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ARTICLE

Introduction to food safety and quality – theoretical and legal considerations

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Abstract

The purpose of this article is to systematise knowledge on food safety from a theoretical and legal perspective. The research methodology is based on desk research, involving an analysis of scientific literature, legal documents, and reports from international organisations. The authors compare various definitions and present a classification of the factors that influence food safety, dividing them into political, social and economic categories. The article also describes threats to food safety, including biological, physical and chemical hazards, risks related to genetic modifications, as well as dangers from food crime and terrorism. Key systems for managing food quality and safety are identified, along with the institutions responsible for oversight in Poland and globally. The paper concludes that the effectiveness of these systems largely depends on the food safety culture within companies and on public awareness, as these factors

determine actual compliance with rules and procedures. Therefore, the continuous improvement of these systems and the effectiveness of control institutions is necessary to meet dynamically evolving threats and consumer expectations.

Keywords food safety and quality, food safety and quality management systems, food safety risks, determinants of food safety

Introduction

Despite the dynamic development of civilisation that we have been observing for many decades, the global repercussions of lack of food security[1] are still present, and not only in developing countries. This has serious social and economic consequences. It is estimated that various forms of malnutrition[2] affect even around 70% of the world's population, generating economic costs of USD 3.5 trillion annually. Approx. 600 million people suffer from illnesses resulting from poor diet or poor-quality food. Although more than USD 100 billion is spent annually on treating these diseases globally, they still account for approx. 20% of all deaths

[1] Currently understood as a state in which all people, at every level of social organisation, have permanent physical, economic and socio-health access to an adequate amount of safe and properly balanced food. It meets their nutritional needs and preferences as well as enables them to lead healthy and active lives. Food security is based on three pillars (dimensions): physical availability of food, economic accessibility of food and its social accessibility, as well as nutritional and health adequacy (utilisation). The relative stability of these elements over time also plays a key role. Stability is often indicated in the literature as one of the main pillars of food security. However, this approach does not fully reflect its importance for food security, as stability is the foundation for the other three aspects – without it, neither physical, economic nor socio-health access to food can be ensured. See: A. Sapa, *Bezpieczeństwo żywnościowe w krajach rozwijających się* (Eng. Food safety in developing countries), "Roczniki Ekonomiczne Kujawsko-Pomorskiej Szkoły Wyższej w Bydgoszczy" 2010, no. 3, p. 233; A. Obiedzińska, *Wpływ strat i marnotrawstwa żywności na bezpieczeństwo żywnościowe* (Eng. Impact of food losses and waste on food security), "Zeszyty Naukowe SGGW w Warszawie" 2017, vol. 17(32), no. 1, p. 128. https://doi.org/10.22630/PRS.2017.17.1.12; A. Obiedzińska, *Wybrane aspekty zapewnienia bezpieczeństwa żywnościowego w Unii Europejskiej* (Eng. Selected aspects of food security in the European Union), "Studia BAS" 2016, no. 4(48), p. 124.

[2] Three types have been identified – quantitative, qualitative and overconsumption, which respectively mean: too few calories consumed, a lack of certain micro- and macronutrients in the diet, and excessive calorie consumption, often accompanied by an imbalance in the proportions of micro- and macronutrients. See: A. Obiedzińska, *Wpływ strat i marnotrawstwa*…, pp. 126–128; A. Obiedzińska, *Wybrane aspekty zapewnienia*…, p. 125.

worldwide[3]. The importance of the third pillar of food security, which, in addition to social access to food[4] and nutrition security[5], also includes food safety, is therefore evident.

The article aims to systematise knowledge on the most important aspects of food safety – its definition, determinants and fundamental threats, as well as the systems and institutions responsible for ensuring it. The research problem concerns questions about the most important theoretical and legal elements that make up the contemporary food safety paradigm and the main challenges to its effective functioning. The subject of the research is the theoretical and legal dimension of food safety, understood as a complex system of interrelated concepts, conditions and institutional mechanisms. The analysis covers the architecture of this system – it examines its conceptual foundations as well as its management and control structures. General categories of threats to the integrity of the entire system are also being studied – from unintentional risks to deliberate criminal activities. This topic is not a new area of research in Polish academia, as evidenced by numerous monographs (including those by Małgorzata Z. Wiśniewska and Joanna Wyrwa, Stanisław Kowalczyk, Magdalena Niewczas-Dobrowolska)[6]

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[3] A. Obiedzińska, *Wybrane aspekty zapewnienia*…, p. 135; S. Nordhagen et al., *Integrating nutrition and food safety in food systems policy and programming*, "Global Food Security" 2022, no. 32, p. 1. https://doi.org/10.1016/j.gfs.2021.100593; T. King et al., *Food safety for food security: Relationship between global megatrends and developments in food safety*, "Trends in Food Science & Technology" 2017, vol. 68, p. 161. https://doi.org/10.1016/j.tifs.2017.08.014.

[4] Understood as the need to provide food that not only poses no direct threat to consumer health, but is also nutritious – providing the right proportions of micro- and macronutrients. In addition, this food should take into account consumer preferences resulting from current trends and lifestyles as well as individual health needs. Cultural, religious and ethical factors that influence the food choices of individuals and societies also play an important role. See: K. Marzęda-Młynarska, *Globalne zarządzanie bezpieczeństwem żywnościowym na przełomie XX i XXI wieku* (Eng. Global food security management in the 20th and 21st century), Lublin 2014, p. 99 et seq.

[5] In narrow terms, nutrition security means following the principles of healthy eating, taking into account age, health and lifestyle. At the same time, a holistic approach to health issues is becoming increasingly popular, taking into account not only dietary issues, but also healthcare and personal hygiene. See: D. Kasprowicz, *Bezpieczeństwo żywnościowe i niedożywienie w Afryce Subsaharyjskiej – nowe kierunki i trendy* (Eng. Food security and malnutrition in sub-Saharan Africa – new directions and trends), "Problemy Higieny i Epidemiologii" 2015, no. 96(1), p. 87; E.H. Pangaribowo, N. Gerber, M. Torero, *Food and nutrition security indicators*, "ZEF Working Paper Series" 2013, no. 108, p. 4.

[6] M.Z. Wiśniewska, J. Wyrwa, *Bezpieczeństwo żywności i żywnościowe w okresie pandemii. Ujęcie interdyscyplinarne* (Eng. Food safety and security during the pandemic. An interdisciplinary approach), Zielona Góra 2022. https://doi.org/10.26366/PTE.ZG.2022.210; S. Kowalczyk, *Bezpieczeństwo i jakość żywności* (Eng. Food safety and quality), Warszawa 2016; M. Niewczas-Dobrowolska, *Jakość i bezpieczeństwo żywności. Systemy – postawy – konsumenci* (Eng. Food quality and safety. Systems – attitudes – consumers), Kraków 2020.

and articles by recognised researchers (including Aleksandra Kowalska, Teresa Korbutowicz and Nina Baryłko-Pikielna)[7]. However, in the authors' opinion, there is a lack of a synthetic and relatively holistic view of the issue as a whole. In order to fill this research gap, a synthesis of secondary research material was carried out using desk research method. This article is part of a series of publications aimed at providing a theoretical reflection on the issue of food security in all its aspects. Thus, it contributes to further research aimed at creating an analytical theoretical matrix.

Food safety and quality – attempt at conceptualisation

'Food safety' is both a legal and scientific term. It has a legal definition that has been in force in the Polish legal system since 2006, as well as strictly academic definitions and definitions resulting from the activities of various national and international institutions. According to the statutory definition, food safety means (…) *all conditions that must be met* (…) *and actions that must be taken at all stages of food production or distribution in order to ensure human health and life*[8]. It is worth noting the holistic approach to food safety emphasised by the legislator – responsibility for this lies with producers, processors, distributors and consumers alike (in accordance with the 'farm to fork' principle)[9]. A similar approach is presented in the international Codex Alimentarius, in which food safety is defined as

[7] A. Kowalska, *Problematyka oszustw żywnościowych w przepisach prawa i standardach branżowych* (Eng. An issue of food fraud in regulatory activities and industry standards), "Kwartalnik Nauk o Przedsiębiorstwie" 2017, vol. 45, no. 4, pp. 30–41. https://doi.org/10.5604/01.3001.0010.7451; T. Korbutowicz, *Żywność genetycznie modyfikowana na świecie – zagrożenia czy korzyści* (Eng. Genetically modified food in the world – threats or benefits), in: *Zdrowie i style życia. Wyzwania ekonomiczne i społeczne*, W. Nowak, K. Szalonka (eds.), Wrocław 2019, pp. 133–156; N. Baryłko-Pikielna, *Konsument a jakość żywności* (Eng. Consumers and food quality), "Żywność. Technologia. Jakość", 1995, no. 4(5), pp. 3–10.

[8] Article 3 point 3 of the *Act of 25 August 2006 on safety of food and nutrition*. See also: A. Litwińczuk et al., *Wdrażanie systemów zapewnienia bezpieczeństwa żywności (GHP, GMP i HACCP) w zakładach i instytucjach związanych z jej produkcją* (Eng. Implementation of system ensuring food safety (GHP, GMP and HACCP) in establishments and institutions associated with food production), "Życie Weterynaryjne" 2016, vol. 91, no. 5, p. 368; I. Jackiewicz, M. Tereszczuk, *Bezpieczeństwo czy niebezpieczeństwo: w poszukiwaniu modelu krajowego systemu kontroli bezpieczeństwa żywności* (Eng. Safety or danger: in the search for a model of the National Food Control System), "Przedsiębiorczość i Zarządzanie" 2017, vol. 18, n. 9, pt. 2, p. 36; C.A. Kwiatkowski, E. Harasim, *Produkcja rolnicza a bezpieczna żywność – wybrane aspekty* (Eng. Agricultural production and safe food – selected aspects), Radom 2019, p. 26.

[9] A. Obiedzińska, *Wybrane aspekty zapewnienia*…, pp. 133–134.

(…) *all factors that ensure food is safe for human health and life, provided it is properly prepared and/or consumed in accordance with its intended use*[10]. The World Health Organization (WHO) and the Food and Agriculture Organization (FAO) view them in a similar way – as measures aimed at eliminating health risks arising from food consumption. They include appropriate procedures at all stages of the food chain – from production, through handling and storage, to preparation – in a manner that prevents infection and contamination[11].

It is worth noting that a different approach from the previous ones – based on the category of risk management – is present in one of the reports published under the auspices of the Organisation for Economic Co-operation and Development (OECD). The food safety was characterised there as a risk of bacteria and pathogens, toxins and chemical residues – which could [negatively – authors' note] affect human health, but also as a risk of spreading diseases or parasites that could potentially affect plant or animal health[12]. Paul L. Knechtges views food safety in similar terms, for whom it constitutes (…) *the state of acceptable and tolerable risks of illness, disease, or injury from the consumption of food*[13]. It should therefore be agreed with Irena Jackiewicz and Mirosława Tereszczuk that the food safety is perceived differently depending on the perspective of individual participants in the food chain – farmers, producers, distributors and consumers will pay attention to different elements. For farmers, the priority is to strike a balance between production efficiency and the need to use plant protection products and veterinary medicines, which directly affects the profitability of farms. In the food industry, food safety mainly involves eliminating chemical, physical and biological hazards that may adversely affect product quality. Distribution and trade representatives view them through the prism of regulatory requirements and consumer expectations, emphasising product compliance with applicable norms and standards. From the consumer's point of view, food safety means that it is fully fit for consumption, which includes both hygienic preparation conditions and the absence of harmful substances such as pesticides or chemical contaminants[14].

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[10] M. Wiśniewska, J. Wyrwa, *Bezpieczeństwo żywności i żywnościowe…*, p. 13; S. Sitarz, M. Janczar-Smuga, *Współczesne zagrożenia bezpieczeństwa żywności, możliwości ich kontroli oraz eliminacji* (Eng. Contemporary food safety hazards, possibilities of their control and elimination), "Nauki Inżynierskie i Technologie" 2012, no. 2(5), p. 69.

[11] A. Kowalska, *Ekonomiczne problemy fałszowania żywności. Instrumenty przeciwdziałania* (Eng. The economic problems of food adulteration. Countermeasures), Lublin 2019, p. 83.

[12] OECD, *Food Safety and Quality. Trade Considerations*, Paris 1999, p. 12.

[13] P.L. Knechtges, *Food Safety. Theory and Practice*, London 2012, p. 36.

[14] I. Jackiewicz, M. Tereszczuk, *Bezpieczeństwo czy niebezpieczeństwo…*, pp. 35–36.

Food quality is generally a broader concept than food safety, which is one of the components of quality. While, as demonstrated earlier, food safety is – in short – the certainty that food that has been properly prepared and consumed in accordance with its intended use does not pose a threat to human health and life[15], food quality includes additional elements such as its healthiness (in a broader sense than just safety), sensory appeal, availability, as well as emotional and material value[16]. It is worth noting that there is no legal definition of food quality *per se* in the Polish legal system, although such a definition can be derived from the *Act on commercial quality of agri-food products*[17]. The Art. 3 of this Act defines commercial quality as (…) *characteristics of an agri-food product relating to its organoleptic, physicochemical and microbiological properties in terms of production technology, size or weight, and requirements resulting from the method of production, packaging, presentation and labelling, not covered by sanitary, veterinary or phytosanitary requirements*. At the same time Art. 4 point 1 stipulates that (…) *agri-food products placed on the market should meet commercial quality requirements, if such requirements are specified in commercial quality regulations, and additional requirements for these products, if compliance with them has been declared by the producer*. Therefore, although Polish legislators give priority to health values, they also take into account other factors that affect food quality, such as its sensory appeal and availability. Thus, there is no discrepancy between the legal definition of food quality in national law and the definitions that have been in use in scientific circles for years. For example, as early as the 1970s, Celestyn Szczucki pointed out that food quality is (…) *the degree of healthiness, sensory appeal and availability in a broad consumer and social sense, relevant only within the limits set by the raw materials, technology and price specified for these products*[18]. Nina Baryłko-Pikielna, on the other hand, emphasises that food quality is a beneficial combination of nutritional value and sensory appeal, while also taking into account the safety and cost aspects of a given food product. In her opinion, sensory characteristics play a significant and often the most important

[15] S. Sitarz, M. Janczar-Smuga, *Współczesne zagrożenia bezpieczeństwa żywności…*, p. 69; K. Rybińska, *Zarządzanie bezpieczeństwem żywności – innowacje* (Eng. Food safety management – innovations), in: *Zarządzanie przedsiębiorstwem wobec współczesnych wyzwań technologicznych, społecznych i środowiskowych*, A. Walaszczyk, M. Koszewska (eds.), Łódź 2021, p. 80. https://doi.org/10.34658/9788366287822.6.

[16] N. Baryłko-Pikielna, *Konsument a jakość…*, p. 4; M. Niewczas-Dobrowolska, *Jakość i bezpieczeństwo żywności…*, pp. 8–9.

[17] *Act of 21 December 2000 on commercial quality of agri-food products*.

[18] Quoted after: M. Niewczas-Dobrowolska, *Jakość i bezpieczeństwo żywności…*, p. 8; A. Kowalska, *Ekonomiczne problemy fałszowania…*, p. 76.

role in consumers' perception of food quality[19]. Magdalena Niewczas-Dobrowolska proposes a similar definition, according to which food quality is determined by (…) *the extent to which its properties meet consumer expectations in terms of healthiness, sensory appeal and availability*[20].

The aforementioned nutritional values – both in quantitative terms, such as calorie content, and qualitative terms, such as the presence of micro- and macronutrients or their absorption – together with the assurance that a given food product is safe, determine the health benefits of food. Another category of food product characteristics that affects its quality is sensory appeal, which is determined by its appearance (shape, size, colour), smell and taste, as well as its texture. Quality also includes food availability, which encompasses its species recognition, as well as the size of a given food product portion, its shelf life and ease of preparation before consumption[21]. A relatively subjective features of a food product are its material value and emotional value. In consumer perception, the relationship between price and quality is not always seen in accordance with the succinct principle that 'quality comes at a price'. Although a high price creates an impression of exclusivity and overall better quality (in accordance with the rule of unavailability), consumers often look for cheaper substitutes for desirable products (e.g. distributed by chain stores under so-called private labels). Emotional value is probably even more difficult to quantify than material value. It often depends on current trends (e.g. organic or fair trade products) or collective and individual beliefs, often based on stereotypes (e.g. regarding the country of origin as a synonym for high quality of a given type of food product). Food producers and distributors try to anticipate consumers' emotional needs and emphasise certain characteristics of food, such as its foreign origin or specific production conditions (e.g. without the use of artificial fertilisers and chemical plant protection products, or in accordance with the principles of sustainable development). In this context, a proposal by German scientists sounds interesting. They suggest that, in addition to the above-mentioned factors, psychological factors (emotions associated with the purchase and consumption of food products), sociocultural factors (eating habits and culture, as well as cultural and traditional conditions, e.g. food taboos), ecological factors (the choice of appropriate products and the way they are prepared should reflect concern for the planet) and political factors (country of origin or related trade policy) should also be included among the determinants of food quality[22].

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[19] N. Baryłko-Pikielna, *Konsument a jakość*…, p. 4.

[20] M. Niewczas-Dobrowolska, *Jakość i bezpieczeństwo żywności*…, p. 10.

[21] Ibid., pp. 8–9.

[22] Ibid., p. 11.

In summary, food quality consists of its broadly understood health value, availability and sensory appeal, as well as its material and emotional value for the consumer. This and other definitions cited in the article are characterised by far-reaching 'consumer-centrism' and, as Niewczas-Dobrowolska accurately notes, the consumer's perception of food quality differs significantly from the producer's perspective. The consumer assesses the quality of the product based on its functional properties, ability to meet specific needs and price, while the producer focuses primarily on economic aspects such as production profitability and market share. Due to the lack of access to objective methods of quality assessment, consumers make subjective interpretations of quality. Moreover, the perception of food quality depends on the specific characteristics of a given food product, and the definition of 'high quality' is shaped individually by each buyer[23].

Determinants of food safety

No typology in science exhausts all potential approaches to the issue, and the abstraction of individual factors affecting food safety may be criticised for the artificiality of this approach. Nevertheless, for the sake of scientific precision, the authors have classified the conditions in question at the national level[24], dividing them into three categories: political, social and economic determinants. Undoubtedly, the legal system in a given country is one of the main socio-political determinants, especially in terms of regulations concerning food quality and safety. Appropriate institutions as well as mechanisms for control and enforcement of regulations are also crucial. Political stability in a given country is also important, as it can have an indirect impact on the public's willingness to comply with standards and maintain a high level of food safety culture at all stages of food production and distribution. Political stability and respect for the law also mean a reduced level of risk associated with food crime – fraud, counterfeiting and even

[23] Ibid., p. 15; S. Adamczyk, *Jakość a bezpieczeństwo żywności* (Eng. Quality versus food safety), "Nauki Ekonomiczne" 2019, vol. 29, p. 45. https://doi.org/10.19251/ne/2019.29(2).

[24] Although food security is currently analysed on up to five levels – individual, household, national, regional and global – due to its inextricable link with the legal system and state institutions responsible for control and enforcement, food security will be analysed at the third level, i.e. the national level. See: A. Sapa, *Bezpieczeństwo żywnościowe w krajach*…, pp. 233–235; A. Obiedzińska, *Wpływ strat i marnotrawstwa*…, p. 128; J. Kraciuk, *Bezpieczeństwo żywnościowe z perspektywy krajów słabo i wysoko rozwiniętych* (Eng. Food security from the perspective of less and highly developed countries), "Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu" 2015, vol. 17, n. 3, p. 206.

acts of terrorism. The effectiveness of these regulations depends, of course, not only on their existence, but also on the degree to which society complies with them. Even the most precise and restrictive regulations remain ineffective if they are widely ignored or circumvented. In the area of food safety, much therefore depends on the level of public awareness – in this context, it is worth mentioning the so-called food safety culture. In broad terms, it refers to a set of established beliefs, values and attitudes shared within an organisation (a farm or food business) that shape behaviour related to food hygiene at the place of processing. In a narrower sense, food safety culture defines how an organisation or group treats food safety within its management system. Its most important elements are: leadership, commitment, knowledge, training and competence, risk awareness, management style and systems, communication, employee responsibility, as well as environmental factors and risk awareness[25]. Moreover, social determinants include citizens' attitudes towards legal norms and rules, as well as traditions and customs – not only culinary ones, but also those related primarily to hygiene.

Economic factors include, on the one hand, the purchasing power of the population and, for example, the resulting tendency to prioritise price over quality and safety when purchasing food. Greater affluence in society often goes hand in hand with greater awareness and a desire to exercise one's rights to healthy and safe food. The level of technological and scientific development is also relevant, as it determines, among other things, the state of infrastructure and means of transport, as well as new methods of food production, preservation, storage and transport – from the farmer to processing plants, then to distribution points and finally to the consumer. A higher level of technological and scientific development also means more effective methods of detecting and combating potential food safety threats, such as improved veterinary care and more effective medicines. On the other hand, changes in consumption patterns also contribute to consumers seeking new, often exotic food products that may not meet national food safety standards and at the same time be more exposed to potential risks (e.g. during long transport). The pursuit of profit at any cost and maintaining only minimum standards of food safety and quality are also significant factors.

[25] K. Kwiatek, E. Patyra, *Kultura bezpieczeństwa żywności jako nowy element w systemie zapewnienia jej bezpieczeństwa* (Eng. Food Safety Culture – a new element in the assurance of safety system), "Życie Weterynaryjne" 2021, no. 96(7), pp. 517–518; M.Z. Wiśniewska, E. Malinowska, K. Piekarska, *Kultura bezpieczeństwa żywności w teorii i praktyce* (Eng. Food safety culture in theory and practice), "Problemy Jakości" 2018, no. 11, pp. 7–15. https://doi.org/10.15199/48.2018.11.1.

Food safety hazards

If we consider the criterion of the source of hazards, four categories of food safety hazards can generally be distinguished: biological, chemical, physical and genetic modifications[26]. Below is a summary of these risks, divided into categories[27].

Biological hazards

This group includes pathogenic microorganisms, as well as parasites and pests that can cause food poisoning and infections. These include:

- bacteria and the toxins they produce, e.g. *Campylobacter jejuni*, *Salmonella spp.*, *Escherichia coli*,
- viruses, including rotaviruses (A, B, C) and caliciviruses, zoonotic diseases (zoonoses), e.g. coronaviruses,
- moulds, including species of the genus *Aspergillus* and *Fusarium*,
- parasites, including:
  - tapeworms, e.g. armed tapeworm,
  - nematodes, e.g. human roundworm, whipworm,
  - flukes, e.g. liver fluke,
- pests:
  - insects, e.g. grain weevils, food moths,
  - rodents, e.g. rats, mice.

Chemical hazards

They include substances that may pose a risk to human health, including:

- naturally occurring toxins, e.g. alkaloids, glycosides,
- allergens, including:

[26] K. Marzęda-Młynarska, *Globalne zarządzanie bezpieczeństwem…*, p. 297; I. Jackiewicz, M. Tereszczuk, *Bezpieczeństwo czy niebezpieczeństwo…*, p. 33; S. Sitarz, M. Janczar-Smuga, *Współczesne zagrożenia bezpieczeństwa żywności…*, p. 74 et seq.; A. Kowalska, *Ekonomiczne problemy fałszowania…*, p. 85; A. Obiedzińska, *Wybrane aspekty zapewnienia…*, p. 134; T. Korbutowicz, *Żywność genetycznie modyfikowana…*, p. 147.

[27] I. Jackiewicz, M. Tereszczuk, *Bezpieczeństwo czy niebezpieczeństwo…*, p. 39; S. Sitarz, M. Janczar-Smuga, *Współczesne zagrożenia bezpieczeństwa żywności…*, p. 74 et seq.; T. Korbutowicz, *Żywność genetycznie modyfikowana…*, p. 147; A. Obiedzińska, *Wybrane aspekty zapewnienia…*, p. 135; D. Janczewska, *Zapewnienie bezpieczeństwa żywności w logistycznych procesach zaopatrzeniowych oraz magazynowania na przykładzie przemysłu cukierniczego* (Eng. Ensuring food safety in logistics supply and storage processes, using the confectionery industry as an example), "Zarządzanie Innowacyjne w Gospodarce i Biznesie. Czasopismo naukowe o problemach współczesnego zarządzania" 2016, no. 2(23), p. 104. https://doi.org/10.25312/2391-5129.23/2016_101-112.

  - legume crops, e.g. soya,
  - nuts, especially peanuts,
  - animal products, e.g. eggs, cow's milk, fish,
  - wheat (gluten),
- plant protection products, e.g. pesticides, fungicides,
- chemical compounds used to control pests, e.g. zoocides,
- mycotoxins, including aflatoxins, ochratoxins, patulin,
- heavy metals, including mercury, lead, cadmium, arsenic,
- residues of chemical substances, e.g. antibiotics, hormones, cleaning agents, lubricants and oils,
- dioxins, radionuclides and other chemical compounds that may pose a health risk.

Physical hazards

This category includes foreign bodies that may be found in food, e.g.:

- elements naturally occurring in food products, such as seeds and bones,
- mechanical impurities, e.g. wood, sand, stones, pieces of glass and metal, plastic, buttons, hair, etc.

Genetic modifications

These include changes in food that cause:

- the possibility of allergic reactions – the introduction of new proteins into organisms may lead to the formation of allergens that were not previously present in a given food product,
- risk of transferring antibiotic resistance genes – some genetic modification techniques use genetic markers associated with antibiotic resistance, raising concerns about the possibility of transferring this trait to pathogenic bacteria,
- uncertainty about long-term effects – due to the relatively short period of use of genetically modified food, the potential long-term health consequences are not fully known.

It is worth bearing in mind that the issue of food produced from genetically modified organisms (GMO) or by these organisms continues to be highly controversial. Teresa Korbutowicz points out that in the past, genetic modifications occurred only naturally, as a result of spontaneous mutations. Thanks to modern genetic engineering methods, it is possible to precisely transfer genes and introduce new genetic information into target organisms. A transgenic organism is an organism whose DNA sequence has been deliberately modified by humans – its genome has been enriched with a transgene, i.e. a fragment of genetic code originating from

another organism. Genetically modified food is a food produced from genetically modified organisms or obtained using them. Given that genetic mutations can occur both with human intervention and spontaneously – and even in the former case, modifications could have been carried out using traditional methods known to farmers for centuries – the definition of GMO may vary depending on the context. In some contexts, this term refers exclusively to organisms modified using modern technologies (European Union), while in others it also includes changes obtained using traditional methods (United States)[28]. Moreover, as Iwona Wrześniewska-Wal emphasises, the fundamental difference between Europe and the US is the different method used to assess the risks of genetically modified food. In Europe, the precautionary principle is applied, while in America, the principle of equivalence is applied. The EU has strict regulations governing the marketing of such foods. The approval process for such products requires rigorous safety assessments, and their presence on the market is subject to strict controls – the decision to grant authorisation for the placing on the market of food and feed derived from GMOs is taken by the European Commission, after consulting the European Food Safety Authority (EFSA). Furthermore, each Member State may ban the cultivation of transgenic crops on its territory. In the United States, the approach to GMOs is much more liberal. Genetically modified food is considered safe if it is similar to its non-modified counterparts, and there is no need to conduct detailed tests[29].

Food-related crime and food terrorism

In each case, it is possible to distinguish between the degree of intent behind the actions causing the threat (deliberate or accidental) and its cause (internal or external). In a situation where the threat was created accidentally, the blame is usually borne by the participants in the supply chain at potentially every stage. Their negligence, lack of knowledge or ignorance, errors in production management or equipment failures are internal sources. External factors include, among others: lack of supervision and control as well as related errors, power supply and ICT network failures, natural disasters and weather anomalies. Deliberately caused threats – in the case of both internal and external factors – include all forms of profit-motivated

[28] T. Korbutowicz, *Żywność genetycznie modyfikowana…*, pp. 134–135.

[29] I. Wrześniewska-Wal, *Bezpieczeństwo upraw GMO i żywności GM na podstawie nowych regulacji prawnych na poziomie międzynarodowym i krajowym* (Eng. Safety of GMO crops and GM foods in the light of new legal regulations at international and national level), "Żywność. Nauka. Technologia. Jakość" 2018, vol. 25, no. 4(117), p. 7 et seq. https://doi.org/10.15193/zntj/2018/117/255; M. Miciń-ska-Bojarek, *Bezpieczeństwo żywności a organizmy genetycznie modyfikowane. Instrumenty administracyjno-prawne* (Eng. Food safety and genetic modified organisms – administrative law instruments), "Studia Iuridica Agraria" 2013, no. 11, p. 264 et seq. https://doi.org/10.15290/sia.2013.11.18.

criminal activity (including food adulteration, counterfeiting, etc.), deliberate food contamination as part of acts of terrorism or sabotage or attempts at extortion, industrial espionage, intellectual property infringement, cyber attacks[30]. Although food crimes have been known since ancient times, they remain a significant problem. They are a form of organised activity in which individuals or groups deliberately commit food fraud, resulting in negative consequences for consumers. Food crime can occur at any stage of food production, processing, distribution and sale. Such activities can pose a threat to consumer health and, in extreme cases, even lead to death[31]. A narrower category, and at the same time, the most common type of food crime is food fraud – unlawful activities aimed at maximising economic gain by manipulating foodstuffs[32]. One of the probably most common types of food fraud is adulteration. A widely used method of adulterating food is adding substances that increase the volume and weight of the product, thereby artificially increasing its commercial value. Moreover, colouring substances are used to improve or change the appearance of the product to make it more attractive to consumers. Another group consists of additives that correct odour, taste and other sensory characteristics, which can mask inferior quality or changes resulting from inappropriate production processes (so-called food laundering)[33]. Another example is tampering, which includes, for instance, changing the expiry date on the packaging or refilling the original containers. Fraud involving the provision of false information on product labels (mislabelling) is similar in nature. It involves deliberately misleading consumers by providing false information about the composition, origin, expiry date, properties of the product or specific conditions

[30] A. Kowalska, *Ekonomiczne problemy fałszowania*…, p. 85.

[31] Ibid., p. 110; Ł. Lenartowicz, *Formy przestępczości żywnościowej na przykładzie branży mięsnej* (Eng. Forms of food crime on the example of the meat industry), "Kortowski Przegląd Prawniczy" 2021, no. 2, pp. 41–42. https://doi.org/10.31648/kpp.6730; M.Z. Wiśniewska, "*Food crime*" *jako patologia na rynku żywności – istota, rodzaje i próba klasyfikacji* (Eng. "Food crime" as a pathology in the food market – essence, types and an attempt at classification), "Zarządzanie i Finanse" 2017, vol. 15, no. 1, p. 128 et seq.; M.Z. Wiśniewska, *Terroryzm żywnościowy oraz obrona żywności w ujęciu formalnoprawnym* (Eng. Food terrorism and food defence in formal and legal terms), "Ruch Prawniczy, Ekonomiczny i Socjologiczny" 2022, vol. 84, no. 4, p. 103. https://doi.org/10.14746/rpeis.2022.84.4.07.

[32] Ł. Lenartowicz, *Formy przestępczości żywnościowej*…, p. 42; A. Kowalska, *Problematyka oszustw żywnościowych*…, p. 31, 114–115.

[33] Ł. Lenartowicz, *Formy przestępczości żywnościowej*…, p. 43; A. Kowalska, *Ekonomiczne problemy fałszowania*…, p. 112 et seq.; A. Kowalska, *Problematyka oszustw żywnościowych*…, p. 31; M.Z. Wiśniewska, "*Food crime*" *jako patologia*…, p. 131; S. Kowalczyk, *Bezpieczeństwo i jakość polskiej żywności* (Eng. Safety and quality of Polish food), "Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu" 2014, vol. 16, n. 4, p. 150 et seq.

of its production (e.g. unjustified use of the term "BIO"). Another category is illegal distribution of food obtained through theft, e.g. during transport, at points of sale or by persons employed by a given company. Fraud can also take the form of grey market trading or parallel trading (diversion) or the production of food without the required permits and certification (unauthorised production). Another type of food fraud – by no means less significant – is the counterfeiting of food products in violation of intellectual property rights. The product may be designed to resemble or simulate the original (simulation) or be an exact replica of a legal product, i.e. its illegal imitation (counterfeiting)[34].

A particular type of crime against food is food terrorism, which the WHO defines as the deliberate contamination of food with chemical substances (e.g. pesticides, medicines, etc.), biological substances (e.g. viruses, bacteria, fungi, etc.), physical substances (solid objects, e.g. pieces of metal or glass) or radiological substances in order to cause harm to the civilian population, endanger public health or destabilise the state in social, economic or political terms. Food terrorism can also be understood as the use or threat of use contaminated or poisoned food and water – at any stage of the food chain – against the civilian population in order to cause fear, illness or death[35]. A food terrorist can also be a person acting alone, who is unstable, frustrated or seeking revenge for real or imagined wrongs committed by their employer. Direct access to food is not even a prerequisite, as an act of terrorism can be carried out using the infrastructure of a production plant (including its IT network) or during transport[36]. Terrorists may benefit from the fact that even the largest food factories – and especially their warehouses and associated logistics centres – are not as well protected and secured as typical targets of terrorist attacks, such as airports, power stations, railway stations and bus stations.

[34] Ł. Lenartowicz, *Formy przestępczości żywnościowej…*, p. 43; A. Kowalska, *Ekonomiczne problemy fałszowania…*, p. 112 et seq.; A. Kowalska, *Problematyka oszustw żywnościowych…*, p. 31; M.Z. Wiśniewska, *"Food crime" jako patologia…*, pp. 131–133. See also: W. Pływaczewski, *Zorganizowane formy przestępczości w sektorze żywności – obszary zagrożeń i przeciwdziałanie zjawisku* (Eng. Organised forms of crime in the food sector – risk areas and prevention of the phenomenon), in: *Przeciwdziałanie patologiom na rynku żywności*, A. Lewkowicz, W. Pływaczewski (eds.), Szczytno 2015, pp. 11–24.

[35] M.Z. Wiśniewska, *Terroryzm żywnościowy oraz obrona…*, pp. 105–106.

[36] Ibid., p. 107.

Food quality and safety management systems as well as control and supervisory institution

Probably the first international attempt to establish a generally recognised set of rules on food safety was the aforementioned Codex Alimentarius. It is a collection of norms, standards and guidelines regulating food-related issues at the international level. The Codex Alimentarius Commission, a body operating within the FAO and WHO, established in the early 1960s, played an important role in its preparation. The main reason for developing this code was the need to harmonise national food regulations in order to improve international trade. The system was also intended to ensure compliance with ethical principles in the trade of foodstuffs and contribute to building trust and transparency in the food market[37]. During the same period, Hazard Analysis Critical Control Point (HACCP) system was born in the United States. It was developed for the National Aeronautics and Space Administration (NASA) to provide safe food for astronauts. The most important principle of the system at that time was the implementation of procedures to prevent hazards throughout he entire production process, rather than merely controlling the quality of the finished product. This was called 'zero defects' strategy. The basic function of the HACCP System is a two-stage approach: risk analysis and the establishment of critical control points. As part of the analysis, data on the sources of risks, their scale and methods of elimination are collected and verified. Critical control points cover all elements of the food production and distribution process that may affect food safety. The system not only defines risk reduction methods, but also establishes corrective procedures that should be implemented if a hazard is detected. It is mandatory in the United States, where it covers all food industries, as well as the catering and food trade sectors, and in all EU countries (since 1 January 2006)[38].

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[37] D. Janczewska, *Zapewnienie bezpieczeństwa żywności…*, p. 106; M. Kardas, M. Grajek, E. Grochowska-Niedworok, *Jakość i bezpieczeństwo żywności* (Eng. Food quality and safety), Katowice 2018, p. 13; A. Kielesińska, *Aspekty prawne bezpieczeństwa i jakości żywności* (Eng. Legal aspects of the food safety and quality), "Logistyka" 2012, vol. 4, p. 995.

[38] A. Litwińczuk et al, *Wdrażanie systemów zapewnienia…*, pp. 369–370; D. Janczewska, *Zapewnienie bezpieczeństwa żywności…*, pp. 105–106; A. Kielesińska, *Aspekty prawne bezpieczeństwa…*, p. 995 et seq.; S. Sitarz, M. Janczar-Smuga, *Współczesne zagrożenia bezpieczeństwa żywności…*, p. 71; A. Obiedzińska, *Wybrane aspekty zapewnienia…*, p. 139; K. Ćwiek-Ludwicka, *HACCP – system analizy zagrożeń krytycznych punktów kontrolnych dla zapewnienia bezpieczeństwa żywności* (Eng. HACCP – Hazard Analysis and Critical Control Points System to ensure food safety), "Roczniki Państwowego Zakładu Higieny" 1995, vol. 46, no. 1, pp. 39–40; A. Klamerek, E. Olek, *Jakość a bezpieczeństwo żywności* (Eng. Quality and safety of food), "Pielęgniarstwo Polskie" 2012, no. 2(44), pp. 88–89; A. Judzińska, *Systemy zarządzania jakością i bezpieczeństwem żywności oraz stan ich wdrożenia w polskim przemyśle spożywczym* (Eng. Food safety and quality management systems and their

Other mandatory food safety systems include Good Manufacturing Practice (GMP) and Good Hygienic Practice (GHP). The first is a set of measures and conditions that must be met to ensure that food and materials intended to come into contact with food are produced in a manner that guarantees adequate health quality and product safety. GMP covers all aspects of the production process, including plant organisation principles, environmental control, hygiene standards and technical operational requirements. The main objective of GMP is to eliminate any randomness in the production process and ensure full control at every stage – from raw material procurement, through storage, packaging and labelling, to distribution of the finished product[39]. In turn, GHP specifies the sanitary and epidemiological measures and standards necessary to ensure food safety at all stages of production and distribution. It sets requirements for personal hygiene of employees, cleanliness of plant infrastructure, washing and disinfection procedures, storage conditions and protecting premises against pests. Both practices are closely related, and their implementation forms the basis for the introduction of more advanced quality management systems. GMP and GHP aim to eliminate health risks by maintaining high standards of production conditions and introducing effective preventive measures[40].

In the context of food safety, non-mandatory management systems also play an important role, among which the ISO 9000, 14000 and 22000 series standards as well as certification systems such as BRC Global Standard for Food Safety,

implementation in the Polish food industry), "Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu" 2017, vol. 19, n. 2, p. 103. https://doi.org/103. 10.5604/01.3001.0010.1167.

[39] I. Jackiewicz, M. Tereszczuk, *Bezpieczeństwo czy niebezpieczeństwo…*, p. 38; A. Litwińczuk et al., *Wdrażanie systemów zapewnienia…*, p. 369; S. Sitarz, M. Janczar-Smuga, *Współczesne zagrożenia bezpieczeństwa żywności…*, p. 70; A. Kielesińska, *Aspekty prawne bezpieczeństwa…*, p. 998; A. Judzińska, *Systemy zarządzania jakością…*, p. 103; A. Klamerek, E. Olek, *Jakość a bezpieczeństwo żywności…*, p. 87; M. Kardas, M. Grajek, E. Grochowska-Niedworok, *Jakość i bezpieczeństwo żywności…*, p. 19; Najwyższa Izba Kontroli, *System kontroli bezpieczeństwa żywności w Polsce – stan obecny i pożądane kierunki zmian* (Eng. Food safety control system in Poland – present state and desired directions for changes), Warszawa 2021, p. 15.

[40] I. Jackiewicz, M. Tereszczuk, *Bezpieczeństwo czy niebezpieczeństwo…*, p. 38; A. Litwińczuk et al., *Wdrażanie systemów zapewnienia…*, p. 369; S. Sitarz, M. Janczar-Smuga, *Współczesne zagrożenia bezpieczeństwa żywności…*, pp. 70–71; A. Judzińska, *Systemy zarządzania jakością…*, p. 103; A. Klamerek, E. Olek, *Jakość a bezpieczeństwo żywności…*, pp. 87–88; M. Kardas, M. Grajek, E. Grochowska-Niedworok, *Jakość i bezpieczeństwo żywności…*, pp. 19–20; Najwyższa Izba Kontroli, *System kontroli bezpieczeństwa…*, p. 16; N. Maruszewska, M. Miśniakiewicz, *O potrzebie konsolidacji systemu bezpieczeństwa żywności w Polsce* (Eng. The need to consolidate the food safety system in Poland), "Nierówności Społeczne a Wzrost Gospodarczy" 2020, no. 2(54), p. 487. https://doi.org/10.15584/nsawg.2018.2.36.

International Featured Standards (IFS) and GlobalGAP occupy an important place[41].

One of the key elements of the food safety system at the national level are official food control institutions. Due to the level of institutional integration of the public food safety supervision system, three basic models of this system can be distinguished[42]:

a) multiple agency system, in which supervisory powers are dispersed among various institutions (including in Poland);
b) single agency system, characterised by a centralised supervisory structure within a single institution, supported by additional specialised organisations (including in the US and France);
c) integrated system, in which coordinated management of control processes is based on a single institution with broad competences (including in Denmark, Sweden and the UK).

It is worth noting that the extensive multiple agency system (decentralised) model operating in Poland is unique in Europe. In 22 out of 27 EU countries, there is one dominant body responsible for food safety supervision, while in Poland these tasks are performed in parallel by several institutions. This hinders coordination and effective control. The food control system primarily comprises: the State Sanitary Inspection, the Veterinary Inspection Service, the Agricultural and Food Quality Inspection and the State Plant Health and Seed Inspection Service. Although their competences are precisely defined by law, in practice the scope of activities of individual inspectorates often overlap, which may lead to inefficiency of the supervisory system. In addition, other entities are involved in the process of ensuring food safety, including the bodies of the National Revenue Administration (Tax and Customs Service) or scientific authorities: the National

[41] A. Kielesińska, *Aspekty prawne bezpieczeństwa…*, pp. 999–1000; A. Judzińska, *Systemy zarządzania jakością…*, pp. 105–106; M. Kardas, M. Grajek, E. Grochowska-Niedworok, *Jakość i bezpieczeństwo żywności…*, p. 19, 35 et seq.; G. Płaza, *Zarządzanie bezpieczeństwem produkcji żywności w kierunku poprawy jakości produktu* (Eng. Safety management in food production to improve the product quality), "Systemy Wspomagania w Inżynierii Produkcji" 2017, vol. 6, no. 8, pp. 30–31; J. Górna, *Znaczenie oceny dostawców dla zapewnienia bezpieczeństwa żywności* (Eng. The importance of suppliers' evaluation with the aim to assure food safety), "Studia Oeconomica Posnaniensia" 2016, vol. 4, no. 12, pp. 50–51. https://doi.org/10.18559/SOEP.2016.12.3. See also: P. Kafel, P. Nowicki, *Bezpieczeństwo żywności i żywienia w prawie unijnym i polskim oraz normach ISO – integracja systemów* (Eng. Nutrition and food safety in the EU and Polish legislation and in ISO standards – system integration), "Zeszyty Naukowe Uniwersytetu Ekonomicznego w Krakowie" 2010, no. 815, p. 96 et seq.

[42] Najwyższa Izba Kontroli, *System kontroli bezpieczeństwa…*, p. 17; S. Kowalczyk, *Bezpieczeństwo i jakość…*, p. 209 et seq.

Veterinary Research Institute and the National Institute of Public Health – National Institute of Hygiene. Decentralised model of food safety control in Poland is one of the most scattered in the EU. There are calls for it to be improved in terms of coordination of activities and exchange of information in order to increase the effectiveness of controls and improve food safety in the country[43].

It is also worth mentioning the fourth model, the so-called regional model – supranational. Its key element is the EFSA – authority established by the *Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety.* The mission of the EFSA is to ensure an optimal level of consumer protection and to restore and maintain public confidence in the food sector, as well as to provide scientific advice and technical and scientific support on EU legislation and policies in areas that have a direct or indirect impact on food and feed safety. These activities include the systematic collection and analysis of data enabling the characterisation and monitoring of potential hazards, the identification of new risk factors, their assessment and the development of appropriate warnings. Moreover, the institution provides scientific support to the European Commission, particularly in the context of food crisis management. As part of its tasks, the EFSA coordinates and supports standardised risk assessment methodologies, provides advice on the interpretation and recognition of expert reports prepared at the request of the European Commission, as well as initiates and finances scientific research necessary for the fulfilment of its mission. Moreover, it establishes and manages

[43] I. Jackiewicz, M. Tereszczuk, *Bezpieczeństwo czy niebezpieczeństwo…*, pp. 39–40; C.A. Kwiatkowski, E. Harasim, *Produkcja rolnicza a bezpieczna*…, p. 12, 26; Najwyższa Izba Kontroli, *System kontroli bezpieczeństwa*…, p. 17 et seq.; N. Maruszewska, M. Miśniakiewicz, *O potrzebie konsolidacji*…, pp. 487–489; S. Kowalczyk, *Bezpieczeństwo i jakość*…, pp. 223–224; A. Kowalska, *Ekonomiczne problemy fałszowania*…, p. 78 et seq.; M.Z. Wiśniewska, A. Kowalska, *Kultura bezpieczeństwa żywności w prawie Unii Europejskiej. Czy polski system kontroli żywności sprosta wyzwaniu?* (Eng. Food safety culture in European Union law. Will the Polish food control system meet the challenge?), "Ruch Prawniczy, Ekonomiczny i Socjologiczny" 2022, vol. 84, no. 2, p. 179. https://doi.org/10.14746/rpeis.2022.84.2.12; P. Szewczyk, M. Kuzan, *Bezpieczeństwo żywności na polskim rynku. Konieczne usprawnienie działań inspekcji* (Eng. Food safety on the Polish market – inspectorates' activities call for improvements), "Kontrola Państwowa" 2020, vol. 65, no. 4(393), pp. 69–70; Z. Kotynia, *Ocena działania urzędowej kontroli żywności – propozycje zmian w systemie* (Eng. Evaluation of official food control – proposals for changes in the system), "Kontrola Państwowa" 2022, vol. 67, no. 1(402), p. 15 et seq. https://doi.org/10.53122/ISSN.0452-5027/2022.1.01. See also: E. Wituska, *W kierunku centralizacji państwowych służb bezpieczeństwa żywności* (Eng. Towards centralisation of state food safety services), in: *Decentralizacja i centralizacja administracji publicznej. Współczesny wymiar w teorii i praktyce*, B. Jaworska-Dębska, E. Olejniczak-Szałowska, R. Budzisz (eds.), Warszawa–Łódź 2019, pp. 661–677. https://doi.org/10.18778/8142-301-4.37.

a network of organisations operating in areas falling within the remit of the EFSA. The scientific opinions prepared by the EFSA are based on orders from the European Commission, the European Parliament and the Member States, but the authority may also decide on its own initiative to carry out a risk assessment, particularly in crisis situations. An important aspect of the EFSA's activities is the clear division of responsibilities between it and the European Commission. It provides independent scientific opinions, while legislative decisions and risk management remain the responsibility of the Commission, which takes the EFSA's expert opinions into account in its decision-making process[44]. On the basis of the aforementioned regulation, the Rapid Alert System for Food and Feed (RASFF) has also been in operation in the EU since 2002. It enables the effective identification and removal of dangerous products from the market. Its operation is based on cooperation between the European Commission, the EU Member States, the EFSA, as well as third countries and international organisations. Each Member State has a contact point that gathers information on potential threats and passes it to the Commission, which enables the rapid notification of other network members[45].

Summary

Ensuring food safety remains one of the most important challenges virtually for all countries in the world, regardless of their level of socio-economic development. The contemporary approach to ensuring this primarily involves the process of maintaining appropriate production standards. The food safety management systems created for this purpose are based on both mandatory and voluntary solutions – all of them shape the framework for the operation of entities responsible for food production. Standards such as ISO 9001, ISO 22000, HACCP, GMP and GHP enable effective monitoring of food quality at various stages of production and distribution, and their implementation increases consumer confidence in the products offered. However, illegal activities in the food sector remain a significant source of food safety risks, both those aimed at financial gain and those aimed at causing harm or creating fear among producers or consumers. Many countries are taking measures to monitor and eliminate such practices more effectively, which

[44] S. Kowalczyk, *Bezpieczeństwo i jakość*…, p. 242 et seq.; I. Wiśniewska, *Rola EFSA w obszarze bezpieczeństwa żywności i informowania o ryzyku* (Eng. EFSA's role in food safety and risk communication), "Hygeia Public Health" 2017, no. 52(1), pp. 10–11.

[45] A. Obiedzińska, *Wybrane aspekty zapewnienia*…, p. 142; M. Buczkowska, T. Sadowski, J. Gadomska, *System wczesnego ostrzegania dotyczący żywności i pasz* (Eng. The Rapid Alert System for Food and Feed), "Problemy Higieny i Epidemiologii" 2014, no. 95(3), p. 550.

is an important part of risk management strategies in the food sector. Analytical tools and modern technologies enabling rapid detection of irregularities in the composition and quality of products are of particular importance here. Another issue is the attitude of employees involved in food production and distribution towards applicable legal regulations and implemented systems. The food safety culture prevailing in food industry companies has a significant impact on employee commitment to maintaining production standards in line with norms. Appropriate risk management practices as well as public education on safe food storage and preparation are also important. Raising public awareness and implementing modern tools for monitoring production and distribution processes can have a significant impact on food safety at all levels. It is necessary to continuously improve food safety systems and increase the effectiveness of control institutions in order to meet dynamically changing threats and consumer expectations.

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