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DEVELOPMENT OF ELEMENTS OF THE HACCP SYSTEM FOR TECHNOLOGY OF STRUCTURED MEAT PRODUCTS

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The main principles of the HACCP system and algorithms for its development for food products are considered. The main critical control points are determined and a basic block diagram of the production of structured meat products is given. Potential risks and limit values of critical control points during product production have been identified. The expediency of using the HACCP system in the development and introduction of new products is substantiated.

Key words: *structuring, meat products, HACCP system, quality and safety indicators, critical control points, pollutants*

РОЗРОБКА ЕЛЕМЕНТІВ СИСТЕМИ НАССР ДЛЯ ТЕХНОЛОГІЇ СТРУКТУРОВАНИХ М'ЯСНИХ ПРОДУКТІВ

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Визначено основні передумови розробки та запровадження системи НАССР на виробничих потужностях підприємств харчової галузі. Показано що на сьогоднішній день застосування принципів НАССР є обов'язковою вимогою законодавства ЄС, США, Канади, Японії та багатьох інших розвинених країн світу. Тож гармонізація законодавства України та Європейського Союзу передбачають постійне впровадження на підприємствах харчової промисловості міжнародної системи забезпечення безпечності харчових продуктів.

Проаналізовано досвід підприємств щодо розробки та запровадження системного контролю безпечності харчової продукції. Визначено особливості та індивідуальні підходи у розробці системи НАССР для підприємств м'ясної, молочної промисловості та ресторанного господарства.

Розглянуто основні принципи системи НАССР. Визначено мету застосування даної системи, проаналізовано алгоритми її розробки для харчових продуктів. Визначено, що система НАССР є науково-обґрунтованою системою, яка дозволяє гарантувати виробництво безпечної продукції шляхом ідентифікації і контролю небезпечних факторів: біологічного, хімічного і фізичного походження, починаючи від сировини до обігу та споживання готової продукції.

Здійснено розробку опису продукту з визначенням основних характеристики. Розглянуто вимоги до сировини та її потенційні забруднювачі: біологічні, хімічні та фізичні, а також можливість їх виникнення. Наведено принципову блок-схему виробництва структурованих м'ясних продуктів, в якій визначено основні критичні точки контролю та джерела забруднювання. Ідентифіковано потенційні ризики та граничні значення китичних точок контролю при виробництві продукції. Обґрунтовано доцільність застосування системи НАССР при розробці та впровадженні нової продукції.

Ключові слова: *структурування, м'ясна продукція, система НАССР, показники якості та безпечності, критичні точки контролю, забруднювачі*

Formulation of the problem. To date, only those manufacturers who actively and purposefully conduct work on the development and implementation of quality management systems, according to the international standards of the ISO 9000 and ISO 22000, can achieve stable commercial success in their activities. Supplement to the Law of Ukraine "On Quality and Safety of Food products and Food Raw Materials" [1], the state standard of Ukraine DSTU 4161-2003 [2] and the ongoing process of harmonization of the legislative base of Ukraine with the EU provide for the

permanent implementation at food industry enterprises of the international system for ensuring the safety of food products of the HACCP (Hazard Analysis and Critical Control Point - analysis of risks and critical control points) [3, 4]. The use of the HACCP system at the stage of development of new food products and their introduction into production allows solving a number of problems, the main ones of which are ensuring the consistently high quality and safety of finished products, increasing their competitiveness, expanding sales markets, etc. Therefore, this approach is justified and responsible from the point of view of introducing innovations at the enterprise and guaranteeing the consumer high quality and safety of products.

Analysis of recent research and publications. According to [5, 6], the local introduction of elements of the food safety system into the practice of the food industry and restaurant industry of Ukraine began more than 20 years ago. However, as early as 1995, this process was started by the McDonald's restaurant chain in accordance with the EU directive on food hygiene 93/43 / EU [7mother].

The quality and safety of food products is a priority task at all stages of the food chain – from the cultivation and primary processing of raw materials to the sale and consumption of finished products, including wholesale and retail trade [7].

The basic idea of the food safety management system is based on the fact that constant control at several separate points of the process, where dangerous factors appear, is simpler, more reliable and less expensive than selective control of finished products. The system suggests dividing business processes into blocks and introducing control over potential risks in each of them [7-11]. In order to produce safe food products, it is necessary to implement three controlled stages:

a) prevention of danger;

b) prevention of the spread of danger;

c) elimination of danger.

In modern conditions, the development and implementation of the HACCP system is a mandatory condition for the functioning of modern responsible enterprises of both the food and restaurant industry.

According to the authors [7, 12], research on the implementation of HACCP in restaurant establishments primarily involves the development of basic sanitary programs in accordance with the requirements of current legislation, which should include the necessary measures for personal hygiene of personnel, cleaning of premises, washing and disinfection of kitchen equipment, inventory and dishes, pest control, storage of raw materials and ingredients, waste disposal, etc. The next stage includes the description of all technological processes related to the production, storage

and sale of dishes, as well as the identification and assessment of potential hazards and the selection of critical control points. For example, such as reception and storage of raw materials, heat treatment of products, temperature, storage conditions and shelf life of ready meals, packaging or serving of ready products, etc. Monitoring procedures, corrective actions in case of exceeding limit values at control points, verification procedures, as well as persons responsible for HACCP procedures during production and circulation of food products should also be defined.

Special attention is paid to the systematic provision of food safety at enterprises processing animal products, in particular meat and dairy products.

Thus, specialists have improved metrological approaches and proposed modern diagnostic methods for determining the content of microorganisms in milk and implementing this control method as relevant to those operating at milk processing enterprises within the framework of the HACCP system [13].

To implement an effective food safety management system in the meat industry, it is necessary, first of all, to train top management, the HACCP group, personnel performing work that affects product safety, and persons responsible for operational control. There may be a need to change technological processes or packaging methods, review requirements for suppliers of raw materials and materials, or even replace production equipment or re-plan premises [14].

The purpose of the article. In view of the above, the purpose of this study is the development and application of some elements of the HACCP system at the stage of development and implementation of the technology of structured meat products (SMP).

Presentation of the main research material. It is common knowledge that for food products, safety indicators are one of the main ones along with quality indicators. Until recently, regulation in the field of food safety in Ukraine was based on the system of pre-market control, the main components of which were the registration of food products, mandatory or voluntary certification, etc.

At the stage of developing the technology of structured meat products, the quality and safety of the raw material, high operational characteristics of the equipment, ensuring sanitary and hygienic norms and rules, high professionalism and culture of the staff were accepted a priori. The development of the technology was based on minimizing the risks of non-standard situations by identifying critical control points (CCP).

According to the basic principles of the HACCP system, the following sequence of development and implementation of the technological system was adopted: product

characteristics ⟶ determination of its purpose ⟶ development and analysis of the technological process ⟶ determination of potential risks and critical limits of control points ⟶ development and implementation of monitoring systems ⟶ development and implementation of corrective actions.

The characteristics of the product are shown in Table 1.

Table 1

Characteristics and technological purpose of SMP

Indicator	Characteristic
1	2
Product name	Structured meat products
Product origin	Animal
Important product characteristics	pH 6.5...7.5; $a_w \leq 0.85$; dry matter content ≤ 75%; protein content ≥10%
Appointment	As an independent dish, as part of salads, cold and hot dishes
Packaging	Hermetically closed polymer container, packed in cardboard boxes
Expiration date	6 months at a temperature of minus 18 °C and a relative humidity of no more than 85%
Realization	Through the network of state-owned restaurant enterprises; in retail and wholesale trade
Labeling instructions	According to the law «On information for consumers on food products»
Special requirements	Avoid physical damage, excessive humidity and temperature above minus 18 °C

The quality and safety of raw materials and materials used in the production process (Table 2) play an important role in the determination of potential risks and CTC functioning of the technological system. At this stage, the identification of dangerous factors that may arise due to the use of raw materials or packaging materials was carried out. Based on the data in Table 2, it should be noted that the main dangerous factors that can cause spoilage of products are biological (B), chemical (C) and physical (P).

Thus, the potential contamination of Escherichia coli bacteria with pathogenic microorganisms (including Salmonella), as well as the presence of mesophilic aerobic and facultative anaerobic microorganisms in an amount that exceeds the established norms, should be attributed to the biologically dangerous factors characteristic of meat raw materials. In addition, bacterial

and fungal spores, rodent excrement, the presence of which is possible in dry ingredients and water, should also be classified as biological pollution.

Table 2

Identification of dangerous factors in raw materials used inthe production of SMP

Name of raw material	Dangerous factors		
	Biological (B)	Chemical (C)	Physical (P)
Raw meat	Escherichia coli bacteria; pathogenic microorganisms (including Salmonella); mesophilic aerobic and facultative anaerobic microorganisms in an excessive amount	Salts of heavy metals; radionuc-leads, histamines; nitrosamines, antibiotics	Foreign impurities
Dry ingredients	Spores of bacteria and fungi; excrement of rodents	Salts of heavy metals, pesticides	Foreign impurities
Fat components	–	Fat oxidation products; free radicals	Foreign impurities
Drinkable water	Coli-forms	Salts of heavy metals	Foreign impurities
Flavoring additives, dyes, preservatives	–	–	Foreign impurities

The main chemical hazardous factors, characteristic of all types of raw materials, are salts of heavy metals, as well as individual pollutants. For example, histamines, nitrosamines and antibiotics may be present in meat raw materials, and fat oxidation products and free radicals are most often inherent in fat components. Physical dangerous factors are characteristic of all types of raw materials and are determined by the possible introduction of foreign impurities into the product.

In the course of experimental studies, a basic block diagram of SMP production was developed (Fig. 1), dangerous factors and critical limits of control points were identified (Table 3)

According to this block diagram, 7 main critical control points are defined in the technological process of SMP production.

CCP-1. Incoming quality control of raw materials is carried out according to Table 2 for compliance of raw materials with the requirements of the current regulatory documentation.

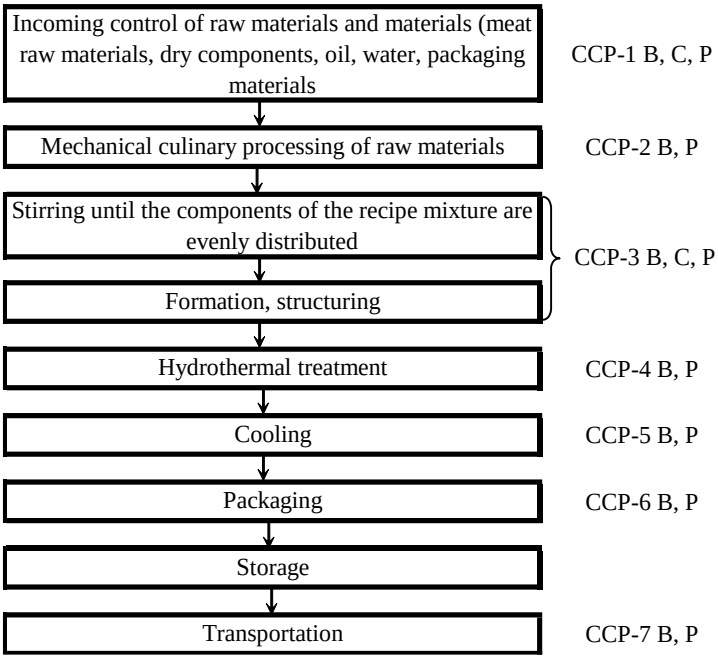

Fig. 1. The basic block diagram of the SMP production with the definition of the main control points

CCP-2. Mechanical culinary processing. Under certain conditions, it can be characterized by physical pollution at the stage of sifting dry ingredients and biological pollution at the stage of thawing fish raw materials.

CCP-3. Mixing, forming, structuring. Biological contamination at the mixing stage is potentially possible due to the growth of bacteria and an increase in the amount of histamine and nitrosamine. This can happen at too high temperatures. The temperature regime of this stage must be adjusted continuously and not exceed 10...12 ºC. Chemical pollution can occur when the exposure time of samples in a solution of polyvalent metals is exceeded, as well as when the concentration of these solutions is too high due to the accumulation of free ions.

CCP-4. Hydrothermal treatment. Inadequate heat treatment can lead to the fact that the product was not brought to the state of culinary readiness, which can cause further biological deterioration of the product. Therefore, the optimal mode is a temperature of 100 ºC and a processing time of 3...5 minutes.

CCP-5. Cooling. Biological contamination of this stage can occur with too slow cooling, which can lead to the appearance of optimal conditions for the development of pathogenic microorganisms. Therefore, the cooling rate should be regulated, and the process should be carried out with continuous temperature measurement.

CCP-6. Packaging. The packaging process involves additional contact of the product with equipment and personnel. Therefore, strict adherence to sanitary rules for personnel and equipment, periodic briefings on sanitary minimums and sanitary treatment of equipment will minimize the occurrence of biological contamination at this stage.

CCP-7. Transportation. Transportation, as well as storage, should be carried out at temperatures not higher than minus 18 oC and relative humidity not more than 85%. Accordingly, the violation of these regimes can lead to the growth of pathogenic microorganisms and fungi, and therefore to biological spoilage.

As for physical contamination, it is potentially possible at all critical stages due to harmful foreign objects getting into the product. Therefore, continuous visual control and the use of metal detectors are relevant at all stages of the manufacturing process.

The main dangerous factors and limit values of CCP are detailed in the table. 3.

For implementing SMP technology, monitoring of dangerous factors allows identifying and controlling all significant threats to product safety or reducing them to an acceptable level.

Table 3

Identification of potential risks and limit values of CCP in the production of SMP

CCP	Dangerous factors			Technological parameters	**Limit values of CCP**
	B	C	P		
1	Given in the table 2			–	–
2	–	–	x	Dimensional characteristics of the sieve (d), mm	0,5<d<1

	x	–	–	Temperature in the thickness of muscle tissue, oC	-1<t<+1
3	– – x – x	– – x – –	x – – x x	Temperature, °C Duration, min Concentration of the solution, % Temperature, °C Duration, min	t≤10...12 5<τ<10 4<c<6 18<t<20 3<τ<5
4	x	–	x	Temperature, °C Duration, min	98<t<100 3<τ<5
5	x	–	x	Final temperature, °C Cooling rate, °C/min	1<t<3 13<V<15
6	x	–	x	–	–
7	x	–	x	Temperature, °C; Humidity, %	t<-18; W<85

In addition, the main advantages of implementing the HACCP system are:

– optimization of production processes at all stages of technological processes;

– early detection of inconsistencies and the possibility of excluding their influence in the future;

– rational use of equipment and material resources;

– compliance of the final product with all client (consumer) requirements, including quality and safety indicators;

– fulfillment of the requirements of the legislation of Ukraine, which provide for the implementation of the HACCP system at all enterprises of the food industry;

– the possibility of entering the European and world markets.

Conclusions. The need to implement global and European requirements for food safety is urgent in today's conditions of globalization and growing demand for safe food. Modern standards such as the HACCP system guarantee manufacturers and other participants — operators of the food market — the opportunity to keep up with the times, be competitive, and realize this important advantage in increasing the efficiency of running their own business.

The given materials confirm the expediency of using the HACCP system both at the stage of development and at the stage of introducing new products and will allow overcoming the complexity of real technological processes, minimizing erroneous decisions and obtaining products of high quality and with safety indicators that would satisfy consumer requirements

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