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HEALTH SAFETY OF BREAD IN SMALL BAKERIES

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Purpose: The aim of the article is to present the safety and health risks in the production process of bread, supported by research in small bakeries located in the Pomeranian Voivodeship.
Design/methodology/approach: The literature research and the critical analysis of both, the national and foreign subject literature have been used as the research methodology.
Findings: Health safety of bread is one of the features that decide its quality. This paper additionally presents other determinants influencing the quality of bread. It also demonstrates opinions showing food safety as a separate attribute of quality. The paper cites Polish domestic and EU legislation in the areas of food safety, as well as competences of sanitary inspection bodies. The major part of the paper is devoted to the identification of types and potential sources of health threats in the production process of bread and the prevailing prevention system, i.e. HACCP. The research on the structure of the bread and the level of implementation of HACCP was performed in Pomeranian small bakeries, which form 89.4% of the overall Pomeranian bakeries.
Practical implications: Practical implications include taking into account the indicated determinants that affect the quality of bread will be an important solution in making a number of decisions by managers and bakery owners in terms of strategic use of them.
Originality/value: Proper implementation of the principles of bread health safety as one of the features that determine the quality of the product, as well as the determination of other determinants that affect the quality of bread, allows to build and maintain a long-term competitive advantage in small bakeries in the bakery industry. Natural identification of the types and potential sources of health risks in the bakery production process and the applicable systems of counteracting these risks, e.g. HACCP, will have a major impact on the long-term process of innovative management of managers and owners of small bakeries

Keywords: bread quality, health safety of bread, health threats of bread, small bakeries, sanitary inspection competences, HACCP.

Category of the paper: research paper.

1. Introduction

The interest in initiatives towards protecting the food safety has been on an increase since the late 19th century. Additionally, this is no longer the domain of the wealthiest countries – safe and high-quality food is currently important to consumers worldwide.

The basic component of each Pole's diet is bread – with rational approach it can regulate the human digestive tract and constitute a major portion of the daily intake of calories required by a human body – 25-30%. Currently, with the noticeable technological advancement and the human nutrition becoming a separate discipline, bread is still a basic component of the human diet and there is no other food product that could replace it (Dziwkosz, 2012; 2018; Gambuś, et al., 2011). Bread was, is, and most likely will continue to be of foremost importance in Poland (Ceglińska, Cacak, Pietrzak, Haber, 2003; Mielcarz, 2004).

Based on a 2021 study in small Pomeranian bakeries, such that employ up to 50 staff and have an annual turnover of less than 10 million PLN, the structure of the bakeries' output was as follows:

- bread: 69%,
- bread rolls: 15%,
- other, i.e. sweet rolls, doughnuts, small pizza rolls, burger buns, baguettes, hot-dog buns, cakes: 16 %.

According to the Law of State Sanitary Inspectorate, food quality is understood through properties and/or features of the product (Law of March 14, 1995).

Based on subject literature (Ambroziak, 2002; Balon, Dziadkowiec, Sikora, 2016) and the authors' observations in small bakeries, it has been determined that bread quality is decided upon based on the following features:

1. Nutritional value, derived from overall chemical composition.
2. Taste, determined chiefly by the composition and quality of the components.
3. Health safety, defined as lack of threats to the consumer's health.
4. Attractiveness, derived from the shape, colour, and packaging.
5. Durability, allowing to store the bread for prolonged time without quality losses.
6. Freshness, derived from external look, smell, crust, inside texture.

The above definition of bread quality has been positively verified within small Pomeranian bakeries.

At all the stages of baking bread, proper quality levels need to be assured, including health safety of the final product. Safe bread does not induce harmful effects on the consumer (Górniak, 2004; Zymonik, Hamrol, Grudowski, et al., 2013).

Subject literature contains a variety of views on quality in connection with food safety. Is the latter an element of the former or does it constitute a separate entity? For instance, according to S. Kowalczyk, J. Spink, and D.C. Moyer (Kowalczyk, 2016; Spink, Moyer, 2011),

food safety is a separate matter. The authors of this view also claim that the mission of the whole system of food safety is to protect and improve public health by assuring that food meets safety norms that are the result of joint activity of the public and private sectors.

Polish subject literature mainly uses the notion of "health safety of food", an element of product quality. Such view is expressed by e.g.: U. Balon, J.M. Dziadkowiec, T. Sikora, D. Kołożyn-Krajewska, Z. Ambroziak (Ambroziak, 2002; Balon, Dziadkowiec, Sikora, 2016; Kołożyn-Krajewska, 2015). Level of health safety is defined by the health quality of food.

Regardless of the views presented above, the authors of this paper received positive opinion of small-scale Pomeranian bakeries on the subject of treating health safety of bread as one of the features that decide its quality.

Perhaps in case of other food products, produced in other global locations and in different production, sanitary, and social regimes, different views about separating food safety from quality considerations are justified. Quality of bread in Poland, however, cannot be separated from its health safety. Therefore, one of the features that decide the quality of bread is health safety. Polish subject literature acknowledges this approach.

2. Food safety in EU legislation

Quality and safety of food are referenced in a common document by FAO and WHO on strengthening national systems of food control. The two organisations consider food quality to be the properties that create value for the consumer. These are positive values, such as origin, taste, colour, composition, or methods of production, and negative: dirt, impurities, spoiling, discolouration, or improper (atypical) smells (Assuring Food Safety And Quality, 2003).

Food safety is an element of national security. Contemporarily, the issue of health safety is related to individuals, institutions, the state. Therefore, safety of bread is the domain of bakeries. The mission of the whole system of food safety is to protect and improve public health by assuring that food meets safety norms (Czupryna, Maleszka, 2006; Drozd, 2020; Miśniakiewicz, 2007).

Issues related to food safety have been of foremost importance to EU legislation. Directive WE/852/2004 on the hygiene of food products (Regulation WE/852/2004, 2004), which forms part of the so-called hygienic package, provides the key determinants to safety of food. These are:

1. Legally binding minimal hygienic norms.
2. State inspections in food industry companies.
3. Established and practiced programmes and procedures for food safety within companies, such as HACCP.

In the baking industry, fundamental systems of assuring health safety, ones that are also present in overall food production are:

1. Good Hygienic Practice – GHP.
2. Good Manufacturing Practice – GMP.
3. Hazard Analysis and Critical Control Points – HACCP.

Minimal requirements for hygiene have been included in one of the health quality assurance systems, Good Hygienic Practice. Its scope is chiefly (Staszewska, 2002):

- maintaining hygiene around the manufacturing facility as well as in manufacturing halls,
- hygiene of machines and devices,
- state of health and hygiene of staff,
- securing the manufacturing facility against pests,
- plan of controlling the execution of cleaning, washing, disinfection,
- trainings for personnel on manufacturing hygiene.

The implementation of GHP as an obligatory system in ensuring health quality of bread ought to be documented at each bakery that implements the system. The records are proof that the manufacturer exhibited due diligence in assuring proper health quality of their products.

Good Manufacturing Practice (GMP) is synonymous to meeting all the fundamental requirements for main assumptions in the area of buildings, technology, equipment, operational practices, and manufacturing methods that results in the appearance of high-quality food that meets the requirements of the consumer (Kijowski, Sikora, 2003). GMP encompasses the basic areas of activity of bakeries with a level which is sufficient to claim that the resultant bread is of high health quality and is safe for the consumers' health.

Small businesses, including bakeries that were studied for the purpose of this paper, need to introduce GMP and GHP. These systems are reflected in the national legislation.

Polish system of food quality control, called "food safety system" is a dispersed system. Also, it is very static, as the recent change was brought to the system in 2003. S. Kowalczyk claims that changes to Polish and global economy in recent years, and even decades, are not reflected in the structure and functionality of the system. Food safety system in many cases does not reflect the needs of Polish food system which underwent some changes e.g. after Poland's accession to the European Union. One weakness of the system is non-existence of investigation authorisation as well as insufficient performance of control authorities.

Competences of individual inspection bodies in the Polish food safety system are as follows (Kowalczyk, 2016):

1. Farming and Food Articles Goods Trade Quality Inspectorate oversees trade quality in manufacturing and foreign sales.
2. Trade Inspectorate oversees trading goods quality in retail.

3. State Sanitary Inspectorate oversees food conditions and health safety, and has the widest areas of competence, as it processes manufacturing, foreign trade, and retail trade.
4. Veterinary Inspectorate oversees hygiene of animal-derived products as well as animal health and protection.
5. State Inspectorate for Protection of Plants and Seeds researches the residual presence of pesticides in food production and foreign trade.
6. Customs Delivers Customs procedures when trading with foreign states.

As can be seen, bakeries can be controlled by Farming and Food Articles Goods Trade Quality Inspectorate as well as State Sanitary Inspectorate. The State Inspectorate for Protection of Plants and Seeds works in favour of the quality of materials delivered to the bakeries. Trade Inspectorate and State Health Inspectorate control quality of bread in retail trade.

Within the EU, HACCP is obligatory for member states as of December 14, 1995 following the directive 93/43 EEC of June 14, 1993 related to hygiene of food. In Poland, HACCP can be found in companies that manufacture and sell food, with the exclusion of small- and medium-sized businesses, as of January 1, 2004, following the law of May 11, 2001 on the health conditions of food (Kowalczyk, 2016).

Small and medium businesses, including bakeries surveyed for this study, are obliged to implement and apply HACCP. However, there is no obligation to maintain documentation of the system. Maintaining HACCP-related records and procedures is required for certified companies. Voluntary, from the legal perspective, certification of small bakeries becomes necessary if they want to cooperate with major retail chains. Such chains expect that the producer of bread will guarantee, apart from health safety, repeated quality of their products.

For this reason, the authors concluded a 2021 study across 67 small bakeries within the Pomerania area, who responded positively to questionnaires. Despite the HACCP system being voluntary, eight of the bakeries have implemented it. The implementation of the system in small and medium-sized companies requires the introduction of the following rules:

- perform a threat analysis,
- define critical control points,
- set up critical limits,
- set up monitoring procedures,
- set up corrective actions,
- set up verification procedures.

In this paper, the authors identified potential health risks which are very likely to occur in bread production.

HACCP is a specific system of assuring food quality. It is a preventive system that relies on defining all possible and actual consumer health threats throughout the manufacturing process and afterwards, developing preventive actions. If required, critical control points are

defined. HACCP is a preventive-preemptive system (Kowalska, Werpachowski, 2008; Piwnik, Drozd, 2019).

Critical control points are indicated in the analysis and are: place, material, or production stage where a health threat may arise, and where such a threat ought to be controlled. It is necessary to prevent the threat, minimise it or eliminate it, before the product reaches the consumer.

HACCP, unlike the previously applied random internal checks of the finished product, runs all along the production process, from raw materials to the finished goods (Kot, 2010).

The idea of HACCP is a conversion from searching for product deficiencies to prevention of the said deficiencies. It is obvious that monitoring all production stages, including raw materials, is not feasible. However, with the definition of critical control points and focusing on monitoring these points, it is possible to prevent the threats in time and to undertake potential corrective actions.

HACCP checks are based on simple measurements, e.g. of temperature or observations, which is an undoubtable advantage of the system (Malinowska et al., 2012).

The basic premise for implementing HACCP is guaranteeing food safety. Poisoning and food-induced infections are a serious threats to people in today's world.

Not only the consumer but also the producer ought to be interested in obtaining food of high quality. When implementing HACCP, the producer guarantees that their products are safe for the health of the consumer. This is especially important in the light of the producer's legal responsibility for losses caused by food that does not follow quality food standards. The consumer gets a guarantee that the food they buy is safe for their health. Therefore, HACCP meets the requirements of the producer and the consumer alike.

In recent years, a shift in quality systems could be observed, from a detection system with elements of corrective activity, towards preventive systems (Wiśniewska, Grudowski, et al., 2014).

3. Food safety in Polish legislation

The definition of food safety in Polish legislation first came in 2001. It was introduced by the May 11, 2001 law on health conditions of food. Safety of food, according to this law, is "all the conditions that need to be met, and activities that need to be undertaken, at all the food production and sales stages so that human health and life can be assured."

The definition was further detailed in the law of food safety of August 25, 2006. According to this law, food safety is the overall list conditions that need to be met, especially related to:

- additives and flavourings,
- levels of impurities,

- pesticide residuals,
- conditions of food radiation,
- organoleptic features

and activities that need to be undertaken at all the stages of food production or sales so that people's lives and health can be assured. The same wording was maintained for further amendments of the law (Law of October 8, 2020).

Among numerous views on the importance of food safety for different people and consumer groups, Aigner's seems especially valuable. Aigner is a former Minister of Agriculture of Germany and she claimed food safety to be a large and indispensable good, as we reach for food every day. For this reason, we face daily risks of reaching for food which is unsafe for our health, life, or material situation (Strategien der Labensmittelsicherheit, 2013). Bread is one such daily need food article.

4. Health risks in baking bread

Lack of threats is defined as a state of safety (Rosicki, 2010). Safe bread brings a variety of benefits for individual consumers but also for the society as a whole. Health safety of bread primarily translates to fewer people that suffer from health loss due to ingestion of bread of low quality, lower health system costs, lower production capacity losses. All this leads to a conclusion that in Poland, safety of bread, among other bakery products, in the context of higher consumption compared to other countries ought to be treated as one of the most important issues (Nierzwicki, 2013).

Health risks that may be found in bread production are of three major categories, i.e. physical, chemical, and biological (microbiological and microbiological alike) (Staszewska, 2002). The summary of health risks in bread production can be found in Table 1.

Table 1.
Health risks in bread production

Health risks in bread production		
Physical (foreign objects, dust, filth, humidity)	**Chemical**	**Biological**
Source	Source	Source
1. Raw materials 2. Environment 3. Production process 4. Staff	1. From raw materials: - pesticide residues - micro-toxins - harmful metals 2. From the production process: - detergent and disinfectant residues, - machine maintenance agent residues - illegal additional substances - overdoses of allowed additional substances	1. Macrobiological: - storage-residing pests (mites, weevils) - insects (flies, cockroaches) - rodents (mice, rats) - birds and their feces 2. Microbiological (risk factors): - pathogenes - microorganisms causing the spoiling of bread (oxygen bacteria)

Source: own work.

The first category is composed of physical threats, namely foreign objects, dust, dirt, humidity, overheating due to atmospheric conditions.

The presence of foreign objects in bread not only makes consumers averse and causes loss of faith in a bakery but also may pose actual health threats, such as damages to the oral cavity or the oesophagus. Sources of foreign objects in bread baking process are varied, from raw materials through the environment to the staff. From among all the threat categories, foreign objects are most often identified by the consumers. Currently, most bakeries have installed X-ray machines at their premises which detect foreign objects.

Another type of physical threats are dust and dirt accumulating on equipment, packaging or raw materials due to negligence in maintaining order and cleanliness. It is a threat that borders on biological one, as microorganisms causing the spoiling of bread or pathogens tend to accumulate on surfaces together with dust and dirt.

Unfavourable atmospheric conditions – snow, rain, excess sunlight – on materials or finished bread, e.g. when they are left on the loading ramp, may cause changes that are harmful to health. For instance, carton packaging getting wet may cause the emergence of mould – a possible source of mycotoxins.

In the course of baking bread, it is difficult to oversee physical threats. The hardest part is preventing foreign objects migrating from the production staff. Prevention in this range of threats comes from observing rules of hygienic behaviour.

The second category of threats in the bakeries is of chemical nature. Bread safety is threatened by the existence of residues of pesticides, mycotoxins, and harmful metals that migrate into the production process with the raw materials. Threats within the manufacturing process are related to the residues of cleaning, disinfection, and machine maintenance agents, illegal additional substances, or overdoses of allowed additional substances.

The level of residue of pesticides, preventing the spreading of plant diseases and pests, is one of the major criteria of assessing materials for bakery use.

Mycotoxins are products of metabolism of a variety of moulds. So far, about 100 mycotoxins of various effects have been described. Some of the more dangerous and better-known ones are aflatoxins and ochratoxin A. Aflatoxins can be found in grains, rice, corn, cocoa seeds, and seasoning (black pepper, paprika, dried fruit, figs, raisins). They are chiefly found in Africa, in Latin America, and China. Ochratoxin A is most often detected in grain and its products. Its presence was also detected in wine, beer, grape juice, and coffee after the seeds have been roasted. The appearance of ochratoxin A is typical of cool and humid climate. Complete elimination of ochratoxin from bread is not possible, therefore steps should be taken to limit its presence to acceptable levels. Ochratoxin A cannot be identified organoleptically and therefore cannot be detected when materials are accepted for the production process. To limit the threat, proper selection of suppliers is advised – ones that are top-noted in national rankings.

The primary source of harmful metals in grain is the environment. Pollution is dependent on the source of emission of metals and usually comes from the industry. Presence of harmful metals in bread is the consequence of pollution of flour and other materials as well as additives, and the pollution of machines and installations. Norms are often violated the content of cadmium and lead and are strictly dependent on the origin country of grain.

The third category of threats in bakery business is biological in nature. It is composed of a large and varied group of threats. One is warehouse pests, insects, rodents, and birds, and another – microorganisms that directly threat the health of consumers or product quality.

The danger from insects – flies, cockroaches – is caused by spreading harmful microorganisms and mould spores.

The grain and flour pests are not only cause for major storage losses but can harm the health as well. The worst are mites, e.g. flour mite. They can be found in grain, flour, seeds of oil plants, powdered milk, etc. Their spreading is accelerated by:

- waste, sweepings, and rubbish that provide food to mites when not removed,
- flour sacks that are not shaken off and disinsectised,
- production machines and transport equipment not cleaned properly.

Flour mites can be carried by people (on clothing and shoes), and rodents. The latter – mice and rats – cause sizeable industry damages, stock losses, pollution of materials with their feces, and most noticeably transmit pathogens, such as salmonella bacteria.

Birds which live freely around production facilities and waste dumps – pigeons, sparrows, seagulls – not only pollute the production halls but are also sources of pathogens, again especially of salmonella.

The most efficient method of pest control is prevention, with its main goal being prevention of the pests permeating into the bakeries, which is part of the abovementioned GHP. Implementation and maintenance of GHP prevents the occurrence of threats coming from pests.

From among the three categories, biological threats cause the most severe effects. Microorganisms cannot be observed with a naked eye and are found throughout the human-inhabited environment. There is no object or a living being that would be free of the presence of a multitude of microorganisms. Not all of them are harmful – there is a range of microorganisms that are beneficial and actually used by humans, such as yeast, lactic bacteria or some moulds. However, in production of bread some harmful microorganisms may be found which:

- cause negative effects to products by inducing spoiling,
- pose actual health risk if found in bread.

Microbiological threats in bread production are:

- microorganisms that cause spoiling of products,
- pathogenic microorganisms.

The former group of microorganisms causes visible changes to products, such as changed consistency, smell, fermentation or visible spread of mould. Such products may not be consumed and their buyer takes a material loss. Typical form of changes caused by bacteria is viscosity of bread. This is caused by the resting organisms of oxygen bacteria, decomposing starch and proteins. Resting form of these bacteria is resistant to heat and cannot be eliminated when baking.

Moulds are also a widespread problem. They cause the loss in expected life of bread.

From the perspective of food safety, the largest source of problems is pathogenic microorganisms. Impurity of raw materials or finished goods from pathogens is especially dangerous. The impurity cannot be observed and does not cause organoleptic changes, and as a result cannot be detected by the consumer. Diseases caused by pathogens are:

1. food poisoning, i.e. acute poisoning caused by live cells or toxins coming from ingestion of polluted food or water,
2. infections resulting from the ingestion and internal development of a live biological pathogen. Infections with disease-carrying bacteria can proceed with no symptoms. The infection occurs when microorganisms that carry a potential to infect others inhabitate and multiply inside a person's body.

The source of pathogenic microorganisms are animal-derived materials, human carriers, and animal pests. Microorganisms of this type rarely appear in bakeries.

Not every bacterial count results in a disease. Danger comes from a sufficiently high number of pathogenic organisms.

Pollution of a finished product with disease-carrying bacteria can be the result of:

- primary presence of bacteria in materials,
- multiplying of pathogens in e.g. improper storage conditions,
- bacteria surviving following inefficient heat treatment, e.g. after the bread has been baked,
- secondary infection, e.g. through staff.

The role of a production technician is to prevent the multiplication of the primary number of pathogens or those that cause damage to products. Here, specific knowledge in technology and the habitation conditions of microorganisms is required.

The above results in a conclusion that the role of staff in bakeries is immensely important. Proper qualifications for individual posts are required as well as trainings in health and safety but also the involvement of the staff members.

The abovementioned health threats that may occur to some degree of probability within the bread production chain and are derived from materials, environment, equipment, the process, staff behaviour. Threat sources in bakeries are presented in Table 2.

Table 2.
Sources of health hazards in bakeries

Sources of health hazards in bakeries				
Materials	Environment	Equipment	Process	Staff
a) flour b) grain products c) additives d) packaging	a) surroundings of the bakery b) production halls c) social rooms d) pests e) waste	a) machines b) equipment c) tools d) transport	a) material preparation b) technological process c) cutting d) packaging	a) state of health b) personal hygiene c) pro-hygienic behaviours d) trainings

Source: own work.

Applying GHP in bakeries allows to minimise or eliminate health threats in production. However, hygienic behaviour of production staff is of key importance. According to German sources, around 60% of quality faults in food products results from staff actions, while the remaining 40% comes from materials, production conditions, and other areas (Staszewska, 2002).

5. Summary

In Poland, bread has long been, is, and most likely will long be the fundamental food product. We reach for bread every day and we are at a daily risk of consuming products that might pose threats to our health.

Issues of food safety are of key importance in EU legislation and form part of the so-called Hygienic package. It covers areas such as:

1. minimum hygiene standards. These have been described in obligatory systems, called Good Hygienic Practice and Good Manufacturing Practice. Components of these practices are reflected in Polish legislation;
2. state inspections in agriculture and food businesses. Bakeries can be controlled by the Farming and Food Articles Goods Trade Quality Inspectorate, and State Sanitary Inspectorate. State Inspectorate for Protection of Plants and Seeds which controls the residues of pesticides works towards the high quality of materials delivered to bakeries;
3. programmes, systems, and procedures on food safety. Within the EU, the HACCP (Hazard analysis and critical control points) preventive system is commonly used. It is specifically aimed at assuring health safety of food and is based on defining potential and actual risks to consumer health and afterwards developing actions of preventing them. If required, Critical Control Points need to be established.

The starting point for the functioning of the HACCP system is threat analysis. In this paper, the authors defined types and potential sources of health threats that may arise with high probability in bakeries. These have been put in three categories: physical, chemical,

and biological. The sources of threats are: materials, environment, equipment, production processes, staff behaviours.

HACCP is not an obligatory system for small bakeries to be certified with. Such small bakeries, however, are obliged to introduce and enforce HACCP-specific rules. Voluntary (from the legal perspective) HACCP certification in small bakeries can prove necessary if such businesses want to cooperate with major retail chains which expect that food suppliers will guarantee steady quality of their products, apart from food being free of hazards.

In 2021, the authors conducted a study of 67 small bakeries in the Pomerania region of Poland. Despite HACCP certification being voluntary, three of the bakeries under study had HACCP certification.

The authors also received positive feedback from the bakeries they questionnaired on the treating of health safety of bread as one of the features that decide bread quality.

In recent years, a shift within quality systems can be observed, towards preventive mode. The systems mentioned in the paper are of that nature.

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