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APPLICATION OF HACCP SYSTEM FOR THE MEAT-PLANT PASTE PRODUCTION

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Abstract. Currently, one of the main tasks for the food producers is the food products production with moderate prices and high nutritional value. In this regard, in the meat processing industry are available various by-products that have possibilities for applying as the secondary raw materials. HACCP system principles in the production technology of combined meat and plant paste by using meat, liver and local raw materials is discussed in the presented work. As the plant additive a boiled and fried millet flour (tary — Kazakh national delicacy) was used. The application of the HACCP system by identification of the critical control points allows for the production of safe and high-quality food products at the international level. At the discovering of the hazardous factors, it is taken into account the following specifics: composition of meat-plant

paste, technological stages, food safety ensuring, etc. The analysis of the technological processes showed that the main hazard is a microbiological factor. As well, the chemical and physical hazardous are identified. The system of preventive and corrective actions in the case of occurrence of risks by stages of technological processes is proposed. The identified hazards in the meat-plant paste technology will minimize or completely reduce emergencies of production risks, as result, significantly affect product food safety. The main advantage in the HACCP system implementation is a guarantee of the food safety and improving of the producer's status on the market.

Keywords: emergency, food safety, food technology, meat by-products, HACCP

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ЕТ-КӨКӨНІС ПАШТЕТТІ ӨНДІРУДЕ ХАССП ЖҮЙЕСІН ҚОЛДАНУ

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Аннотация. Ауруды төмендету, халықтың әлеуметтік және кәсіптік белсенділігін арттыру мақсатында жергілікті шикізаттан қолжетімді азық-түлік өнімі,

тағамдық құндылығы жоғары ет-көкөніс паштетін өндіру технологиясы әзірленді. Тара ұны (қазақтың ұлттық дәмді тағам) өсімдік қоспасы ретінде пайдаланылды. Тамақ өндірісінде өнімнің жаңа түрлерін әзірлеу ғылыми зерттеулердің өзектілігін анықтайды, атап айтқанда өнімнің сапасы мен қауіпсіздігін қамтамасыз ету саласында. Жұмыстың мақсаты — жаңа ет-көкөніс паштетін өндіру бойынша ХАССП жоспарын әзірлеу. ХАССП жүйесін қолдануы халықаралық деңгейде қауіпсіз және жоғары сапалы өнім шығаруды көздейді. Жұмыста ет-көкөніс паштетін өндірудегі өмірлік циклдің барлық кезеңдерінде бақылауды қамтамасыз ететін ХАССП жүйесі негізіндегі сыни бақылау нүктелерін зерттеу нәтижелері берілген. ИСО 22000 талаптарына сәйкес ет-көкөніс паштетін өндірудің технологиялық процесіне талдау жүргізіліп, сыни бақылау нүктелері анықталды. Қауіпті факторларды анықтау кезінде біз мыналарды ескердік: ет-көкөніс паштетінің құрамы, оны өңдеудің технологиялық процесі және т.б. Технологиялық процестердің операцияларын талдау негізгі қауіп микробиологиялық екенін көрсетті. Ет-көкөніс паштетін өндіру процесінде химиялық және физикалық сипаттағы ықтимал қауіпті факторлар да анықталады. Мониторинг әрбір бақылау пункті бойынша жоспарланған кезектілік бойынша жүргізілді. Технологиялық процестің кезеңдері бойынша тәуекелдер туындаған жағдайда алдын алу және түзету әрекеттерінің жүйесі ұсынылады. Ет-көкөніс паштетты өндірудегі анықталған қауіптер өндірістік тәуекелдердің туындауын барынша азайтады немесе толығымен азайтады, нәтижесінде өнімнің қауіпсіздігіне айтарлықтай әсер етеді. ХАССП жүйесін енгізу кезінде артықшылық компанияның мәртебесін жақсарту және қауіпсіз өнімдерге сенімді арттыру болып табылады.

Түйін сөздер: ет-көкөніс паштеті, сапа, тамақ қауіпсіздігі, ХАССП

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ПРИМЕНЕНИЕ ХАССП СИСТЕМЫ В ПРОИЗВОДСТВЕ МЯСОРАСТИТЕЛЬНОГО ПАШТЕТА

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Аннотация. В настоящее время одной из основных задач производителей продуктов питания является производство продуктов питания с умеренными ценами и высокой пищевой ценностью. В связи с этим в мясоперерабатывающей промышленности имеются различные субпродукты, имеющие возможности для использования в качестве вторичного сырья. В представленной работе рассмотрены принципы системы ХАССП в технологии производства комбинированных мясорастительных паштетов с использованием мяса, печени и местного сырья. В качестве растительной добавки использовалась вареная и обжаренная пшенная мука (тары — казахское национальное лакомство). Применение системы ХАССП путем определения критических контрольных точек позволяет производить безопасные и качественные продукты питания на международном уровне. При выявлении опасных факторов учитываются следующие особенности: состав мясорастительного паштета, технологические этапы, обеспечение безопасности пищевых продуктов и др. Анализ технологических процессов показал, что основную опасность представляет микробиологический фактор. Также определены химические и физические опасности. Предложена система предупреждающих и корректирующих действий при возникновении рисков по стадиям технологических процессов. Выявленные опасности в технологии мясных паштетов позволят минимизировать или полностью снизить аварийные производственные риски, как следствие, существенно повлиять на пищевую безопасность продукта. Основным преимуществом внедрения системы НАССР является гарантия безопасности пищевых продуктов и повышение статуса производителя на рынке.

Ключевые слова: мясорастительный паштет, качество, пищевая безопасность, ХАССП

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Introduction

Technology production meat-plant pastes of new generation ensures rational use of secondary meat raw materials and designed to reduce growth of morbidity, increase social and professional activity of the population. Various vegetable components with a high content of proteins and dietary fibers are using as binding ingredient. With introduction of herbal additives, texture, also flavor and aroma characteristics of the finished product improves.

As additive can use not only wheat flour, but also other types of flour, such as tary flour (Kazakh national delicacy). Tara groats are very useful for the human digestive system, this is hand-processed millet, technological process of which is very difficult. Tary cereal contains a large amount of fiber, which binds fats and toxins, and then removes them from the intestines. Tary contain about 11–15 % protein and about 5 % fat, which contain lecithin — substance that promotes better protein absorption (caloricizer). Also, composition of talkan includes ligin, which removes excess cholesterol and bile acids from the body, bioflavonoids, which are strong antioxidants and have positive effect on the immune and endocrine systems of the body. Bioflavonoids prevent the formation of tumors (including cancer), helps to cleanse body of toxic substances, take an active part in cell regeneration, and catalysts for many biological processes. Tary contains B vitamins, which are antidepressants and vitamins of youth, have positive effect on memory and condition of the skin and hair (including nails), amino acids alanine and cysteine, which restore hair structure and regulate the secretion of sebum. The lack of these amino acids is cause of hair loss and brittleness, avenanthramides, which prevent the formation of plaques on the walls of blood vessels, protect against clogging of the arteries. From macro- and microelements, cereals are especially rich in silicon, fluorine, iron, manganese, magnesium, copper (Vershinina et al., 2012; Yanova et al., 2015).

Appearance and quality of raw materials, methods, technologies and conditions of production, packaging, transportation and storage have the most significant impact on the formation and preservation of the quality of food products.

Production of safe food products is determined by the degree of purity and good quality of raw materials. Food products may contain many harmful contaminants with carcinogenic, mutagenic, teratogenic, and immunosuppressive effects.

The content of contaminants in food products sometimes leads to death, and contaminated food products impair immunity, body's defenses, cause changes in heredity and lead to diseases. In many cases allergic, oncological, cardiovascular and other dangerous diseases occur as result of violation of biochemical reactions in the body, mainly caused by use of poor-quality food [Fred, Fung et al., 2018; ISO 22000–2018, Dunchenko, 2008; Diyarov et al., 2022).

Effective quality management of the production meat-vegetable paste, based on the principles HACCP - an important direction, and will achieve stable and high quality, safety, that in currently is main component of the production of any food product.

The object of the study is the technological process for the production of high-quality and safe meat-vegetable paste.

The subject of research is HACCP methodology in relation to the production of new meat-vegetable paste.

The goal of the work is to ensure quality and safety of products with using principles HACCP at development of new meat-vegetable paste.

To achieve this goal, it is necessary to solve the following research tasks:

- identification of critical control points of technological process for production meat-vegetable paste;
- development of corrective measures to ensure the safety of manufactured products;
- development of recommendations on the organization and distribution of responsibility for corrective actions.

The HACCP system helps to prevent occurrence of hazards at early stage of food production and based on preventive approach to ensuring quality and safety during production process, and can also be used in the development of new types of products.

Use new types of raw materials and technologies in food production determines the relevance of scientific research, namely in the field of ensuring quality and safety of products. The application of the HACCP system serves as guarantee of quality and food safety at the international level.

As result, percentage of implementation HACCP should be 100 % for all food criteria, from field to table. The implementation of HACCP system means continuous application of accounting, monitoring, corrective actions consistent with HACCP plan (Kasza et al., 2022; News, 2018). The ongoing maintenance of an effective HACCP system depends on timely scheduled verification activities. In general, food safety takes into account origin of food, this includes agricultural practices, hygiene, food labeling, pesticide residue content, import and export verification procedures, and food certification systems (Kasza et al., 2022; News, 2018).

According to the HACCP system, hazards are divided into biological, chemical and physical. Chemical factors that threaten human health include hazards from chemical compounds that enter products during preparation, transportation or improper storage. These include: toxic elements, pesticides, dioxins, antibiotics, chemicals (cleaners and detergents), diarrhoeic shellfish poisoning (DSP), ciguatoxin, paralytic shellfish poisoning (PSP), shellfish toxins, mushroom toxins, allergens, scombrotoxin (histamine), cyanogenic glycosides, etc. (Morya et al., 2022; Rather et al., 2017). Physical hazard for health can occur when foreign objects from the external environment enter the finished products. These include solids: hair, plastics, jewelry, metals, fingernails, etc. (Bushra et al., 2022; Sarker et al., 2017). Biological hazards include: pathogenic microorganisms (*Salmonella*, *Clostridium botulinum, Escherichia coli, Listeria, Vibrio cholerae, Cronobacter spp, etc*.), viral pathogens (such as Enterovirus, Hepatitis A, Norovirus, Rotavirus, etc.), parasitic pathogens (such as *Cryptosporidium, Entamoeba histolytica, Giardia, Trichinella*, etc.), also rodents and insects. For reproduction, microorganisms need moisture, nutrient medium, room temperature and time. These factors are present in most foods [Atambayeva et al., 2022; Bosch et al., 2018; Ceylan et al., 2021; Alibekov, 2019).

HACCP plan is list of control measures necessary to maintain safety of production processes, which created based on analysis of the main critical points. This is basic document on the basis of which management systems for ensuring food safety are

established and implemented. They involve identification and elimination of biological, chemical and physical risks at all production stages (Fred, Fung et al., 2018; ISO 22000–2018; Dunchenko, 2008).

Goals of development and implementation of HACCP (Fred, Fung et al., 2018; ISO 22000–2018; Dunchenko, 2008):

Minimizing risks, associated with production of food products, sale, storage, movement and disposal of food (including raw materials, semi-finished products, finished products, etc.).

Management, control, protection of production processes from various types of risks and hazards.

Market promotion within country, abroad.

The plan development process includes the following steps (Fred, Fung et al., 2018; ISO 22000–2018; Dunchenko, 2008):

organization of group that will deal with HACCP-plan;

analysis of raw materials and final product;

defining how the product should and can be used;

creation of a flow diagram of the technological process and its confirmation;

assessment of potential risks;

finding and defining critical control points;

establishment of critical limits for each control point;

creation of monitoring system for control points;

preparation of corrective actions;

development of verification procedures;

preparation of accounting and control documentation.

HACCP plan development team should include specialists who have deep technological knowledge, and also understand related areas (veterinary medicine, general chemistry and biology, technology and food safety, legislation).

Stage of identifying potential hazards and risks is one of the most important in the process of creating plan. Team members should be well aware of the risks and threats that exist today, also methods to overcome them. The following situations are potentially dangerous (Fred, Fung et al., 2018; ISO 22000–2018; Dunchenko, 2008; Diyarov, 2022):

launch of new product and use of new raw materials;

technology adjustment;

equipment replacement or upgrade.

Serious risks are identified at these and other stages, team should develop operational countermeasures. The most important step is definition of critical control points. This is name of the stages with a high risk of errors, failures, violations and deviations from technology. Due to the complexity of the process or properties of the raw materials, they require special attention, and task of the group is to reduce their number to minimum.

For each critical point, criteria for the acceptability and inadmissibility of specific biological, chemical and physical parameters should be developed. Points must be under constant control. This can be both continuous monitoring and periodic verification

activities. In case of deviation from the specified parameters, corrective action plan is created. It is recommended to include the following items:

establishing causes of critical situation;

selection method of disposal defective products;

documenting actions taken.

The final stages of the HACCP plan are determination of procedures for its verification (validation), also creation of documentation for all its points and the implementation of control measures. The important documents of the plan are following (Fred, Fung et al., 2018; ISO 22000–2018; Dunchenko, 2008; Diyarov, 2022; Kasza et al., 2022):

order to create HACCP group;

block diagram of the technological process;

description of raw materials, finished products and packaging;

protocol selection monitoring method and control procedures;

list of responsible specialists.

In the Republic of Kazakhstan there are standards for ensuring quality and safety of food products, such as ST RK 1179–2003 "Quality systems, HACCP principles for food products quality management. General requirements", and ST RK ISO 22000–2019 "Food safety management systems. Requirements for organizations involved in the creation of food products", which ensure the implementation of the HACCP plan in enterprises, Technical regulations of the Customs Union (TR CU), which establish requirements for food products, production processes, storage, transportation, distribution and disposal. Requirements for all organizations in the food production and consumption chain", which ensure implementation HACCP plan at enterprises, the Technical Regulations of the Customs Union (CU TR), which establish requirements for food products, production processes, storage, transportation, distribution and disposal. In TR CU 021/2011 "Food Safety" for the first time establishes requirement which provides that manufacturer, when implementing production processes, consistent with established food safety requirements, obliged to create, introduce and promote procedures based on the principles of HACCP.

Materials and methods

Generally accepted standard research methods were used in the performance of the work. Development HACCP plan was carried out in accordance with ISO 22000. CCP for each type of raw material used, also for all stages included in the flowchart of production process, was determined using the Decision Tree method (ISO 22000–2018; Dunchenko, 2008).

Risk probability was assessed in points according to the criteria given in Table 1.

Table 1. Criteria for assessing probability of risk

Criterion	Probability score
Probability of dangerous factor is practically absent	1 score
Low probability of hazardous factor	2 score
Significant probability of a hazardous factor	3 score
High probability occurrence of hazardous factor	4 score

Guided by this algorithm, possible to fully assess probability realization of each identified potential hazard with subsequent risk analysis by hazard (Dunchenko, 2008; Diyarov, 2022; Kasza et al., 2022). Risk analysis for each potentially dangerous factor was carried out taking into account probability of the factor and severity of its consequences according to the risk analysis diagram. Use of risk analysis diagram when managing quality of the production of new type of meat-vegetable paste makes it possible to identify potentially hazardeous factors at its production, which must be taken into account in the future when determining CCP (Kasza, 2022; News, 2018; Morya et al., 2022; Rather et al., 2017).

Research results and discussion

At the first stage of research, initial information on the production of meat-vegetable paste was collected and scheme of the production process was drawn up (Fig.1).

After receiving raw meat, its preparation is carried out according to traditional technology: beef liver is cleaned from films, large blood vessels are removed, then lymph nodes, beef meat and liver are washed in water. Preliminary heat treatment of liver and beef meat of the 2nd grade is carried out until structures are softened. Then crushed on cutter for 5-8 minutes, where boiled carrots, onions sautéed in sunflower oil, beef broth, spices, garlic and salt are added to paste mass according to the recipe, then minced meat components are mixed. Additionally, before mixing, hydrated tary flour is added to the minced meat in the ratio of flour and water 1:3 for 3 hours.

As vegetable oil, proposed to use sunflower oil, which is rich by polyunsaturated fatty acids, including linolenic acid, that is ω-3 fatty acid, and also contains vitamins such as E and B4.

At second stage of the research, probability of the implementation of each hazardous factor was assessed.

At the third stage of research, CCP of the raw materials used and at all stages of the technological process for the production of meat-vegetable paste were determined. An assessment was made of probability implementation of hazardous factor and, in addition, at this stage of the research, subsequent risk analysis was carried out for each potentially hazardous factor. The risk analysis was assessed taking into account probability of occurrence factor and severity of its consequences. Thus, as result of the analysis hazardous factors and risks for each potentially dangerous factor, list of potential hazards taken into account in production was compiled. The identified hazards in production of new type meat-vegetable paste will minimize or completely reduce occurrence of production risks, which will drastically affect safety of research object. В результате проведенных исследований были выявлены ККТ. As result of conducted research, CCPs were identified. Critical control points in the production of new type meat-vegetable paste are shown in table 2.

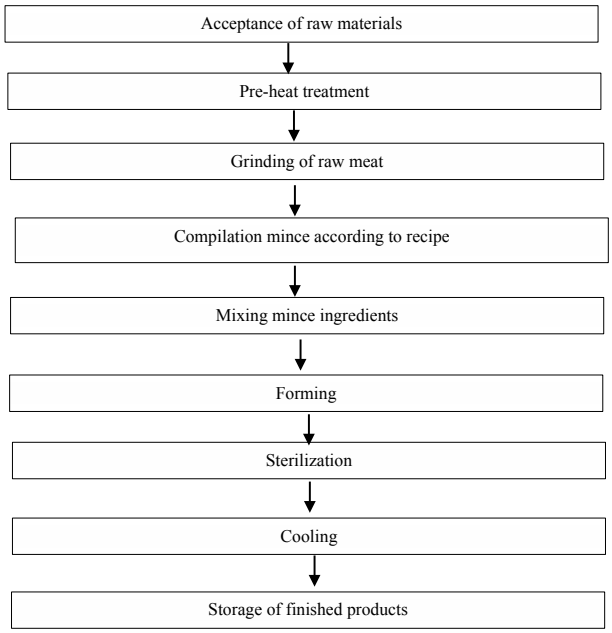

Fig. 1. Scheme of production process meat-vegetable paste

Table 2. List of hazardous factors in technological process of production meat-vegetable paste

№	Name of the technological operation	Name of control points	Considered hazard	Responsible for control and execution
1	Acceptance of raw materials	CCP 1	Microbiological and chemical. There is danger of not eliminating hazards with insufficient heat treatment	Head of laboratory
2	Pre-heat treatment	PPM	Microbiological. Incomplete destruction of microflora, but they are destroyed during further heat treatment.	Technologist
3	Grinding of raw meat	PPM	Microbiological and physical. Possibility of microbial growth, but they are destroyed during heat treatment. Foreign impurities are removed using magnesium traps	Technologist
4	Compilation of minced meat according to the recipe	CCP 2	Microbiological. If temperature regime and the duration of exposure are not observed, also if salt concentration is not observed, too much growth of microorganisms may occur that cannot be eliminated at the stage of heat treatment, which can lead to product spoilage	Technologist
5	Mixing mince ingredients	CP 1	Microbiological and physical. Growth of microorganisms and ingress of foreign matter. Compliance technological modes and parameters of mixing components. Good Hygiene and Manufacturing Practices	Technologist

6	Forming	PPM	Microbiological and chemical. Growth of microorganisms due to equipment downtime and detergent residues. Thorough cleaning of the equipment is required.	Technologist
7	Sterilization	CCP 3	Microbiological. Occurs with insufficient processing time, non-compliance with temperature. Requires compliance technological regime, personnel briefing	Technologist
8	Cooling	CP 2	Microbiological. Growth microorganisms with improper observance of the regimes. Carry out production control, conduct additional microbiological analyses. Removal of defective products	Technologist
9	Storage of packaging material	CP 3	Microbiological and chemical. Presence of chemicals, cross-contamination. Removal of inappropriate packaging.	Warehouse manager Head of workshop
10	Storage of finished products	PPM	Microbiological. Growth microorganisms in case of improper storage conditions. Removal of defective products. Warehouse control.	Warehouse manager

Preventive actions have been developed to control hazards. Preventive actions are also taken in cases that are not critical controls, but constant control over which is necessary, since if they are not sufficiently controlled, they can lead to failure of the technological process.

Preventive actions should include:

- compliance technological regimes;
- heat treatment;
- control over sanitary condition of the equipment;
- strict observance of the rules for operation of equipment and use of metal traps;
- good hygiene and production practice;
- increasing professional literacy and qualifications of employees responsible for the effectiveness of quality system.

It should be noted that in some cases number of preventive actions are necessary, for example, lowering pH and temperature for products with high acidity, in other cases, some hazards (e.g. pathogen infestation) can be eliminated by single preventive action, such as heat treatment.

Besides to preventive actions, corrective actions have been developed that are taken in case of violation of critical limits.

These include:

- supplier monitoring;
- verification of measuring instruments;
- equipment check;
- rejection or processing of non-conforming products, etc.

Conclusion

Based on the foregoing, following conclusion can be drawn that the HACCP plan is modern system for controlling quality and safety of finished products, which improves performance of enterprise.

HACCP system provides control at all stages of the life cycle in the production of meat-vegetable paste. At identifying hazardous factors, following were considered: composition of the meat-vegetable paste, technological process of its processing, etc. An analysis of the operations technological processes showed that main hazard is microbiological. In the process of production meat-vegetable paste, possible hazardous factors of chemical and physical nature are also identified. Monitoring was carried out according to the planned sequence for each control point. System of preventive and corrective actions is proposed in case of occurrence risks by stages of the technological process.

Thus, HACCP system gives the company competitive advantage in the food production market.

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