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# DEVELOPMENT OF A FOOD SAFETY MANAGEMENT SYSTEM BASED ON HACCP PRINCIPLES FOR THE PHILADELPHIA ROLL

***Abstract.*** *The article presents the results of a study aimed at enhancing the safety and quality of a popular foodservice product – Philadelphia sushi. The relevance of the research is determined by the growing production and consumption of Japanese cuisine products, along with the associated microbiological risks arising from the use of perishable ingredients. The purpose of the study was to develop and substantiate a food safety management system based on HACCP principles, with a focus on the critical control points (CCPs) of the technological process. The research employed methods of hazard analysis, CCP identification using a "decision tree," as well as the establishment of critical limits and corrective actions. A detailed analysis of the technological cycle, which included 16 processes and 54 operations, initially identified 11 CCPs. For practical implementation, the system was optimized to four of the most significant control points: raw material acceptance, storage of rice and fish semi-finished products, the production process, and storage of finished products. For each CCP, strict critical limits were defined in terms of temperature, storage time, and microbiological indicators, along with monitoring procedures. The scientific and practical significance of the study lies in the development of an adapted and effective HACCP plan, the implementation of which substantially reduces microbiological risks, ensures consistent quality and safety of the finished dish, and proves to be economically viable for foodservice enterprises.*

***Keywords:*** *HACCP, critical control points, food safety, microbiological risk, organoleptic properties, Philadelphia sushi, technological process, catering.*

**Introduction.** The growing popularity of Japanese cuisine worldwide, particularly in Kazakhstan, has led to the widespread presence of restaurants and delivery services offering sushi and rolls. The "Philadelphia" roll, being one of the most in-demand dishes, is characterized by the use of perishable ingredients such as fresh fish, cream cheese, and cooked rice. These components pose a potential risk of microbiological

spoilage and can serve as a medium for the growth of pathogenic microorganisms, such as *Salmonella* spp., *Listeria monocytogenes*, *Staphylococcus aureus*, and others. The relevance of this study is driven by the need to develop scientifically grounded and practical measures to ensure food safety in public catering establishments, minimizing risks to consumer health and preventing foodborne illnesses. The implementation of the HACCP (Hazard Analysis and Critical Control Points) system is an internationally recognized approach to achieving these goals.

**Conditions and methods of research.**The study was conducted at a typical public catering establishment specializing in Japanese cuisine. The research object was the technological process of preparing Philadelphia rolls. A set of methods was applied:

1. *Hazard analysis:* biological, chemical, and physical hazardous factors were identified at all stages of the production cycle—from raw material receipt to finished product storage.
2. *CCP identification:* Critical Control Points (CCPs) were determined using the logical "decision tree" recommended by the Codex Alimentarius.
3. Establishment of Critical Limits: for each CCP, critical limits were set based on regulatory documents (ST RK 1179-2003, SanPiN), technical specifications, and experimental data (temperature, time, organoleptic indicators).
4. Monitoring and verification: monitoring systems were developed for each CCP (frequency, method, responsible person), as well as verification procedures to confirm the effectiveness of the HACCP system.

Philadelphia sushi is a made-to-order dish offered in a chain of Japanese cuisine restaurants. It is widely available and has no consumption restrictions, except for individuals with allergic reactions to the ingredients included in the dish. The product is intended for direct consumption as food, as well as for use in public catering establishments.

**Research results and discussion.** *Description of Technological Processes and Flowchart.* For a more detailed examination of the production process of Philadelphia sushi, a process flowchart was developed, providing a clear and simple overview of all stages of the process that are under the direct control of the catering establishment. Considering that public catering organizations typically offer a wide range of dishes and culinary products, it is deemed appropriate to prepare a flowchart not for each dish, but specifically for Philadelphia sushi and its corresponding semi-finished products.

*Technological cycle of preparing "Philadelphia" sushi*

The technological cycle of preparing "Philadelphia" sushi includes a set of technological processes and operations presented in the flowchart in Figure 1. Below is a brief description of 16 technological processes and 54 technological operations of the technology for preparing "Philadelphia" sushi: The process of acceptance of raw materials and ingredients includes qualitative and quantitative identification of raw materials in accordance with specifications. The process of storing raw materials used in the preparation of "Philadelphia" sushi includes two modes:

1.2.1 Storage of raw materials and ingredients at a temperature from 0 to +25 °C;

1.2.2 Storage of raw materials and ingredients at a temperature from +2 to +6 °C. The process of opening transport containers of raw materials and ingredients.

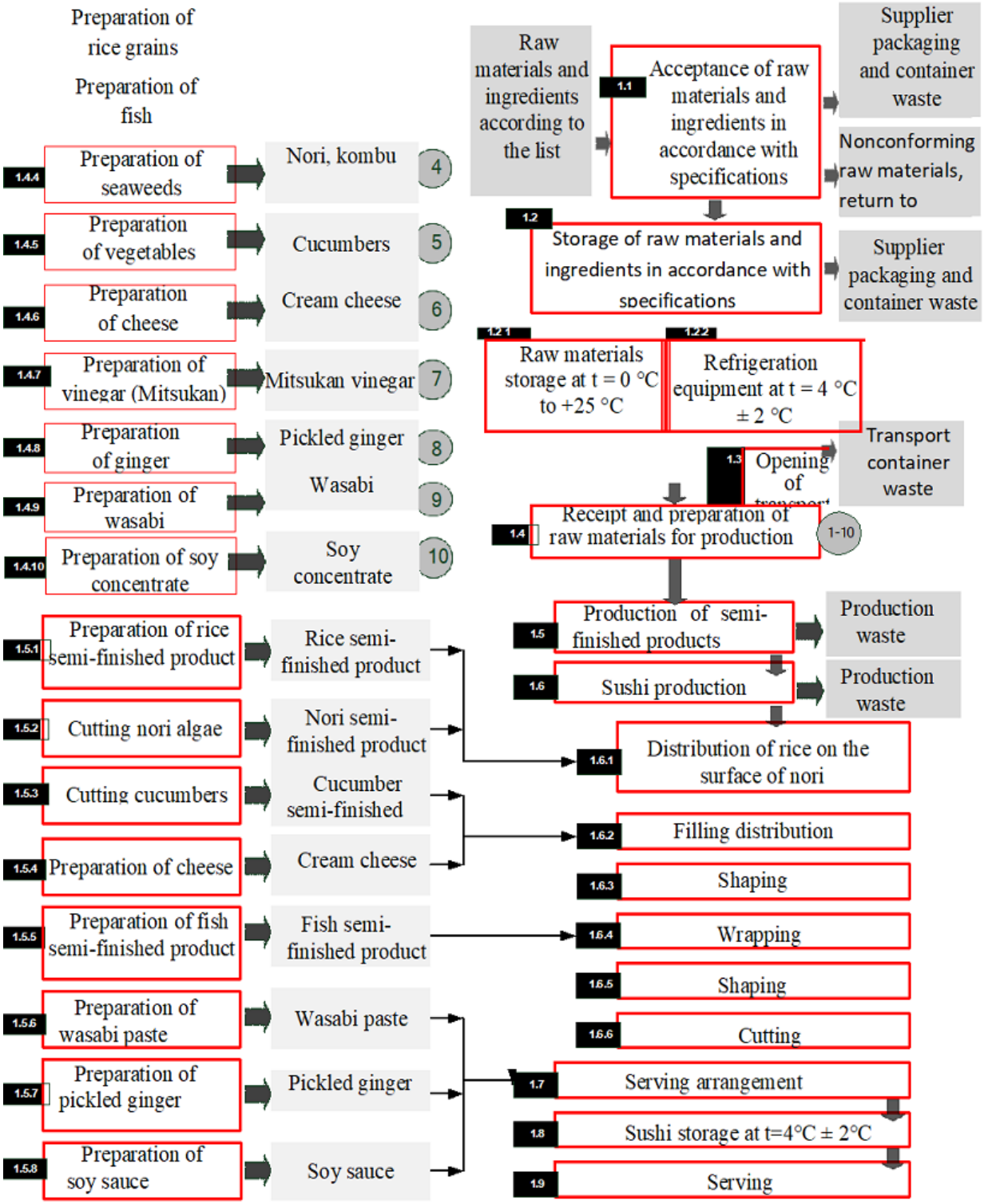


Figure 1. Flowchart of the technology for preparing Philadelphia sushi roll

The process of acceptance and preparation of raw materials for production includes the following operations:

1.4.1 Unpacking of bulk raw materials (sugar, salt);
1.4.2 Unpacking of rice grains;
1.4.3 Unpacking of fish and removal of ice chips;
1.4.4 Unpacking of nori seaweed;
1.4.5 Unpacking of cucumbers;
1.4.6 Unpacking of cream cheese;
1.4.7 Unpacking of Mitsukan vinegar;
1.4.8 Unpacking of pickled ginger;
1.4.9 Unpacking of wasabi powder;
1.4.10 Unpacking of soy concentrate.

Technological processes for producing semi-finished products for sushi preparation include:

Preparation of rice semi-finished product, which includes the operations shown in Figure 1.2:

1.5.1.a.1 Mixing Mitsukan vinegar, sugar, salt, kombu seaweed;
1.5.1.a.2 Heating the mixture of Mitsukan vinegar, sugar, salt, kombu seaweed;
1.5.1.a.3 Boiling the mixture of Mitsukan vinegar, sugar, salt, kombu seaweed;
1.5.1.a.4 Cooling the semi-finished mixture of Mitsukan vinegar, sugar, salt, kombu seaweed;
1.5.1.b.1 Sieving rice grains;
1.5.1.b.2 Washing rice grains;
1.5.1.b.3 Boiling rice grains;
1.5.1.b.4 Steaming cooked rice at a temperature of at least 65 °C;
1.5.1.c.1 Mixing the semi-finished product of Mitsukan vinegar, salt, sugar, kombu seaweed with cooked rice;
1.5.1.c.2 Storing the rice semi-finished product at a temperature of at least 60 °C. Production of semi-finished product from nori sheets includes the operations shown in Figure 1.3:

1.5.2.1 Cutting roasted nori seaweed sheets into 18x10 cm;
1.5.2.2 Storage of nori semi-finished sheets at 0 to +25 °C.

Production of semi-finished product from fresh cucumbers includes the operations shown in Figure 1.4:

1.5.3.1 Removal of foreign impurities from cucumbers;
1.5.3.2 Sorting cucumbers;
1.5.3.3 Washing cucumbers;
1.5.3.4 Removal of stalks, overdeveloped seed parts, and thick peel;
1.5.3.5 Cutting cucumbers into thin strips;
1.5.3.6 Storage of cucumber semi-finished product at t = 4±2 °C.

Preparation scheme for cream cheese for convenient use in technological operations is shown in Figure 1.5:

1.5.4.1 Transferring cream cheese into a pastry bag;
1.5.4.2 Storage of cream cheese in a pastry bag at t = 4±2 °C.

Production of fish semi-finished product includes the operations shown in Figure 1.6:

1.5.5.1 Washing chilled fish;
1.5.5.2 Cleaning fish from scales;
1.5.5.3 Removing fins and head of the fish;
1.5.5.4 Separating fish fillet from bones;
1.5.5.5 Cutting fish fillet into semi-finished slices (3–5 mm thick);
1.5.5.6 Storage of fish semi-finished product at t = 4±2 °C.

Production of wasabi paste includes the operations shown in Figure 1.7:

1.5.6.1 Heating water to 100 °C;
1.5.6.2 Cooling water to 25 °C;
1.5.6.3 Mixing water with wasabi powder;
1.5.6.4 Storage of finished wasabi paste at t = 4±2 °C.

Preparation of pickled ginger includes the operations shown in Figure 1.8:

1.5.7.1 Separation of marinade from ginger;
1.5.7.2 Storage of ginger without marinade at t = 4±2 °C.
Production of soy sauce includes the operations shown in Figure 1.9:
1.5.8.1 Mixing soy concentrate with water;
1.5.8.2 Heating soy sauce with water to 100 °C;
1.5.8.3 Cooling soy sauce;
1.5.8.4 Storage of soy sauce at t = 4±2 °C.
The process of producing “Philadelphia” sushi includes the stages shown in Figure 1.1:
1.6.1 Spreading rice on the surface of nori;
1.6.2 Spreading filling of prepared cheese and cucumber semi-finished product;
1.6.3 Forming the roll;
1.6.4 Wrapping the roll with fish;
1.6.5 Forming the roll with fish;
1.6.6 Cutting the roll.
Decoration of the finished “Philadelphia” sushi dish on serving plates.
Storage of the finished “Philadelphia” sushi dish at a temperature from +2 to +6 °C.
Serving the finished “Philadelphia” sushi dish.
*Definition of Critical Control Points.* A Critical Control Point (CCP) is a step or procedure at which control can be applied, resulting in a hazard being eliminated or reduced to an acceptable level. Potential contaminants that, if not controlled, are reasonably likely to cause various diseases or injuries must be addressed through the identification of CCPs. Information obtained from hazard analysis is crucial for determining which process stages are CCPs. The identification of critical control points was conducted in two stages. At the first stage, the
"Decision Tree" method, presented in Figure 2, was used to determine the CCPs.
Based on the application of this method, 11 critical control points were identified for each individually considered hazard factor (Table 1).
Process 1.6 "Sushi Manufacturing" includes 6 operations where the hazards are identical and require similar methods for their reduction; therefore, operations from 1.6.1 to 1.6.6 were combined into a single process for ease of analysis. Hazard type: Ch - Chemical, Ph - Physical, M - Microbiological.
At the second stage, the number of critical control points was reduced, as managing 11 CCPs is not practical for an enterprise. Thus, 4 CCPs were established that need to be managed:
CCP 1 – Receipt of raw materials and supplies;
CCP 2 – Storage of the rice semi-finished product;
CCP 3 – Storage of the fish semi-finished product;
CCP 4 – Sushi manufacturing.
*Establishment of Critical Limits for each Critical Control Point.* According to ST RK 1179-2003 (Standard of the Republic of Kazakhstan 1179-2003), the following must be established for critical control points:

1. Identification criteria - for hazardous factors;
2. Criteria for acceptable (unacceptable) risk - for controlling risk indicators;

Allowable limits - for applied preventive measures. Critical limits must be set considering all possible deviations, including measurement observation, it is advisable to use

reference samples. Critical limits must be recorded in the HACCP worksheet.

After identifying the CCPs, allowable limits were defined for each of them (Table 2)

Table 1

Identified CCPs for Each Individually Considered Factor

| **Operation Name** | **Hazard typ** | **Is control for the i-th hazard provided in this operation?** | **Does this operation perform actions to reduce risk (to an acceptable level) or eliminate the i-th hazard?** | **Can the risk of the i-th hazard exceed an acceptable level after this operation?** | **Will the risk of the i-th hazard be eliminated or reduced to an acceptable level in a subsequent operation?** | **CCP** |
|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| 1.1 Receipt of Raw Materials | Ch | Yes | No | Yes | No | CCP № 1 |
| | Ph | Yes | No | Yes | No | CCP №2 |
| | M | Yes | No | Yes | No | CCP №3 |
| 1.2.2 Storage of raw materials at +2 to +6$^0$ C | M | Yes | Yes | - | - | CCP №4 |
| 1.5.1.b.1 Sieving of rice grits | Ph | Yes | Yes | - | - | CCP №5 |
| 1.5.1.c.2 Storage of rice semi-finished product at ≥65$^0$ C | Ph | Yes | No | Yes | No | CCP №6 |
| | M | Yes | No | Yes | No | CCP №7 |

Continuation of Table 1

| Operation Name | Hazard type | Is control for the i-th hazard provided in this operation? | Does this operation perform actions to reduce risk (to an acceptable level) or eliminate the i-th hazard? | Can the risk of the i-th hazard exceed an acceptable level after this operation? | Will the risk of the i-th hazard be eliminated or reduced to an acceptable level in a subsequent operation? | CCP |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1.5.5.6 Storage of fish semi-finished product at t=4±2$^0$ C | M | Yes | Yes | - | - | CCP №8 |
| 1.6 Sushi Manufacturing | Ph | Yes | Yes | - | - | CCP №9 |
| | M | Yes | Yes | - | - | CCP №10 |
| 1.8 Storage of the finished dish "Philadelphia Roll" at 2 to 6$^0$ C | M | Yes | Yes | - | - | CCP №11 |

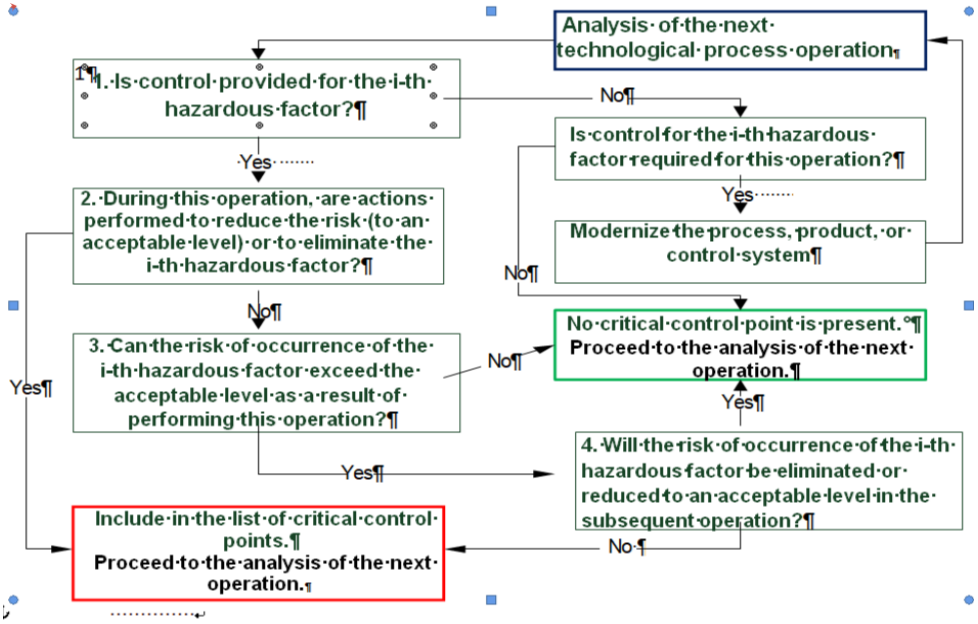


Figure 2. Decision tree for CCP identification

Table 2.

Allowable Limits for CCPs

| Operation Name | CCP No. | Hazardous Factor | Controlled Parameters and Their Critical Limits |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 1.1 Receipt of Raw Materials and Packaging | | | |
| | CCP 1 | Excessive content of production contaminants (food additives, nitrates, nitrites, etc.), technical means and preparation s, or other foreign elements. | Verification of packaging integrity, verification of labeling. Absence of production con taminants, technical means and preparations, or other foreign chemical elements. |
| | | Physical. Foreign objects, inclusions from packaging (glass, wood, polymers, etc.). | Verification of packaging integrity, verification of labeling. Absence of fragments, foreign objects. |
| | | Microbiological. Undesirable microorganisms. | Verification of packaging integrity, verification of labeling. Absence of undesirable microflora. |
| 1.5.1.v.2 Storage of Rice Semi-finished Product | | | |
| | CCP 2 | Physical. Foreign impurities (stones, sand), uncooked rice. | Organoleptic analysis. Absence of foreign impurities, uncooked rice. |
| | | Microbiological. Undesirable | Compliance with storage times and temperature. No more than 3 hours and not below t=65°C. Absence of undesirable microflora. |
| 1.5.5.6 Storage of Fish Semi-finished Product | | | |
| | CCP 3 | Microbiological. Undesirable microorganisms. | Compliance with storage times and temperature. No more than 48 hours and at t=4±2°C. Absence of undesirable microflora. |

Continuation of Table 2

| Operation Name | CCP No. | Hazardous Factor | Controlled Parameters and Their Critical Limits |
|---|---|---|---|
| 1.6 Sushi Preparation | | | |
| | CCP 4 | Physical. Foreign impurities, fish bones, scales. | Organoleptic analysis. Absence of foreign impurities, uncooked rice, fish bones, scales. |
| | | Microbiological. Undesirable microorganisms. | Organoleptic analysis. Compliance with preparation times and conditions. Preparation time for one dish does not exceed 10 minutes. Absence of undesirable microflora. |

Table 3.

CCP Monitoring System for "Philadelphia" Sushi Dish

| Operation Name / CCP | What? | How? | When? | Who? | Records |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| **1.1 Receipt of Raw Materials** | Packaging, containers | Visual inspection | Every batch | Storekeeper, Commodity Expert | Raw Material Receipt Checklist |
| **1.5.1.v.2 Storage of Rice Semi-finished Product** | Chamber temperature, storage time. Presence of impurities. | Measuring chamber temperature with a thermometer, measuring time with a clock. Visual inspection. | 3 times/day (8:00, 14:00, 21:00) | Senior Chef | Rice Preparation and Storage Checklist |
| **1.5.5.6 Storage of Fish Semi-finished Product** | Chamber temperature, storage time. | Measuring chamber temperature with a thermometer, measuring time with a clock. | 3 times/day (8:00, 14:00, 21:00) | Senior Chef | Fish Storage Checklist |
| **1.6 Sushi Preparation** | Work surface temperature, preparation time. Contaminants. | Measuring temperature with an electronic thermometer, measuring time with a clock. Visual inspection. | Every dish unit | Chef | Quality Control Journal |

When monitoring CCPs, it is necessary to maintain records and documents that are dated and signed by the person performing the monitoring. Records must be accurate and timely; omissions, smudges, and corrections are not permitted. whether a CCP is under control and to generate accurate records for future use in verification. The developed monitoring system is presented in Table 3.

*Establishment of Corrections and Corrective Actions.*

Although the HACCP system is designed to eliminate or reduce the likelihood of hazardous risks, non-standard situations leading to deviations from established procedures can always occur. When deviations from established critical limits occur, measures must be taken to correct the situation. Accordingly, corrections and corrective measures were developed for processes where danger may arise (Table 4).

Table 4.

Corrections and Corrective Actions of the HACCP System for Sushi Production CCPs

| Operation Name / CCP | Corrections for Critical Limit Breach | Corrective Action | Where it is Recorded |
|---|---|---|---|
| **1.1 Receipt of Raw Materials** | Identify the raw materials as non-conforming | Monitor suppliers and select alternative ones | Raw Material Receipt Checklist |
| **1.5.1.v.2 Storage of Rice Semi-finished Product** | Identify the rice semi-finished product as non-conforming | Adjust equipment, dispose of non-conforming product | Rice Preparation and Storage Checklist |
| **1.5.5.6 Storage of Fish Semi-finished Product** | Identify the fish semi-finished product as non-conforming | Adjust equipment, dispose of non-conforming product | Fish Storage Checklist |
| **1.6 Sushi Preparation** | Identify the finished dish as non-conforming | Train personnel, dispose of the non-conforming dish | Quality Control Journal |

*Establishment of a Monitoring System for each Critical Control Point.*

Monitoring is the act of conducting a planned sequence of observations or measurements to assess

The final stage in developing the sushi safety management system is the compilation of the HACCP Plan. The HACCP Plan is a set of worksheets for all CCPs. The HACCP Plan for the four critical control points in sushi production must contain the data described above in Tables

Subsequently, the HACCP safety system involves "Establishment of Verification Procedures" and "Establishment of Documentation and Record-Keeping". These principles are implemented at enterprises with an established HACCP system.

**Results and discussion.** As a result of a detailed analysis of the technological scheme, which includes 16 processes and 54 operations, 11 potential critical control points were initially identified. For practical implementation and improved management efficiency, the system was optimized to 4 most significant CCPs:

1. *CCP 1: Receipt of Raw Materials and Supplies.* Control of documentation, packaging integrity, organoleptic indicators, and temperature regimes of incoming raw materials.

2. *CCP 2: Storage of Rice Semi-Finished Product.* Maintaining a temperature not lower than +65°C to prevent spore germination and microbial growth.

3. *CCP 3: Storage of Fish Semi-Finished Product.* Strict adherence to the temperature regime (+4±2°C) and storage periods (no more than 48 hours).

4. *CCP 4: Manufacturing and Storage of Finished Rolls.* Control of preparation time, sanitary condition of the workplace, storage temperature of the finished product (+2…+6°C), and its shelf life.

Critical limits were established for each CCP, and corrective actions were developed in case of their violation.

The results of the study demonstrate that the proposed abbreviated HACCP plan, focused on managing four key points, is sufficient to effectively control major hazards. Optimizing the number of CCPs makes the system more manageable and economically feasible for implementation in small and medium-sized public catering establishments without compromising safety. The established critical limits, especially the temperature regimes for storing rice and fish semi-finished products, are a decisive factor in suppressing the growth of mesophilic pathogenic microflora. The discussion also includes a comparative analysis with similar studies in other countries, confirming the universality of the chosen approach.

**Conclusion.** A HACCP plan for the production of Philadelphia rolls has been developed and scientifically substantiated. The system is based on managing four critical control points, which allows for effective control of microbiological risks and ensures consistently high organoleptic indicators of the finished product. The implementation of this system in public catering establishments will help standardize processes, guarantee consumer safety, and ensure compliance with current sanitary norms and rules. Future research prospects include assessing the effectiveness of the implemented HACCP plan in the long term and developing similar models for other types of high-risk culinary products.

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## «ФИЛАДЕЛЬФИЯ» РОЛЛЫ ҮШІН ХАССП ҚАҒИДАТТАРЫНА НЕГІЗДЕЛГЕН ТАМАҚ ӨНІМДЕРІНІҢ ҚАУІПСІЗДІГІН БАСҚАРУ ЖҮЙЕСІН ӘЗІРЛЕУ

**Аңдатпа.** *Мақалада қоғамдық тамақтану саласындағы танымал өнім – «Филадельфия» сушиінің қауіпсіздігі мен сапасын арттыруға бағытталған зерттеу нәтижелері ұсынылған. Зерттеудің өзектілігі жапон асханасы өнімдерінің өндірісі мен тұтынуының кеңеюімен және тез бұзылатын ингредиенттерді қолдану кезінде туындайтын микробиологиялық тәуекелдермен айқындалады. Зерттеудің мақсаты – технологиялық үдерістің сыни бақылау нүктелеріне (СБН) шоғырланған ХАССП принциптеріне негізделген тағам өнімдерінің қауіпсіздігін басқару жүйесін әзірлеу және негіздеу болып табылады. Жұмыста қауіптіліктерді талдау әдістері, «шешім ағашы» арқылы СБН-ді айқындау, сыни шектерді белгілеу және түзету әрекеттерін әзірлеу қолданылды. 16 процесс пен 54 операцияны қамтитын технологиялық циклді егжей-тегжейлі талдау нәтижесінде бастапқыда 11 СБН анықталды. Практикалық іске асыру үшін жүйе төрт ең маңызды бақылау нүктесіне дейін оңтайландырылды: шикізатты қабылдау, күріш пен балық жартылай фабрикаттарын сақтау, дайын өнімді өндіру және сақтау үдерістері. Әрбір СБН үшін температура, сақтау уақыты және микробиологиялық көрсеткіштер бойынша қатаң сыни шектер белгіленді, мониторинг рәсімдері әзірленді. Зерттеудің ғылыми және практикалық маңызы – бейімделген әрі тиімді ХАССП жоспарын әзірлеуде, оның енгізілуі микробиологиялық тәуекелдерді едәуір төмендетуге, дайын тағамның тұрақты сапасы мен қауіпсіздігін қамтамасыз етуге, сондай-ақ қоғамдық тамақтану кәсіпорындары үшін экономикалық тұрғыдан тиімді болуына мүмкіндік береді.*

**Тірек сөздер:** *ХАССП, сыни бақылау нүктелері, тағам қауіпсіздігі, микробиологиялық тәуекел, органолептика, «Филадельфия» сушиі, технологиялық үдеріс, қоғамдық тамақтану.*

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## РАЗРАБОТКА СИСТЕМЫ УПРАВЛЕНИЯ БЕЗОПАСНОСТЬЮ ПИЩЕВОЙ ПРОДУКЦИИ НА ОСНОВЕ ПРИНЦИПОВ ХАССП ДЛЯ РОЛЛА «ФИЛАДЕЛЬФИЯ»

**Аннотация.** *В статье представлены результаты исследования, направленного на повышение безопасности и качества популярного продукта общественного питания – роллов «Филадельфия». Актуальность работы обусловлена расширением производства и потребления продукции японской кухни и связанными с этим микробиологическими рисками, возникающими при использовании скоропортящихся ингредиентов. Целью исследования являлась разработка и обоснование системы управления безопасностью пищевой продукции на основе принципов ХАССП, сфокусированной на критических контрольных точках (ККТ) технологического процесса. В работе применены методы анализа опасностей, идентификации ККТ с использованием «дерева решений», установления критических пределов и*

*корректирующих действий. В результате детального анализа технологического цикла, включающего 16 процессов и 54 операции, было первоначально выявлено 11 ККТ. Для практической реализации система была оптимизирована до 4 наиболее значимых точек контроля: приемка сырья, хранение рисового и рыбного полуфабрикатов, процесс изготовления и хранения готовой продукции. Для каждой ККТ установлены строгие критические пределы по температуре, времени хранения и микробиологическим показателям, разработаны процедуры мониторинга. Научная и практическая ценность работы заключается в разработке адаптированного и эффективного плана ХАССП, внедрение которого позволяет существенно снизить микробиологические риски, гарантировать стабильное качество и безопасность готового блюда, а также является экономически целесообразным для предприятий общественного питания.*

**Ключевые слова:** *ХАССП, критические контрольные точки, пищевая безопасность, микробиологический риск, органолептика, суши Филадельфия, технологический процесс, общественное питание.*

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