the consumption of lean meats and products that are low in fat and cholesterol (Dahlan et al., 2008). An increasing focus is placed on food safety and animal diseases that can pose risks to human health and determine meat quality (Font-i-Furnols et al., 2014). Foods of this kind need to be stored for as long as possible and preserve high, consistent quality.

Quality is defined as the suitability of a good or service for use (Juran, 2010); however, from the perspective of a producer, quality represents specific characteristics. Food quality is understood as: 1) food safety or harmlessness, emphasizing that the quality characteristics of food must be such that it cannot cause damage to human health either in the short or long term, or even cause the death of a person; 2) expected properties of the food product, e.g. organoleptic, nutritional properties etc.; 3) desired characteristics of food, which meet consumer expectations regarding value added. It should be considered that there is increasing discussion on meat quality and the role of it, yet there is no consensus on the meaning of the term quality. It is generally considered to be a combination of two main elements. One of the characteristics is overall meat quality, which includes properties that can be measured, e.g. microbiological condition, tenderness, colour, juiciness, a shelf life, a pH value and toxin content. However, quality is also determined by immeasurable aspects: the consumer personal perception of meat and its quality value. According to research studies by the European Food Institute, the number of consumers in the European Union who consider food healthiness as the main criterion for choosing and purchasing food products and associate it directly with fresh, non-frozen meat tends to increase (Vaarst, Hovi, 2004). This means that food quality does not represent only organoleptic properties or other characteristics of food, the quality means the desired characteristics of food that could justify value added; e.g. the type of food production (organic farming, environmental protection, animal welfare), production areas (designations of origin) and the related traditions, a different demand for high-quality foods with low cholesterol and fat contents, e.g. for game meat, which differs in specific taste characteristics, as well as functional products with more physiologically active principles (Yamada et al., 2008).

Food safety criteria could be considered objective food quality evaluation criteria. The International Organization for Standardization (ISO) has defined quality (ISO 9000 series standards) as achieving long-term satisfaction, considering the wishes of consumers within the limits of their needs, stating that "quality is the degree to which a set of inherent characteristics of an object fulfils requirements". In fact, it represents compliance with the requirements set (e.g. international, national, sectoral etc.) or general conditions for the good or service produced and is able to satisfy the imagined needs of the consumer.

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Therefore, from the perspective of a producer, quality represents specific characteristics to be achieved by the producer.

However, the organoleptic (e.g. colour, taste, consistency) and desirable properties of food (e.g. produced on an organic farm) are what each consumer understands by this concept individually; therefore, they can be considered as subjective evaluation criteria. American scientist J. Juran (2010) defines quality as the suitability of a good or service for use, i.e. if the good or service fully meets the needs of the consumer, it is suitable for use. The competitive advantages of deer farming are provided by food characteristics that are different from those of traditional food, such as the quality and organoleptic properties of venison (Rock, MacMillan, 2022); however, it is important to ensure the quality of venison in the long term as well. In food production, processing, packaging and distribution can increase or decrease the quality of agricultural products, and it should be especially emphasized that on many deer farms, the deer are harvested by being shot from a distance in the field. This requires additional pre-processing of the carcass on the farm and timely transportation of the carcass to a slaughterhouse for further processing, division and cooling. This stage is one of the most critical risk factors that can negatively affect the quality of the final venison product. Accordingly, external factors (e.g. an inaccurate shot) and errors in the technological process (e.g. during animal pre-processing) can negatively affect the quality characteristics of meat during the processing and storage thereof. This could create preconditions for the production of low-quality venison, resulting in economic losses, and the technological chain formed over a long period and the investments made in its creation would not bring the expected revenue. Thus, one can claim that in deer farming, harvesting conditions, deer pre-processing, carcass storage etc. technological aspects in the meat production process play a decisive role in the supply of high-quality, harmless and high-value venison products to consumers.

The mentioned factors make a significant impact on the competitiveness of deer farming both in the domestic and foreign markets. There are various techniques for storing venison: chilling, freezing and vacuum packing, which have different storage requirements and shelf lives. It is known that fresh meat has a higher market value; therefore, research on the possibilities of storing meat for as long as possible without freezing is particularly important. The research problem: fresh venison and its products that meet consumer requirements need to be stored fresh for as long as possible and preserve high, constant quality.

To achieve the longest period of storage of fresh venison and deliver the fresh venison to the domestic and foreign markets, the venison is cooled down and vacuum packaged. However, the technology of venison harvesting differs from farm to farm, which can affect the supply of safe fresh venison to consumers. Therefore, the research **aims** to identify changes in venison quality important to the consumer during venison harvesting and storage. The research focused on the most significant parameters that indicated technological risks that might arise as a result of human activity and significantly affect the economic performance of the farm, shorten the shelf life of the product and affect the consumer.

The present research tested venison samples obtained from four farms that were stored up to 50 days to identify the chemical and microbiological characteristics of the venison by employing laboratory testing methods. Before the carcass was divided and vacuum packaged, the carcasses of batches 1-4 were cooled in a refrigerator to a temperature of +2-+4 ℃ and stored for 1 to 2 days; the venison samples of batch 2 were rinsed with water before vacuuming. However, to achieve the recommended game meat maturation period, the carcasses of batch 5 were stored in the refrigerator for 8 days before being divided and packaged.

Research results and discussion

In Europe, deer farming has been practiced since ancient times, and it is a cultivated and strong tradition in many countries (Mirceta et al., 2016). Today, the most common deer species that are farmed in Europe (in captivity) are red deer (*Cervus elaphus*) and fallow deer (*Dama dama*) (Costa et al., 2016; Daszkiewicz et al., 2015; Florek, Drozd, 2013). Deer farms provide inputs for various industries, supplying not only meat and its products to the food industry but also deer skins, horns, teeth, hair, velvet horns to pharmaceutical and furniture factories etc. (Drew, 1992; Kuba et al., 2015).

Factors affecting the production of food are similar in all livestock industries, yet, there are certain differences in deer farming that, to a great extent, influence the quality of products and ensure its differentiation. In food production, the quality of a final product is largely affected by the technological processes of production, processing and sale, which determine preconditions for demand and supply in the food market. During production, all technological processes strongly relate to each other and therefore they affect each other because the positive and negative factors present at one stage pass to the next stages. An important factor affecting quality, the author believes, is associated with the production of meat in deer farming. In traditional livestock farming, the production of meat is related to the transportation of animals and an increased stress level during the pre-slaughtering period. According to researches (Jansons, 2010), stress negatively influences qualitative indicators of meat. In deer farming, animals are shot for meat in their natural environment without causing stress to animals, as they are not caught and transported. It reduces the stress hormone level in meat, ensuring a higher quality of meat. It has to be emphasised that shooting deer in a pasture requires additional pre-processing of their carcases on the spot on a farm and timely transportation of their carcases to a slaughter-house for further processing, cutting, and cooling. This stage is one of the most critical risk factors, which may negatively affect the quality of final products of venison.

The quality of venison is affected by various factors: environmental pollution, pathological changes, stress etc., which the deer has encountered during the life. It is important to cool the carcasses of game animals as quickly as possible to the maximum permissible temperature of +7 ℃ (Wiklund, Malmfors, 2004). The colour of meat is one of the most important parameters that determine the acceptability and choice of the product for the consumer. A dark colour is usually associated with firm and dry meat, in the case of venison, a strong red colour indicates good quality and is a typical sign of game meat (Font-i-Furnols, Guerrero, 2014; Ramanzin et al., 2010). Game meat, incl. venison, is characterized by a high proportion of muscle tissue; therefore, it is extremely important to mature the meat so that it becomes softer and meets consumer preferences. Therefore, one of the most important physical parameters that determine the quality of meat is an extreme pH value of the meat, which is identified approximately 24 h after the slaughter of the animal. Forty minutes after the deer was slaughtered, the pH value decreased to 5.4-5.7, which could be explained by the formation of lactic acid due to the breakdown of glycogen. This process is called meat maturation. It should be noted that rapid changes in the pH value affect the organoleptic properties of meat that are important for the consumer: colour, taste, aroma, juiciness and structure, as well as technological properties: water resistance. As glycogen reserves in muscle tissues decrease, the meat maturation process is disturbed, which gets longer and rapidly lowers the quality of the meat and shortens its shelf life due to the high pH value (6.0 - 6.2), which makes the meat tough (Atanassova et al., 2008). With increased stress in the pre-slaughter period, glycogen reserves are depleted in the animal's body during the stress, and, consequently, lactic acid

synthesis does not occur to a sufficient extent, resulting in dark-coloured, firm and dry meat (DFD) (Dikeman, Devine, 2014).

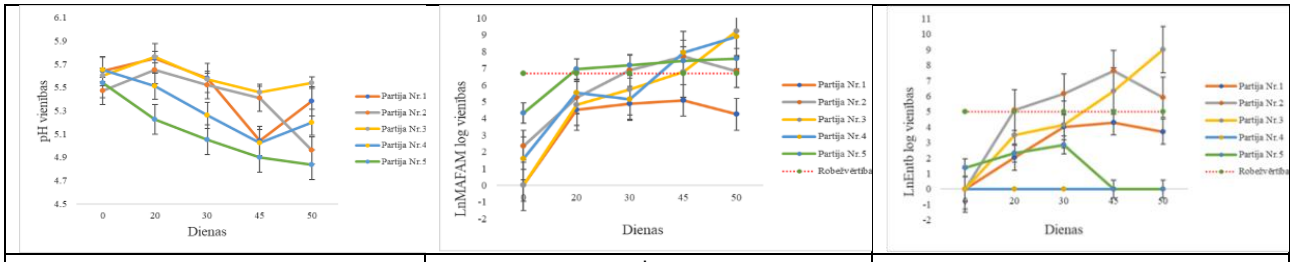
The pH value of high-quality game meat should be in the range of 5.5-5.7 (Wiklund et al., 2014). When storing game meat up to 14 days after slaughtering the animal, the pH value practically does not change (Hoffman, Wiklund, 2006). Meat with pH values in the range of 5.5-5.8 is packed in gas-tight packaging from which air is extracted, and the meat package is stored at a temperature of +2-+4 ℃. The potential of free air and water release for the product in such packaging is reduced, resulting in a significant reduction in the potential for bacterial growth. The shelf life could be up to 3 months, yet provided that the meat meets a good microbiological standard before packaging (Collins and Huey, 2015), i.e. the hygiene requirements have been met during meat processing, which enables producers to gain competitive advantages and geographically wide markets. Meat spoilage at a pH value of <5.8 is caused by potentially hazardous bacteria, which multiply in muscle tissues (salmonella, listeria etc.) (Green, Nattress, 2004).

Based on the pH values identified on the first day of testing on the farms (Fig.1 (a)), it could be established that the deer carcasses were cooled immediately after the deer were harvested and processed in a slaughterhouse, and the deer were not subjected to stress that would contribute to the deterioration of venison quality.

In addition to the nutrients contained in meat, the suppliers of safe and high-quality food to consumers focus on the microbiological characteristics of meat. In the world, the most common foodborne infections relate to human enteric diseases caused by bacteria in foodstuffs (Newell et al., 2010). Meat contaminated with pathogenic microorganisms that are common to both humans and animals and parasites that cause various diseases is dangerous to human health. Fresh meat and fresh meat products can contain microorganisms such as Escherichia coli and Salmonella, which can pose a high risk of danger to human health. The pathogens are considered to be priorities for food safety control in the meat processing industry (Dikeman, Devine, 2014). Microorganisms get on meat during the processing, transportation and storage of it. For example, the producer incurs losses if the animal is unsuccessfully shot in the stomach, as this creates an increased risk of reproduction of microorganisms that are harmful to the health of the consumer. Often in such situations, game meat is washed with water; however, the meat rinsed with water begins to spoil faster and is not be suitable for long-term storage. The regulations of the European Union Commission (No. 2073/2005 on microbiological criteria for foodstuffs etc.) (EU, 2005), the legislation and Cabinet regulations of the Republic of Latvia (Law on the Supervision of the Handling of Food etc.), as well as the Guidelines for Best Hygiene Practices must be complied with to ensure the quality and safety of meat. All market actors involved in the handling of food must ensure the identification of any supplier, and the supply of food commodities and products must be traceable in the territory of the EU (Gavriļenko, 2008). To produce high-quality meat, it should be ensured that the animals intended for slaughter are rested, the carcass must be well bled, special equipment for processing the carcass must be clean. The safety of fresh meat is determined by the organoleptic, physical and chemical as well as microbiological properties of the product. It is not always possible to identify the safety of meat by looking at the product and examining the organoleptic properties of it. Basically, it is necessary to make sure that there is no microbiological contamination in the meat, which is directly affected by the physical and chemical properties of the product. The growth and development of microorganisms in food is affected by a number of internal and external factors. The internal factors include: pH value, water activity (aw), nutrients in meat, as well as natural protective barriers etc. The external factors include storage temperature, relative humidity, gases in the environment etc. (Gavrilenko, 2008). The way food is processed and stored affects the stability and safety of food and can also affect the nutritional value, sensory, technological and economic properties of it. From

a hygienic perspective, wild and captive (farmed) deer should be processed in slaughterhouses. An important step to prevent the carcass from being contaminated and polluted by various microorganisms is the removal of the skin, as hair from the skin often end up on the carcass, as well as the evisceration of the carcass. After being harvested, the carcasses of deer are transported to the slaughterhouse in cooling containers, the skin is not removed from carcasses, and the unskinned carcasses are transported to the slaughterhouse. The meat cooling and maturation period is also important when a dry crust forms on the carcass, which protects against the penetration of microorganisms.

The count of mesophilic aerobic and facultative anaerobic microorganisms (MAFAM) enables an assessment of the hygienic status of venison, as reported by Carter (1990). On the first day of testing venison samples in the laboratory, the total count of microorganisms was in the minimum range (Fig.1 (b)). The contamination of meat with microorganisms was inevitable, as the microflora of the animal's own digestive tract could get on it, as well as the environment, the hands, clothes and tools of the slaughterhouse worker could serve as a source of contamination (Reinken et al., 1980). An analysis of venison samples taken on the first day of storage revealed that the processing of venison samples and carcasses of batches 1 and 3 was done at the highest quality, complying with all hygiene requirements for slaughterhouses (Cabinet regulation No. 328). By increasing the storage period of fresh venison to 50 days, the total count of mesophilic aerobic and facultative anaerobic bacteria increased in all the sample batches, which could be explained by the active development of microorganisms; however, the samples of batch 1 maintained a low level of contamination until day 50, i.e. high-quality, according to the market requirements. The worst performance was found for the sample of batch 5, which could be explained by a long cooling period of the carcass, the carcass was stored at a temperature of +2-+4 ℃ for 8 days, and only after that the samples were vacuum packaged. In contrast, the second worst performance was found for the sample of batch 2, which was rinsed with drinking water before being vacuum packaged, which apparently contributed to the contamination with microorganisms and created a favourable environment for their development. It follows that the risk of infecting the lowest quality samples with any of the bacterial diseases is posed already soon after the carcass has been processed, reaching the critical period on the 20th day of storage.



a | b | c

Source: authors' calculations based on research data

Fig. 1. **Changes in meat quality during storage**

Enterobacteriaceae bacteria affect meat quality and serve as an indicator of poor hygiene, processing technology and post-processing problems regarding the product (Food Safety, 2016). According to Carter (1990), the presence of Enterobacteriaceae bacteria serves as an indicator for assessing the hygienic status of game meat, based on which it could be established that the technique of harvesting venison and the processing technology have been chosen correctly and could ensure high quality meat. Accordingly, complying with the hygiene requirements in the slaughterhouse and during meat processing provide a longer storage period for meat and meat products. As shown in Figure 1 (c), the critical period was reached on the 20th day of storage of venison samples (batch 2); after 30 days of storage, this level of

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contamination with representatives of the Enterobacteriaceae group was found in the samples of batch 3. This means a low-quality venison production process can endanger the health and even life of consumers. It should be noted that the samples of batches 1, 4 and 5 did not reach the critical period during 50 days of storage.

At the same time, microorganisms dangerous to human health (causing foodborne pathogens) such as Escherichia coli, Pseudomonas spp. and Salmonella spp., were not found in the venison samples, which indicated that best hygiene practices were followed overall; however, technological errors made at certain stages did not allow us to reach a maximum long (up to 50 days) fresh venison storage period.

An analysis of the characteristics of the technological process of meat production on farms and of quality of meat, the need for special meat processing enterprises and game meat processing lines should be emphasized to cover a wider domestic market and enter foreign markets. Retailers consider venison quality and the regularity of supply as a limiting factor in selling venison products. When setting quality, supply regularity and quantity requirements for venison products, it often turns out that the production capacity of each individual enterprise is insufficient to meet the requirements. The principles of partnership based on long-term cooperation contracts etc. activities could serve as a basis for the establishment of a specialized game animal slaughterhouse and processing enterprise, which would provide the production of higher quality venison products. In view of the high fuel prices and long distances from slaughterhouses to deer farms, it is financially unprofitable to transport the deer to a specialized slaughterhouse, pay for slaughtering services and laboratory tests and then deliver the products to retailers. Therefore, it is necessary to find a possibility to ease the requirements for the construction and equipment of low-capacity slaughterhouses to foster the emergence of such slaughterhouses in the regions where specialized slaughterhouses are located too far from deer farms. This could be achieved through the establishment and certification of mobile and low-capacity slaughterhouses. The range of customers for mobile slaughterhouses would be allowed to be relatively wide if the deer farms are small, and there is no need for slaughterhouse services for several farms at the same time. By establishing low-capacity slaughterhouses in Latvia, the construction and equipment of which would comply with the eased requirements of legal acts, consumers would have an opportunity to purchase fresh venison harvested in Latvia, and the price of venison would be competitive in the domestic market.

Conclusions, proposals, recommendations

1) It is possible to store fresh venison for up to 50 days in vacuum packaging if the venison processing technology and hygiene requirements have been met, provided that all the hygiene requirements are met during venison processing, which makes it possible not only to sell the product in the domestic market but also export the fresh venison.
2) Enhancing the culinary properties of venison through a long maturation period (delayed vacuum packaging of fresh venison) as well as rinsing the venison with drinking water before packaging contributes to an increase in the count of microorganisms and reduces the shelf life of fresh venison; therefore, it cannot be used when planning the sale of fresh venison over a long period.
3) To make the production, processing and sale of venison continuous, it is necessary to increase the output of venison and its products and provide regular supplies to the market, which could be achieved by achieving a longer storage period for fresh venison.
4) The establishment of mobile and low-capacity slaughterhouses on farms can contribute to faster pre-processing of venison and, consequently, higher quality production, which would improve the regularity and continuity of venison supplies to retailers in the future.

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Bibliography

1. Atanassova, V., Apelt, J., Reich, F., Klein, G. (2008). Microbiological quality of freshly shot game in Germany. *Meat Science*, vol.78(4), pp.414-41.
2. Cabinet Regulation No. 328 of 2013 on Requirements for Slaughterhouses if Meat of Animals Slaughtered Therein is Sold on the Domestic Market in Small Quantities. Retrieved: https:// https://likumi.lv/ta/id/257753-prasibas-mazjaudas-kautuvem. Access: 16.01.2023.
3. Carter, M.E. (1990). Enterobacteria. Diagnostic procedures in veterinary bacteriology and mycology. Eds M.E. Carter, J.R. Cole. Academic Press, San Diego, pp.92-98.
4. Cawthorn, D.M., Hoffman, L.C. (2014). The role of traditional and non-traditional meat animals in feeding a growing and evolving world. *Animal Frontiers*, vol.4(4), pp.6-12. Retrieved: https://doi.org/10.2527/af.2014-0027. Access: 28.01.2023.
5. Collins, D.S., Huey, R.J. (2015). Grasey's Meat Hygiene. John Wiley & Sons Ltd, West Sussex. Editions 11th, p.352.
6. Costa, H., Mafra, I., Oliveira, M.B.P.P., Amaral, J.S. (2016). Game; types and composition. In: F. T. B. Caballero, P. M. Finglas, F. Toldrà (Eds.) Encyclopedia of food and health, Amsterdam: Elsevier, vol. 3, pp.177-183.
7. Dahlan, I., Horfarizan Hanoon, N.A. (2008). Chemical composition, palatability and physical characteristics of venision from farmed deer. *Animal Science Journal*, vol.79(4), pp.498 – 503. Retrieved: https://doi.org/10.1111/j.1740-0929.2008.00555.x. Access: 22.08.2022.
8. Daszkiewicz, T., Hnatyk, N., Dabrowski, D., Janiszewski, P., Gugołek, A., Kubiak, D., Koba – Kowalczyk, M. (2015). A comparison of the quality of the Longissimus lumborum muscle from wild and farm – raised fallow deer (Dama dama L.) *Small Ruminant Research*, vol.129, pp.77-83. Retrieved: https://doi.org/10.1016/j.smallrumres.2015.05.003. Access: 15.12.2022.
9. Dikeman, M., Devine, C. (2014). Encyclopedia of Meat Sciences. United Kingdom, Academic Press. 2nd Edition, p.569.
10. Drew, K.R. (1992). *Plenary lecture: Venison and other deer products*. In: R. D. Brown (Ed.). The biology of deer Springer New York, pp. 225-232.
11. EU (2005). Commission Regulation (EC) No 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs. OJ L 338, 22 of December 2005, p.12.
12. Florek, M., Drozd, L. (2013). Związki bioaktywne w mięsie jeleniowatych// Bioactive compounds in deer meat. *Medycyna Weterynaryjna*, vol.69(9), pp.535-539.
13. Font-i-Furols, M., Guerrero, L. (2014). Consumer preference, behavior and perception about meat and meat products: An overview. *Meat Science*, vol.98(3), pp.361-371. Retrieved: https://doi.org/10.1016/j.meatsci.2014.06.025. Access: 10.02.2023.
14. Food Safety Authority of Ireland (2016) Guidance Note No.3 Guidelines for the Interpretation of Results of Microbiological Testing of Ready – to – Eat Foods Placed on the Market, Dublin, FSAI, Revision 2, p.48.
15. Gavriļenko, E. (2008). Sanitārija un higiēna pārtikas aprites uzņēmumos. Rīga, SIA Biznesa augstskola Turība, 80 lpp.
16. Green, G.G., Nattress, F.M. (2004). Standard methods. Encyclopedia of meat sciences, Eds K.W. Jensen, C. Devine, M. Dikeman. Amsterdam, vol. 2, Elsevier Academic Press, pp.745-754.
17. Hoffman, L.C., Wiklund, E. (2006). Game and venison – meat for the modern consumer. *Meat science*, vol.74, pp.197-208. Retrieved: https://doi.org/10.1016/j.meatsci.2006.04.005. Access: 05.01.2023.
18. Jansons I. (2010) Fito un organisko skābju piedevu ietekme uz cūku produktivitāti un gaļas kvalitāti. Promocijas darbs. Jelgava, Latvijas Lauksaimniecības universitāte, 121 lpp. (in Latvian)
19. Juran J. M. (2010) Key Concepts: What Leaders Need to Know about Quality. In: *Juran's Quality Handbook*. Juran J. M., De Feo J. A. (eds.). McGraw-Hill Professional; 6th edition. pp.3–326. (p.1136). Kuba, J., Landete – Castillejos, T., Udala, J. (2015). Red deer farming: Breeding practice, trends and potential in Poland – a review. *Animal Science*, vol.15(3), pp.591-599. Retrieved: https://doi.org/10.1515/aoas-2015-0033. Access: 08.10.2022.
20. Law on the Supervision of the Handling of Food (1998). Retrieved: https://likumi.lv/ta/en/en/id/47184. Access: 04.01.2023.
21. Mirceta, J., Urosevic, M., Petrović, J. (2016). Deer farming in European Union and Serbia: Veterinary legislation perspecitve. Conference paper: International Symposium on Animal Science (ISAS) 2016
22. Newell, D.G., Koopmans, M., Verhoef, L., Duizer, E., Aidara – Kane, A., Sprong, H., Opsteegh, M., Langelaar, M., Threfall, J., Scheutz, F., der Giessen, J.V., Kruse, H. (2010). Food – borne diseases – the challenges 0f 20 years ago still persist while new ones continue to emerge. *International Journal of Food Microbiology*, vol.139(1), pp.S3-15. Retrieved: https://doi.org/10.1016/j.ijfoodmicro.2010.01.021. Access: 04.11.2022.
23. Ramanzin, M., Amici, A., Casoli, C., Esposito, L., Lupi, P., Marsico, G., Marinucci, M.T. (2010). Meat from wild ungulates: Ensuring quality and hygiene of an increasing resource. *Italian Journal of Animal Science*, vol.9(3), pp.318-331.

24. Reinken, G., Hartfiel, W., Korner, E. (1980). Damtierhaltung. Verlag Eugen Ulmer, Stuttgart, pp.174-187.
25. Rock, K. I., & MacMillan, D. C. (2022). Can Substitutes Reduce Future Demand for Wildlife Products: A Case Study of China's Millennial Generation. Human Ecology, 50(1), 91-111.
26. Sans, P., Combris, P. (2015). World meat consumption patterns: An overview of the last fifty years (1961 – 2011). Meat Science, vol.109, pp.106-111. Retrieved: https://doi.org/10.1016/j.meatsci.2015.05.012. Access: 03.02.2023.
27. Vaarst M., Hovi M. (2004). Organic livestock production and food quality: a review of current status and future challenges. In: Proceedings of the 2nd SAFO Workshop. Witzenhausen, Germany, 25 – 27 March 2004, pp. 7–15.
28. Wiklund, E., Farouk, M., Finstad, G. (2014). Venison: Meat from red deer (Cervus elephus) and reindeer (Rangifer tarandus tarandus). *Animal Frontiers*, vol.4(4), pp.55-61. Retrieved: https://doi.org/10.2527/af.2014-0034. Access: 03.02.2023.
29. Wiklund, E., Malmfors, G. (2004). The effects of pre-slaughter handling on reindeer meat quality – a review. *Animal Breeding Abstracts*, vol.72(I), IN-6N.
30. Yamada K., Sato-Mito N., Nagata J., Umegaki K. (2008) Health Claim Evidence Requirements in Japan. *The Journal of Nutrition*, Volume 138, Issue 6, p. 1192S-1198S. Retrieved: https://doi.org/10.1093/jn/138.6.1192S