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## RESEARCH OF METHODS OF OBTAINING CONTINUOUS FIBRES OF WHISKERS

Об'єктом дослідження є управління безпекою розроблених борошняних кондитерських виробів з органічної сировини – кексів, тістечок та бісквітів. Існує багато підходів до впровадження системи управління безпекою харчових продуктів. Однак на практиці встановлено, що система управління безпекою харчових продуктів не може бути запозиченою у іншого підприємства, а також не може бути уніфікованою. Кожен харчовий продукт має свої особливості виробництва, різні небезпечні фактори, які впливають на його безпеку, що зумовлює необхідність розроблення системи управління безпекою для кожної групи харчових продуктів окремо. До того ж, дослідження аспектів впровадження системи управління безпекою харчових продуктів є важливим питанням для підприємств, оскільки регламентоване законодавством у більшості країн світу.

Спираючись на вимоги належних гігієнічних та виробничих практик, у роботі приведені особливості розроблення програм-передумов для підприємства, яке здійснює виробництво розроблених борошняних кондитерських виробів. У програмах-передумовах визначено, які оперативні записи повинні вестися підприємством. Також, базуючись на 7 принципах та 12 кроках системи HACCP (Hazard Analysis and Critical Control Points), розроблено алгоритм впровадження системи управління безпекою під час виробництва борошняних кондитерських виробів. Зокрема, розроблені підходи до формування групи HACCP, запропонована уніфікована блок-схема виробництва борошняних кондитерських виробів. Наведені основні небезпечні фактори у виробництві борошняних кондитерських виробів та визначені критичні точки контролю, а також запропонований HACCP-план виробництва. У роботі також запропоновані підходи до валідації та верифікації системи HACCP. У роботі наведені форми журналів та чек-листів, які можуть вестися підприємством з метою ведення системи HACCP. Результати досліджень дають можливість підприємствам борошно-кондитерської галузі використовувати основні положення. Завдяки дослідженню, наведеному у роботі, підприємствам харчової промисловості вдасться покращити безпеку продукції, що випускається.

**Ключові слова:** борошняні кондитерські вироби, система управління безпекою харчових продуктів, система HACCP, програми-передумови.

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### 1. Introduction

Many diseases that currently affect the population, such as cardiovascular disease, osteoporosis, diabetes, or certain cancers caused by or associated with the food that people eat [1]. Food safety is a concept that includes the processing, preparation and storage of food in such a way as to prevent foodborne illness. This means that food manufacturers and distributors must follow a number of procedures to avoid potentially serious health hazards. According to WHO (World Health Organization), an adequate amount of safe and balanced nutrition is an important factor for maintaining life and improving health. That is why the introduction of a Hazard Analysis and Critical Control Points (HACCP) food safety management system is an extremely important step in creating safe food products. The goal of introducing HACCP in the flour industry is to obtain high-quality products without risk to consumers. The HACCP system is based on the requirements of Regulation 852/2004 of the European Parliament and of the Council for the observance of general hygiene

standards for all food products. This normative document establishes that food safety depends on various aspects. In particular, legislation should establish minimum hygiene requirements; formal controls should be in place to verify that food enterprises comply with standards. These establishments should establish and implement programs and food safety procedures based on HACCP principles. Since flour confectionery is a fairly popular product among the population, consumed almost daily, it is very important to observe the norms and principles of the food safety management system in their production.

### 2. The object of research and its technological audit

*The object of research* is the safety management of developed flour confectionery products from organic raw materials – muffins, cakes and biscuits. In connection with the introduction of new recipes for flour confectionery products, an important task is the development of a food safety management system in production. It should be

noted that the mandatory implementation of a food safety management system based on the principles of HACCP in Ukraine is regulated by the Law of Ukraine «On Basic Principles and Requirements for Food Safety and Quality».

### 3. The aim and objectives of research

*The aim of research* is the scientific justification for the implementation of a safety management system based on the principles of HACCP in the production of flour confectionery. Based on the foregoing, it is possible to formulate research objectives, which are:

1. Risk analysis at an enterprise producing flour confectionery.
2. Development and implementation of the HACCP system at an enterprise producing flour confectionery.

### 4. Research of existing solutions of the problem

In [2], it is proposed, before introducing a food safety management system, to analyze such factors as the size of the organization, the degree of automation, and the type of product group. From the point of view of food safety, the latter factor is of particular importance, in particular, the technology of its production and hazardous factors that may affect the final product. So, the source [3] defines the physical, chemical and biological hazards in the production of flour confectionery. The first author includes metal, plastic, glass objects, stones, heat-insulating materials, fruit bones, hair. To this group it would also be advisable to include foreign objects from staff clothing. Chemical hazards include migrating substances from plastic containers and packaging materials, residues of chemicals and pesticides, biphenyls. The author divides biological factors into macrobiological, microbiological and pathogenic bacteria, such as E-coli, Salmonella spp., Bacillus cereus. In the case of small bakeries, the implementation of HACCP is especially difficult, since there are not enough personnel to work with so many products. Before setting up the HACCP concept, good manufacturing practice is necessary. From the point of view of food safety, products from creamy filling require special attention. Special risks when baking products are dirty equipment and non-compliance with hygiene requirements by personnel. That is why scientifically sound methods for reducing the level of microorganisms on equipment. It was found that the addition of acetic or citric acid to creams delays the growth of pathogenic microorganisms by lowering the pH level. Cream and fruit products are more stable due to lower pH, so fruit should be preferred in the summer. Cooling is an essential measure to prevent microbiological growth [4].

The study [5] presents the results of microbiological analysis of cookies before and after the introduction of the HACCP system. The work notes that in both cases the indicators were within normal limits, however, the HACCP system still had a positive impact on the quality and safety of products. An important factor in the implementation of the HACCP system for the flour industry is the establishment of control critical points. So, in the study [6], the following critical control points are proposed for the FC (flour confectionery) production: receipt and storage of raw materials, mixing, packaging, storage of the product. However, this approach has certain drawbacks, since such stages of

the technological cycle as the receipt and storage of raw materials, packaging and storage of the product can be established in the prerequisite programs and not be part of the HACCP plan [7]. It should be noted that the prerequisite programs are an important basis for the implementation of a food safety management system. The source [8] states that cross-contamination with allergens can be a critical reference point in the production of flour products.

The author has proposed approaches to the implementation of the HACCP system in the production of organic confectionery products in sources [9, 10], however, the specifics of the introduction of prerequisite programs have not been previously investigated.

### 5. Methods of research

To introduce the HACCP system in production, a quantitative and qualitative risk analysis is used. A quantitative risk analysis should make it possible to determine the number and size of individual risks and the risk of the project as a whole. Qualitative analysis identifies factors, boundaries and types of risks. For risk analysis, the method of analogy, the method of expert assessments, the calculation-analytical method and the statistical method are used. To determine critical control points in food production, the decision tree method is used. The method of applying the decision tree and the probabilistic approach allows to consider various scenarios of the development of events caused by exposure to various risk factors.

### 6. Research results

The first step in introducing a food safety management system based on the principles of HACCP is the development of prerequisite programs based on the analysis of good manufacturing and hygiene practices (GMP and GHP). Prerequisite programs are the basic conditions and activities necessary to maintain hygienic conditions at all stages of the food production chain, taking into account the requirements of good manufacturing and hygiene practices.

When developing prerequisite programs, in addition to the requirements of sanitary norms and rules, it is necessary to take into account the requirements of such good practices as GMP (Good Manufacturing Practice) and GHP (Good Hygiene Practice). Since the implementation of these programs takes place along the entire food chain – from growing raw materials, their production, auxiliary materials to the production of finished food products. This will significantly reduce the risk of product pollution and prevent many diseases.

Responsible persons are appointed for the development, updating, requirements of the prerequisite programs (order, order, job descriptions, etc.).

Prerequisite programs are executed in any form.

Prerequisite written programs contain:

- name, links to regulatory acts;
- information about the responsible persons (who conducts the events and who has the control role);
- specific activities (process description);
- frequency of events;
- other information as necessary.

Routes of movement of employees and portable equipment must be organized in such a way as to minimize possible

contamination or spoilage of products during production. Responsibilities for personnel working in the garage for dump trucks or in the workshop for the receipt of raw materials should be such as to minimize or completely eliminate the need to go through production and packaging areas. The movement of personnel, employees and visitors across the territory of the plant and its production facilities should begin in the production and packaging area and be carried out in the direction of receiving raw materials and external equipment of the plant.

In a written prerequisite program, it is necessary to schematically depict the following directions of movement:

- movement of raw foods;
- movement of processed products;
- movement of personnel (without observing hygiene rules);
- movement of personnel (subject to hygiene rules).

Color zoning of the floor plan is also important for the selection of inventory. Usually, when planning and organizing cleaning, production facilities of enterprises are divided into color zones. The equipment used to clean these areas is also selected, taking into account the color coding systems.

In the written prerequisite program «Requirements for the condition of premises, equipment, repair work, equipment maintenance, calibration, etc., as well as measures to protect food from pollution and impurities», it is recommended to analyze:

- materials of which the floor, walls, ceiling, windows, doors are made;
- analysis of possible dangers caused by the condition of the room;
- list of technological equipment and a passport for it;
- schedule for checking and calibrating equipment, a list of responsible persons. Also, the prerequisite program involves maintaining accounts for repairs.

It is proposed to enter information on all identified inconsistencies in the production, require repair work, as well as record information on the implementation of such work. It is important that cross-contamination of food products can be avoided during repairs.

Prerequisite program «Requirements for the planning and state of communications: ventilation, water supply, electricity and gas supply, lighting, etc.» provides procedures for maintaining communications in good condition. For manufacturing enterprises, a written prerequisite program should contain:

- plan for sewer networks;
- ventilation plan;
- power plan;
- gas supply plan.

A prerequisite program for the safety of water (ice) should provide:

- determination of the source of water supply (water supply network or well) and associated risks;
- compliance with water storage conditions;
- condition of the water supply network at capacity;
- preparation of water for use;
- method of using water and the impossibility of cross-contamination through contact surfaces.

Since water, which is used for washing and preparing products, can be a source of microbiological contamination of finished products, it is important to keep a schedule and periodically examine microbiological indicators.

The market operator should regularly check (verify) the effectiveness of the cleaning, washing and disinfection processes. Verification can be carried out visually and using laboratory monitoring. Based on the results of an analysis of the effectiveness of cleaning, washing and disinfection processes and identified inconsistencies, market operators introduce appropriate measures or corrective measures.

The company should provide for an inadmissibility of the work carried out with the aim of preventing the possibility of contamination of food products due to the inadequate state of health of personnel or its appearance. There should be a magazine or questionnaire for admission of visitors to production facilities.

When introducing prerequisite programs, attention should be paid to pest control, especially given the specifics of flour confectionery products, it is worth focusing on monitoring pests and production facilities and storage facilities. In the case of pests, it is recommended to carry out work on their destruction, which should also be fixed.

Toxic detergents and disinfectants must be marked (labeled) and stored so that products, surfaces in contact with food, and packaging materials are protected from contamination. All relevant rules and regulations on their application, use or storage issued by the manufacturers of these funds and state bodies should be followed.

The process of selecting suppliers is important for the implementation of a security management system. The ranking of suppliers is carried out for all suppliers of raw materials. The most significant criteria for ranking for organic producers is the state registration of the supplier, the HACCP system has been introduced, the presence of an organic certificate and the compliance of quality indicators with the requirements of regulatory documents.

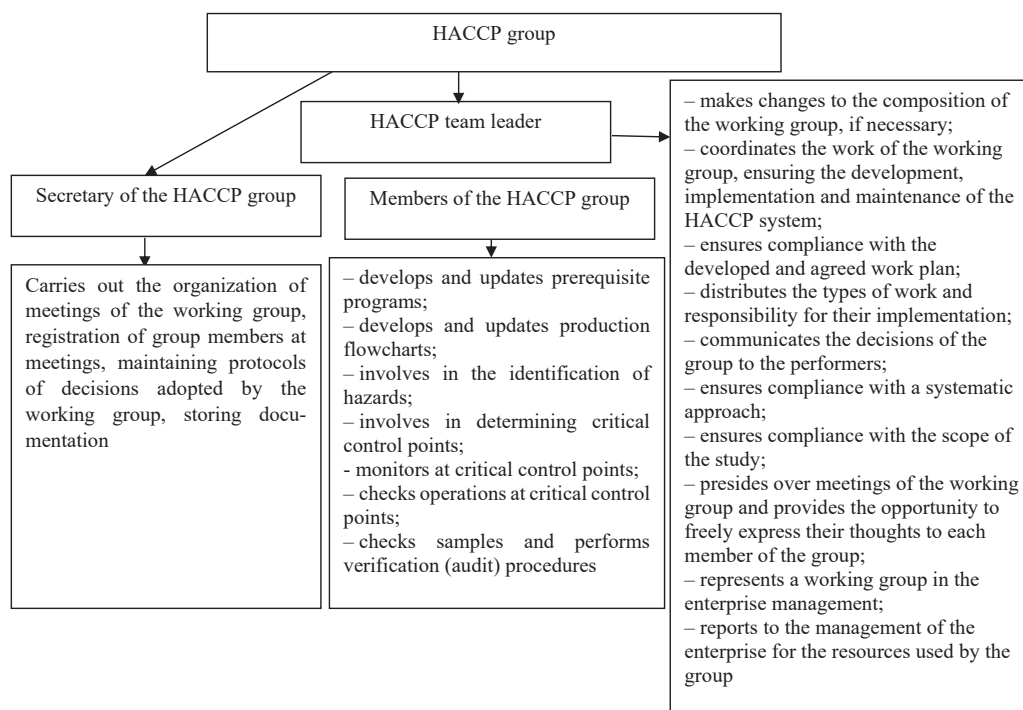
The implementation of the HACCP system provides for 12 consecutive steps. The first step is the formation of a HACCP group in production. Its recommended composition is the leader, secretary and members of the HACCP group. The distribution of duties between members of the HACCP group is shown in Fig. 1.

So, according to Fig. 1 it can be seen that the main participants in the HACCP group are the leader, secretary and members of the group. Their recommended number is from 2 to 6. However, for the convenience of making decisions during a meeting of the HACCP group, in particular on recalling products, if necessary, the desired number of members of the HACCP group should be odd.

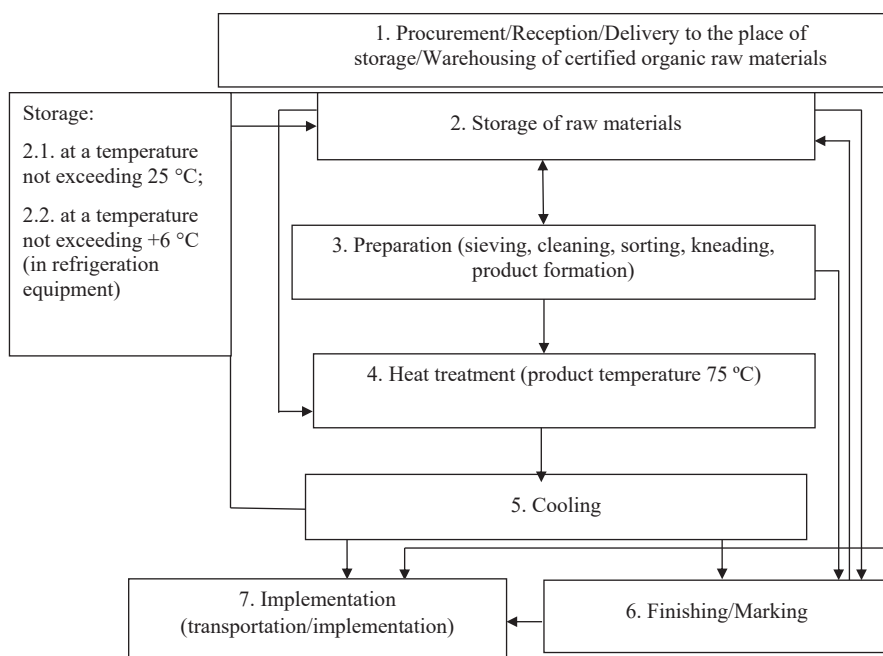
The next step in the implementation of the HACCP system is the description of products, in particular raw materials. At this stage, it is important to determine the range of products, their composition, requirements for safety indicators, type of processing, type of packaging, transportation and storage, as well as labeling requirements.

To analyze hazardous factors and establish critical control points, it is necessary to build a block diagram of the production process and validate it in production. For the manufacture of flour confectionery products from organic raw materials, the block diagram shown in Fig. 2.

Analysis of hazardous factors at each stage of the flow-chart gives reason to believe that the stage of heat treatment of products is the most dangerous from the point of view of food safety. Monitoring the indication of allergenic information on the label also requires special attention in order to prevent negative allergic reactions.



**Fig. 1.** Structure of the Hazard Analysis and Critical Control Points group in a manufacturing facility



**Fig. 2.** Flow chart for the production of flour confectionery products for the implementation of the Hazard Analysis and Critical Control Points system

A special biological risk in the manufacture of confectionery products is the presence of bacteria of the paratyphoid Salmonella group in eggs. It is important that salmonellosis is still the dominant disease among food poisoning in the United States. Great Britain, Germany. Bacteria of the genus Salmonella belong to the group of pathogenic intestinal bacteria, gram-negative and non-disordered. These bacteria can cause the three main types of salmonellosis – typhoid fever, gastroenteritis, and the local type with salmonellosis. Although processing temperatures above 60 degrees inactivate bacterial growth, egg storage and processing is an important food safety issue.

The cause of food poisoning can be opportunistic microorganisms that can be found in food raw materials. Such microorganisms include those that, under certain conditions, when the body is weakened, can cause poisoning. In particular, *E. coli* bacteria can cause coli bacteria toxicoinfections. But these bacteria easily die during processing, therefore, to prevent them from getting into ready-made food products, it is important to observe the hygiene rules by the employees of the enterprise and to avoid cross contamination.

Bacteria *Clostridium perfringens* are large gram-positive spore-releasing microorganisms that can be in flour

and cause toxic infections. *Bacillus cereus* is an aerobic, spore-releasing microorganism that can be found in milk powder and egg powder. The spores of these bacteria are heat resistant, so it is important to periodically check the raw materials and select suppliers.

A significant hazard in food production is the presence of mycotoxins in raw materials. Toxin-releasing fungi affect plants during the growing season and can develop on raw materials during storage, and when they enter the body of animals, they can accumulate in muscle tissue. Aflatoxicosis can be caused by *Aspergillus flavus* and *A. parasiticus* fungi.

However, a massive case of this disease was recorded in India in 1974, when 400 people fell ill. Aflatoxins are not destroyed by culinary processing, although during the heat treatment of flour products, their number is reduced by 60–80 %.

Infections transmitted from humans in the food industry include bacterial dysentery, cholera, typhoid fever, paratyphoid fever and viral hepatitis.

The main chemical hazards in the production of flour products are the content of toxic elements and pesticides in raw materials. However, since for the production of products considered in the work, the selected organic raw materials, such a risk is minimal.

Physical hazards may include foreign objects entering the finished product. This risk is significant, however, an analysis of production practices indicates an insignificant frequency of its occurrence.

So, the most significant hazards in the production of flour products based on organic raw materials is the ingress of glass when opening glass containers; the presence of pathogens after heat treatment and the presence of allergens in the products.

Important factors in observing food safety are monitoring temperature conditions, observing hygiene rules by personnel, clean working surfaces, and monitoring glass objects. It is these hygienic processes that must be monitored daily. To establish critical control points, the decision tree method was used to determine them. A critical control point is the stage of ensuring «food product safety», at which it is possible and important to carry out a management measure to prevent, eliminate or reduce to an acceptable level the danger threatening food safety. The effectiveness of the HACCP system is characterized by the possibility of its implementation. Therefore, it was proposed not to burden the production process with critical control points (CCP), but to

install only one CCP at the stage of heat treatment and supply (checking for allergens on the label).

Thus, the implementation of the HACCP system at all stages requires the participation of a fully qualified HACCP plan, which can help food market operators improve their food safety management. It has been established that the implementation of a safety management system involves a detailed analysis of hazardous factors, which includes an analysis of each stage of the production process. The solution to the control of significant hazardous production factors can be the maintenance of daily safety letters. HACCP-plan for the production of flour confectionery products are presented in Table 1.

So, enterprises producing flour confectionery, it is recommended to establish 2 critical control points at the stage of heat treatment and supply of the product (verification of correct labeling).

The next step is to establish an adjustment procedure. Such a procedure establishes the procedure for the implementation of corrective and preventive actions in the framework of fulfilling safety management functions with the aim of eliminating and preventing detected violations, errors, and non-compliance with the requirements of the technological map in order to prevent their possible negative impact on the quality of finished products. If non-conformities are found, it is recommended to use the non-conformance log.

The next step in the development of a safety management system for flour confectionery products is the validation and verification of the HACCP plan.

The HACCP group is introducing verification procedures to establish whether control measures achieve the desired effect, that is, control dangerous factors.

Verification is carried out at least once a year or with changes in technological processes or food products, affects their safety. If the HACCP system is recently implemented, it is recommended that verification be carried out more often.

Verification is carried out by a person who is not responsible for conducting monitoring or taking corrective measures. If verification can't be carried out by internal forces, then external experts are involved. The method by which verification is carried out consists in examining and providing objective evidence of compliance with certain requirements of the food safety management system.

Validation is carried out in order to establish that the procedures of the food safety management system are correctly prescribed by the market operator.

Table 1

Hazard Analysis and Critical Control Points organic pastry production plan

CCP number	Stage number and name	Hazard description	Critical limits	Control measures	Monitoring			
					What?	How?	How often?	Responsible person
CCP No. 1	4. Heat treatment	Microbiological pollution due to non-compliance with temperature conditions	Temperature and cooking time; product temperature	Selective control. Compliance with cooking technology instructions	Product temperature	Performance monitoring	Daily	–
CCP No. 2	7. Implementation (transportation/implementation)	Allergens	Presence of allergen labeling	Monitoring the presence of allergen labels on the label	Presence of allergen labeling	Verification of technological schemes	Menu design and approval	–

Given the principles of HACCP, a production flow chart has been drawn up, which is the basis for the analysis of hazardous factors. Hazardous factors of the production of flour confectionery products from organic raw materials are analyzed and a HACCP plan is drawn up. Procedures for adjusting, validating, and verifying the HACCP plan have been developed.

## 7. SWOT analysis of research results

**Strengths.** This study can be used by enterprises in the flour and confectionery industries as the basis for the introduction of a food safety management system. This study proposes a detailed algorithm for the development of documents and analysis of hazardous factors in the production of flour products.

**Weaknesses.** The implementation of the HACCP system at each production facility is individual and can't be borrowed; therefore, this study can serve only as the basis for the introduction of a food safety management system.

**Opportunities.** Opportunities for further research will be directed to the development of a new assortment of organic flour products, taking into account the principles of the HACCP system. This series of studies is interesting for food industry enterprises in many countries, since the principles of food safety management based on the principles of HACCP are mandatory in most countries.

**Threats.** The main threats in introducing a new range of flour products, taking into account the principles of HACCP, are the additional costs associated with training personnel, as well as viewing suppliers and using better raw materials.

## 8. Conclusions

1. The risks associated with non-observance of good manufacturing practices by food industry enterprises are analyzed. The most significant hazards in the production of flour products based on organic raw materials is the ingress of glass when opening glass containers; the presence of pathogens after heat treatment and the presence of allergens in the products.

2. The implementation of the HACCP system provides for 12 consecutive steps. Given the principles of HACCP, a production flow chart has been drawn up, which is the basis for the analysis of hazardous factors. Hazardous factors

of the production of flour confectionery products from organic raw materials are analyzed and a HACCP plan is drawn up. Procedures for adjusting, validating, and verifying the HACCP plan are developed.

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