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QUALITY AND SAFETY ENSURING IN THE DEVELOPMENT OF FLAVORED SPICES BASED ON GREATED CEREALS USING THE HACCP PRINCIPLES

The object of research is the production of a new flavor seasoning of increased nutritional value based on sprouted green buckwheat using the HACCP (Hazard Analysis and Critical Control Points) principles. Research is aimed at drawing up a HACCP plan in order to control the safety of flavoring condiments of increased nutritional value. The new flavor seasoning is developed on the basis of sprouted green buckwheat of the «Bogatyr» variety, dried vegetables (carrots, pumpkin, garlic), dried herbs (celery, basil, oregano, dill), spices (ginger, turmeric, curry, paprika, coriander). For a flavoring seasoning with the addition of 30 % sprouted green buckwheat, technical conditions have been developed, where the requirements for organoleptic, physico-chemical and microbiological quality indicators are normalized.

The paper describes the method of germination of green buckwheat grain, as well as the standards used for drawing up the HACCP plan at the enterprise.

As a result of the analysis of the production process of flavoring seasoning, dangerous factors and management measures were identified. Three critical control points have been identified: in the process sprouted, in the process disinfection under grain germination, and in the process packaging of the finished product. Biological, chemical and physical hazards that can occur at each stage of seasoning production are identified. Once the risk factor was identified, critical limits were identified and monitoring procedures were established, as well as corrective actions were developed. During the research, a HACCP plan was developed for a new type of flavor seasoning with increased nutritional value in order to improve the safety and quality of products. The application of the HACCP plan will allow to effectively manage processes, use preventive measures, and accurately identify critical processes.

Keywords: *flavor seasoning, sprouted green buckwheat, critical control point, HACCP plan.*

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1. Introduction

The orientation towards a healthy lifestyle is becoming more and more popular among various groups of the population, which in turn entails an increase in the demand for products for «healthy eating». These products include products with a reduced amount of fat, sugar, but high in dietary fiber, vitamins, minerals. The need to enrich products with biologically active substances and dietary fibers is relevant for the development of food products that meet the needs of the modern consumer. A stable supply of the population with high-quality, biologically complete, ecologically safe food products can be ensured by developing the production potential of the food industry [1].

Food safety is becoming increasingly important in the food industry. The main reason is the susceptibility of products to microbiological, physical and chemical hazards. Hazard Analysis and Critical Control Points (HACCP) is a systems approach that aims to identify food hazards, identify critical control points (CCPs) and bring them under control. The Codex Alimentarius Commission describes CCPs as control steps to prevent, reduce or eliminate hazards. For the food industry, the HACCP program is currently recognized as the best approach to food safety control [2].

Considering that grain processing products are among the affordable products of everyday demand, there is a question of giving them functional properties. Of particular interest are

sprouted grains of cereals and legumes, their use allows to diversify the range of products, give the products an original flavor range and enrich them with biologically active substances [3].

During germination, grain turns into a real concentrate of vitamins, micro- and macroelements, and becomes the leader among all products in terms of enzyme content. In addition, young sprouts are a source of proteins and antioxidants. Sprouts are very nutritious, cleanse the body of toxins, improve intestinal function, strengthen immunity, energize, prolong youth and beauty [4].

Spices and condiments are an indispensable ingredient in most recipes, from salads and first courses to desserts. Of course, neither spices nor seasonings are essential products, but they help to expand the range of dishes and facilitate the process of their preparation [3].

Thus, *the object of research* is the production of a new flavoring seasoning of increased nutritional value based on sprouted green buckwheat using the HACCP principles. *The aim of this research* is to prepare a flavoring seasoning with increased nutritional value and to study the potential hazards for the safe production of flavoring seasoning using the HACCP principles.

2. Methods of research

In order to increase the nutritional value of the seasonings, a recipe for a new type of flavoring seasoning

based on sprouted green buckwheat has been developed. On the basis of the conducted marketing research it was revealed [5] that the majority of consumers (70 %) consider it necessary to produce seasonings based on natural ingredients with increased nutritional value. One of the cereals characterized by a high content of biologically active substances is green buckwheat or paspalum (Latin *Paspalum*), a genus of herbaceous plants of the Poaceae family. Green buckwheat is distinguished by a balanced composition of vitamins, mineral elements, proteins, essential amino acids, contains phytosterols, carbohydrates (characterized by high fiber content), as well as purines necessary for the full functioning of the body. Another important value of sprouted cereals is its antioxidant properties. Green buckwheat is responsible for the level of cholesterol in the blood, helps cleanse blood vessels, removes toxins and toxins from the body, and reduces the risk of blood clots [3, 6]. In the process of germination in buckwheat grain, the activity of enzymes is activated that contribute to the breakdown of those contained in the grain (carbohydrates, fats and proteins) into organic components that are simpler in structure and easily assimilated by the human body. The use of sprouted green buckwheat will make it possible to obtain a product with increased nutritional value, which has a positive effect on the physiological functions of the human body.

When developing a new flavoring seasoning, sprouted green buckwheat of the Bogatyr variety was used as the main component. The seasoning also included dried vegetables (carrots, pumpkin, garlic), dried herbs (celery, basil, oregano, dill), spices (ginger, turmeric, curry, paprika, coriander).

To improve the biological value, the grain of green buckwheat was germinated to a sprout length of 1–1.5 mm, then the grains were washed and dried to a moisture content of 14–14.5 % at a temperature not higher than 45 °C in order to avoid the destruction of vitamin C, enzymes, folic acid and other biologically active substances. Sprouted, then dried to a moisture content of 14–14.5 % and crushed green buckwheat grains served as the main raw material for the preparation of a new product. According to the recipe, dried crushed sprouted grains and all other ingredients were mixed. Friable, powdery appearance of the flavoring seasoning for the first courses was received, weighed in 100 g and stored in glass jars.

When developing the HACCP plan, let's use the standards of the Republic of Kazakhstan, which ensure the implementation of the HACCP plan at the enterprises:

- ST RK 3.53-2004 «Quality Management System. The procedure for certification of the quality management system based on the principles of risk analysis and critical control points (HACCP)»;
- ST RK 1179-2003 «Management system. Food quality management based on HACCP principles. General requirements»;
- ST RK ISO 22000-2019 «Food safety management systems. Requirements for all organizations in the food production and consumption chain».

3. Research results and discussion

An important part of the study is the development of a HACCP plan to monitor the safety of flavoring condiments with increased nutritional value. Work has been carried out on the development of recipe compositions,

the formation of a high-quality type of flavoring seasoning with the addition of sprouted green buckwheat, and a possible algorithm for determining the CCP was proposed. By organoleptic analysis of the obtained samples, it was found that the addition of sprouted green buckwheat to the composition of flavoring seasonings to improve the organoleptic characteristics and to increase the nutritional value of ready-made products confirm the results of sensory analysis. These products were characterized by harmonious, spicy, refreshing, slightly tart, slightly pungent and bitter taste and aroma, pleasant color, crumbly and uniform appearance [5, 7].

Technical specifications have been developed for a flavoring seasoning with the addition of 30 % sprouted green buckwheat ST AO 990840000359-02-2020, where the requirements for organoleptic, physicochemical and microbiological indicators of new products are normalized (Table 1).

During the production of a new type of flavoring seasoning, critical control points (CCPs) were determined at each stage of production using the Decision Tree. A monitoring system has been developed for each CCP, which allows carrying out the order of observations and measurements according to the plan and detecting violations of critical limits.

Hazard analysis considers the likelihood and severity of hazards if all possible hazards have been identified at all stages, and actions and procedures have been defined to prevent hazards from occurring. The HACCP plan provides for such types of hazards as biological, chemical and physical. Biological hazards include pathogens, bacteria, viruses, parasites, fungi and molds. Chemical hazards include:

- toxins of various origins;
- food additives in high concentration or unauthorized in the country;
- detergents and disinfectants;
- lubricants and fluids from equipment.

Physical hazards include solids such as glass, wood, metal, plastic.

All hazards are controlled in accordance with the HACCP plan for each CCP using the monitoring and corrective action procedure and with the production program of mandatory preliminary measures (PPMPM) [8].

The results of the analysis of decision making on hazardous production processes of a new type of flavoring seasoning and critical control points (CCP) are presented in Table 2.

According to the Table 2, among these process stages there are three critical control points (CCPs) – the germination stage, the disinfection stage during the germination of the grain, and the packaging stage. At the stage of grain germination, a physical hazard can arise – the ingress of foreign objects. The disinfection stage during grain germination is characterized by a biological hazard – an expired preparation lacks disinfection efficiency. There is a biological, chemical and physical hazard for the packaging stage – leakage and absorption of moisture from the environment caused the growth of microbes. Storage and distribution conditions are critical to maintaining consumer acceptability and shelf life.

Establishing critical limits is necessary to prevent, eliminate, or reduce contamination present to an acceptable level. Fig. 1 shows a process flow diagram of a flavoring production process with established measures for managing critical control points. The process flow diagram shows the flow of the production process and makes the process transparent.

Table 1

Quality indicators of flavoring seasoning with the addition of 30 % sprouted green buckwheat in accordance with ST AD 990840000359-02-2020

Indicator	Characteristics
Organoleptic indicators	
Appearance	Loose, homogeneous, powdery, without impurities
Colour	Light orange to dark orange
Taste	Spicy taste characteristic of the recipe composition of the mixture. The presence of mildly sweet/mildly spicy/mildly pungent, mildly sulphurous, refreshing, mildly woody, green, mildly pungent, mildly tart, mildly pungent, harmonious, flavor, without off-flavor
Smell	The aroma is characteristic of spices, greenery, without foreign smell, spicy, slightly sweet, refreshing, slightly woody, greenery, slightly harsh, slightly tart, slightly pungent, harmonious, flavor
Physical and chemical indicators	
Humidity, % no more	14
Mass fraction of ash, % no more	3.0
Impurities	Not allowed
Pest infestation	Not allowed
Metallomagnetic impurity, % no more	0.03
Toxic elements	
Lead	5.0
Arsenic	3.0
Cadmium	0.2
Microbiological indicators	
QMAFAnM, CFU/g (cm ³), no more	1×10 ⁴
Mold, CFU/g (cm ³), no more	100
BGKP (coliforms), not allowed in the mass of the product, g (cm ³), no more	0.01
Sulfite-reducing clostridia, not allowed in the mass of the product, g	1.0
<i>S.aureus</i> , not allowed in the product mass, g	1.0
<i>B.cereus</i> , not allowed in the product mass, g	100

Table 2

Analysis of decision making on hazardous production processes of a new flavoring seasoning and critical control points

Step no.	Process step	Hazard		Control measures (standard operating procedure (SOP) or work instructions)	V-1: Are there preventive control measures?	V-2: Is the step specifically designed to eliminate or reduce the likelihood of the hazard occurring to an acceptable level?	V-3: Can contamination with identified hazards occur in excess of acceptable levels, or can it increase to unacceptable levels?	V-4: Will the next step eliminate the identified hazards or reduce the likelihood of their occurrence and the acceptable level?	CCP or preventive measures
1	2	3		4	5	6	7	8	9
1	Receiving raw materials (grain, vegetables and other ingredients)	B	Biohazard content in grain and other raw materials	Microbiological and chemical analysis of raw materials and ingredients. Standard operating procedure (SOP) for raw materials. Material Suppliers	Yes	No	No	-	CCP (PPMPM)
		C	Additives and heavy metals. Residual chemicals						
		P	Foreign particles						

Continuation of Table 2

1	2	3		4	5	6	7	8	9
2	Washing in water ($t = 14\text{ }^{\circ}\text{C}$)	B	No	Standard operating procedure (SOP)	No	-	-	-	CCP (PPMPM)
		C	Heavy metals. Residue of chemicals						
		P	Foreign particles						
3	Soaking grain in water	B	The growth of microorganisms is due to a change in storage temperature	The grain is swollen in water at $t = 18\text{--}20\text{ }^{\circ}\text{C}$ for 7–8 hours	Yes	No	-	-	CCP (PPMPM)
		C	No						
		P	No						
4	Germination of grain 24–72 h, $W = 40\text{--}60\%$	B	No	The swollen grain germinates at room temperature for 24–72 h, $W = 40\text{--}60\%$. Visual control. Staff compliance	Yes	No	No	-	CCP (HACCP plan)
		C	No						
		P	Ingress of foreign objects						
5	Disinfection during germination	B	The growth of microorganisms is caused by changes in temperature and humidity	During germination, let's disinfect according to the method. Expired product lacks disinfection efficiency	Yes	Yes	-	-	CCP (HACCP plan)
		C	No						
		P	No						
6	Drying	B	No	Temperature and humidity will be controlled during grain drying ($t = 40\text{--}45\text{ }^{\circ}\text{C}$, 12–14 h, $W = 14\text{--}15\%$)	Yes	No	No	-	CCP (PPMPM)
		C	No						
		P	No						
7	Shredding	B	No	When grinding, the sizes of all ingredients are controlled (sieve No. 1, 2, at least 80 %)	Yes	No	-	-	CCP (PPMPM)
		C	No						
		P	No						
8	Mixing ingredients	B	No	Mixing time of all ingredients is controlled (3–4 min)	Yes	No	-	-	CCP (PPMPM)
		C	No						
		P	No						
		P	No						
9	Packaging	B	Microbial growth due to leakage and absorption of moisture from the environment	Leak test, humidity test, humidity control by ensuring controlled room temperature and humidity. Foil packaging test. Personnel hygiene procedure, CIP (Clean In Place) for packaging machine and weighing machine	Yes	Yes	No	-	CCP (HACCP plan)
		C	Chemical hazard from foil packaging						
		P	Foreign particles present during weighing and forming						
10	Storage	B	No	Temperature and humidity will be controlled during storage of finished products	Yes	No	-	-	CCP (PPMPM)
		C	No						
		P	No						

Note: B – biological hazard; C – chemical hazard; P – physical hazard

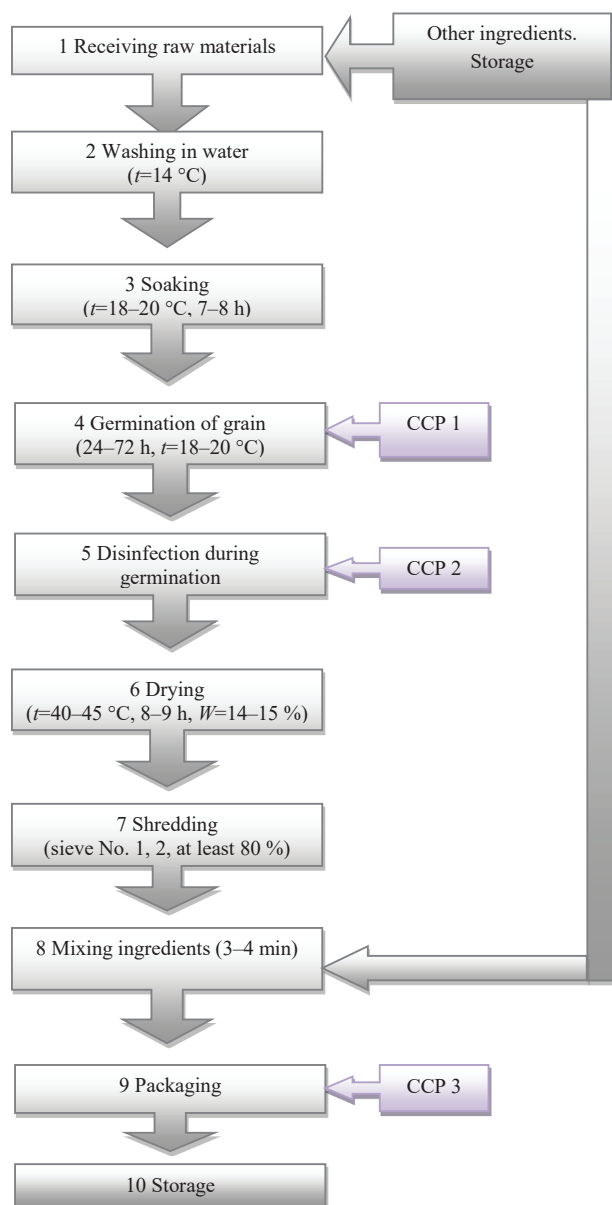


Fig. 1. Description of the process flow diagram

After identifying hazards, establishing critical limits and critical control points, to prevent all of the listed hazards for each installed CCP, a HACCP plan was developed for the production of a new flavoring seasoning.

In the production of a new type of flavoring seasoning, the presented HACCP plan is applied in conjunction with PPMPM, only then it is possible to eliminate or reduce the risks of hazards and the possibility of producing safe, high-quality products.

Table 3 shows all potential critical hazards, critical control point, critical limits, responsible person, frequency, recording, corrective action.

For each CCP, the frequency and order of monitoring is established, which shows the controllability of management actions. The monitoring system includes all planned actions that relate to hazards. The HACCP plan specifies corrective actions for each CCP.

Therefore, the implementation of the HACCP plan requires the participation of all personnel involved in production at all stages [9, 10].

4. Conclusions

HACCP plan for a new flavoring seasoning with increased nutritional value is developed. The developed HACCP plan will make it possible to efficiently manage the production processes of high quality flavoring seasoning based on sprouted green buckwheat, spices, dried vegetables and herbs, while using preventive measures and accurately identifying critical processes.

As a result of the analysis of the production process of flavoring seasoning, dangerous factors were identified: physical (ingress of foreign objects, leakage, absorption of moisture), biological (growth of microorganisms). Preventive measures have been developed to eliminate risks or reduce them to an acceptable level. As a result of the analysis of the production process of flavoring seasoning, three CCPs were identified: in the process of germinating grain, in the process of disinfection during germination of grain and during packaging of the finished product. When risk factors are identified, critical limits are determined that are necessary to determine whether a CCP is under control or not.

Table 3

HACCP plan for the production of a new type of flavoring seasoning

No.	Process step	Danger	Control measure	Critical limit	Monitoring				Corrective action
					How	Who	Frequency	Recording	
1	Germination of grain 24-72 h, W = = 40-60 %	Physical hazard	Production control	Not allowed	Checking the condition of the workshop, monitoring the procedure. Staff compliance	Production director	Daily	Monitoring and logging	Visual control
2	Preparation for disinfection during germination	Biological and physical hazard	Production control	Storage temperature (0±5 °C) and shelf life no more than 2 days	Temperature-time control	Production director	Daily	Monitoring and logging	Disposal of non-conforming products
3	Packaging	Biological, chemical and physical hazards	Temperature and humidity control. Leak test	No leakage. Temperature and humidity control of the packaging room (<30 °C and <60 %)	Automatic packing and leakage control in a temperature controlled room	Packaging operator and quality control department	Every 30 min (check packages, temperature and humidity)	Leakage test report	Reject the wrapper, finished packaging and recheck the entire batch

For the first CCP, hazardous factors are not allowed, for the second CCP, the critical limits are the storage temperature of the drug (0 ± 5 °C) and a shelf life of no more than 2 days, and for the third CCP, the critical limits are the temperature and humidity of the packaging room (<30 °C and <60 %). For each CCP, the frequency and order of monitoring is established, which shows the controllability of control actions. Corrective actions are developed, namely, to correct the identified hazardous factors, visual control is carried out on 1 CCP, inappropriate products are disposed of at 2 CCPs, and the finished packaging is rejected at 3 CCPs and the entire batch is rechecked.

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