

## APPLICATION OF HACCP PRINCIPLES FOR QUALITY AND SAFETY IN THE DEVELOPMENT OF GRAIN PRODUCTS OF WELNESS PURPOSE

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### Abstract

The article presents solution of manufacture of safe high quality goods at complete satisfaction of consumer requirements for food industry companies through implementation of the quality management system, namely, implementation of the principles of HACCP system. We have carried out work on the development of new recipe compositions, and quality formation of new types of grain crisp breads of wellness purpose and suggested a possible algorithm for determining critical control points. We exercised control of all factors which with any degree of certainty may endanger the safety of production of new types of grain crisp breads of wellness purpose. The degree of accountability was evaluated in accordance with the schedule of dependence of the probability of hazard from the severity of the consequences of its implementation. Application of diagram of risk analysis in quality control of grain crisp bread, enriched with vegetable additives allows identifying potentially dangerous risks of their production that must be considered in future on determination of the critical control points. After analysis of all stages of production we have developed corrective actions, i.e. safety management plan of grain crisp bread. The suggested measures for the implementation of the HACCP system at the company will allow avoiding possible risks of danger on the production of new types of grain crisp bread of wellness purpose, thereby to provide receipt of the harmless and high quality product by the consumer.

**Keywords:** food safety, grain crisp bread of wellness purpose, HACCP-plan, critical control points, potentially dangerous factors, corrective actions.

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## 1. INTRODUCTION

Regardless of nationality, social status and age, people can not go without food. However, the use of food is too often accompanied with the risk to the health or life of the consumer. According to the World Health Organization, there are three to four million cases of various enteric infections diseases and severe poisoning caused by poor food quality every year. The actual number of victims is much higher than these figures, since not everyone seek for professional medical assistance. It is believed that the number of prerequisites leading to an increase in poisonings tends to escalate. This is due to environmental degradation, use of new types of agricultural raw products (e.g. genetically modified), wide range of pesticides and agrochemicals used for soil treatment, hormonal therapy accelerating the growth of animals and birds, variety of food additives,

stabilizers, flavours, colourants, etc. (Priyatnogo appetita, 2009; M. R. Mardar *et al.*, 2015; S. E. Belins'ka *et al.*, 2011).

In the food industry, the quality shall be put into the process of products' manufacturing, so the most important factor for its maintenance and one of the main positive elements of manufacturers' competition is a management system of the enterprise. In this way, the consistent increase of the role of enterprise management system is based on an indispensable factor for increasing the company's ability to compete that makes it possible to achieve the main goals of the company: reduce the cost of goods produced with the full satisfaction of customer's requirements (C. Norton, 2003; I. S. Arvanitoyannis *et al.*, 2009).

The most popular solution of this problem in the food industry shall be an introduction of a quality management system and an

implementation of HACCP principles. The system shall determine critical control points where the potential risks are to be taken into account. Based on the analytical work with accumulated information, there is generated actions project which contributes to minimization of risk of unsafe products. The personnel responsible for the implementation of activities shall be also determined.

Quality assurance in accordance with the principles of HACCP shall be held throughout the entire manufacturing process of the product, resulting in an advantage and an important characteristic of the system (S. Mortimor *et al.*, 2014; Sistema HACCP. Dovidnik, 2003).

Goal of research – HACCP drawing up - a plan for the company producing grain crisp bread.

## 2. MATERIAL AND METHODS

In Ukraine, the requirements for the development and implementation of HACCP principles of food safety management system are declared in DSTU 4161-2003 "Food safety management system. Requirements" and DSTU ISO 22000:2007 "Food safety management systems. Requirements to any food chain organizations".

HACCP concept (HACCP - Hazard Analysis and Critical Control Points) provides a reliable food safety and reduces the risk of infection diseases related to food consumption. HACCP is an international system and is based on seven principles (in accordance with ISO 22000), aimed at this system's management implementation and execution at the enterprise (Sistema HACCP. Dovidnik, 2003; A. N. Mamcev *et al.*, 2007; I. Z. Aronov *et al.*, 2008; O.V. Orlenko, 2015):

1. identification of hazards that must be prevented, eliminated or reduced to acceptable levels;

2. identification of critical control points (CCP) at a particular process stage (stages); CCP monitoring to prevent or minimize the impact of hazards. Risk factors may be potential, acceptable and unacceptable;

3. establishing critical limits, which should be followed to ensure that CCP are being under control. Critical limit is a maximum or minimum parameter value in CCP, for its values are not allowed to go out of its range.

4. developing and implementing effective control procedures at critical points. To assure the compliance of the production process and finished products with the requirements of internal standards and specified critical limits, one should ensure the continuous monitoring of every CCP. Specified monitoring is a system of observations and measurements aiming to assure that the state of the critical point is within the prescribed limits;

5. development of corrective actions to be implemented if the monitoring results indicate that a certain critical point suffered a loss of control. Corrective actions are to identify the reasons for deviation, exclusion of low-quality product reaching the consumer and provide the process to be held within the prescribed limits;

6. development of audit procedures that allow to verify the effectiveness of HACCP system. The audit should confirm that HACCP plan adequately reflects the hazards and is being properly performed. The audit procedure is the systematic control of measuring equipment, conditions of individual production stages, correct documentation maintenance.

7. procedures documenting and data registration required for the functioning of HACCP system (ДСТУ-Н ISO/TS 22004, 2009).

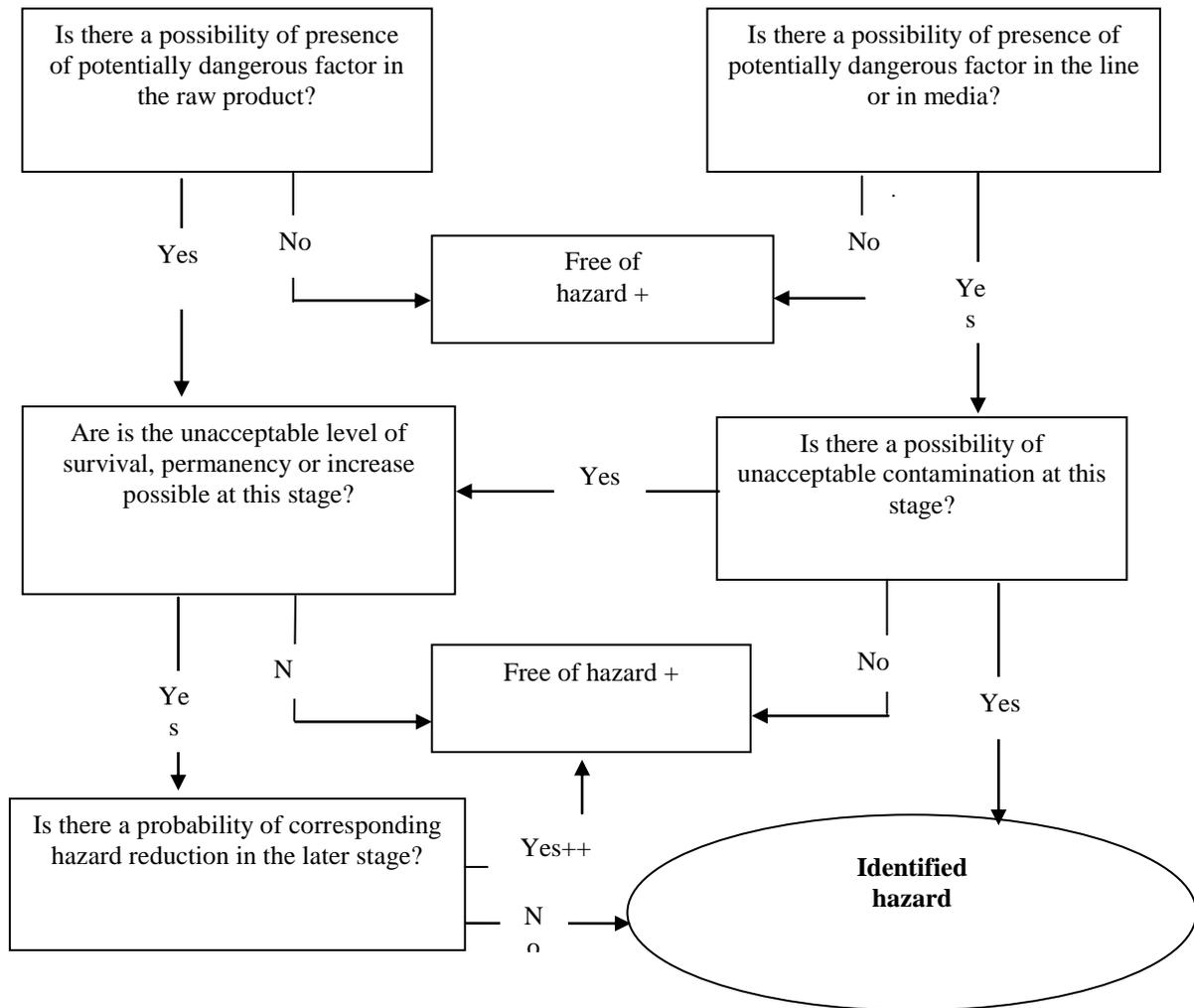
## 3. RESULTS AND DISCUSSION

We have carried out the work on the development of formula, quality of grain crisp bread of wellness purpose (I. A. Ustenko *et al.*, 2015; M. Mardar *et al.*, 2016) and proposed an algorithm for CCP determining.

We define the presence of CCP according to the algorithm shown in Figure 1. The decision tree demonstrates more obviously the process of CCP identification (Sistema HACCP. Dovidnik, 2003).

Figure 2 shows the developed technological diagram of obtaining grain crisp bread, which was the basis to carry out an identification of the hazards and CCP establishment. Hazards analysis involves collecting and evaluating information on hazards and conditions that may lead to their occurrence. It was carried out in two stages: listing of

potential risks and their assessment. In our research work, we have supervised all the factors (according to HACCP), which were sufficiently likely to endanger the safety of the production of grain crisp breads of wellness purpose. These factors have been divided into biological, chemical and physical ones (Table 1).



+ No hazard which is controlled at this stage.  
++ The stage of the level of hazard decrease becomes CCP.

Figure 1. Decision tree of determining the hazards

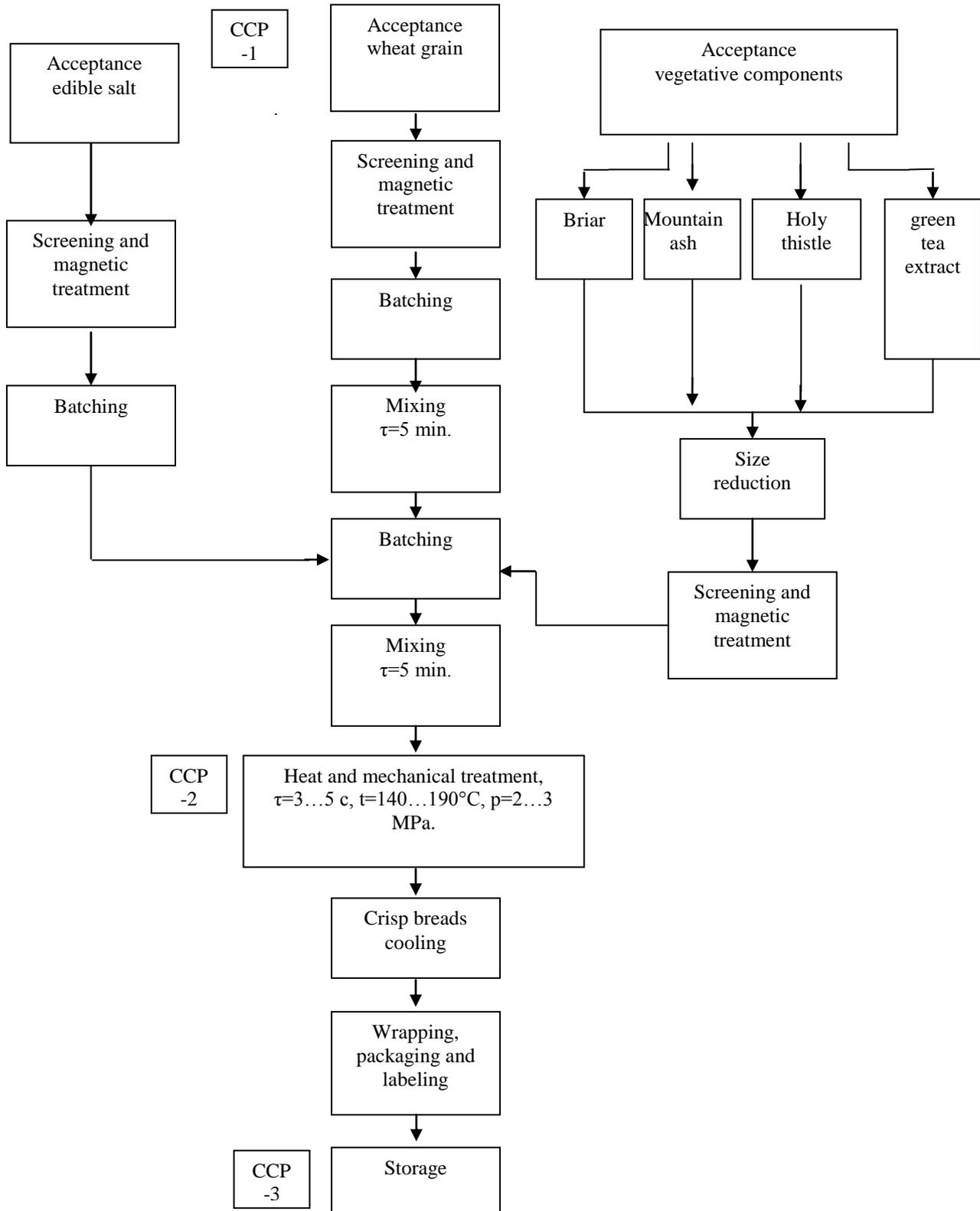


Figure 2. Process diagram of grain crisp breads manufacturing

**Table 1. Identification of potential hazards on production of grain crisp bread**

Hazard	Severity of the consequences - estimation	Likelihood of occurrence – estimation	The hazard is subject (+) or not (-) for consideration
<i>Potentially hazardous biological factors</i>			
Spore-forming bacteria: <i>Salmonella spp.</i> , <i>Listeria monocytogenes</i> ; spore-forming bacteria: <i>Clostridium perfringens</i> at raw material acceptance	1	No – 1 Incoming laboratory control	-
Mesophilic aerobic and facultative anaerobic microorganisms, coliforms, <i>Salmonella spp.</i> , <i>Bacillus subtilis</i> , <i>S.Aureus</i> and mold in acceptance of raw materials	1	No – 1 Incoming laboratory control	-
<i>Bacillus subtilis</i> , <i>S.Aureus</i> contaminated of packaging materials and equipment during heat treatment	3	Yes – 2	+ CCP-2 (B)
Mesophilic aerobic and facultative anaerobic microorganisms, coliforms contamination of containers while product storage	4	Yes – 3	+ CCP-3 (B)
<i>Potentially hazardous chemical factors</i>			
Pesticides, toxic elements in acceptance of raw materials	3	Yes – 2	+ CCP-1 (Ch)
Chemicals from packaging materials: vinyl chloride, printing ink and ink	1	No – 1 (GMP)	-
Remains of detergents after washing can cause chemical pollution of a product	2	No – 1 Process control	-
<i>Potentially hazardous physical factors</i>			
Foreign matters	2	No – 1 (GMP)	-
Glass, equipment parts	2	No – 1 Process control	-
Jewelry, workers' hair	2	No – 1 Process control	-

**Table 2. The severity of the consequences of hazard implementation**

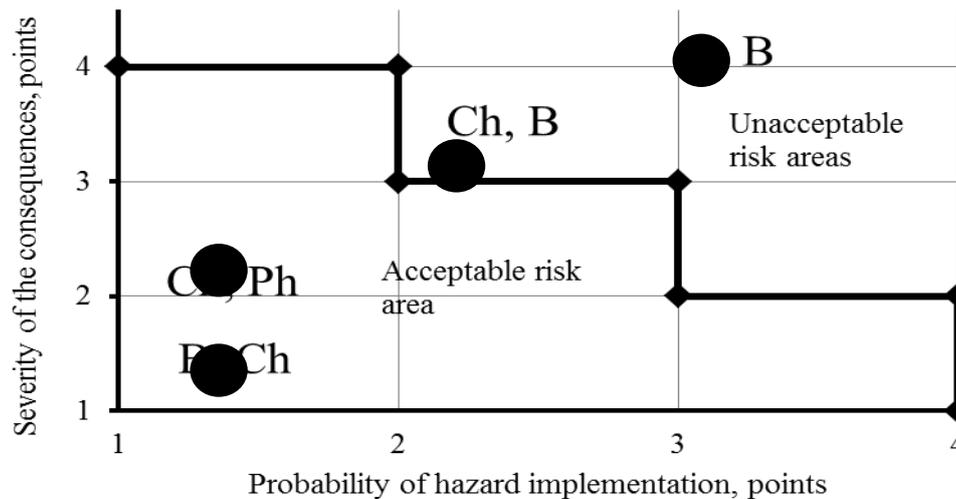
Estimation	Criterion of hazard level
1	Moderate hazard level (hazard effect does not result in the loss of working capacity)
2	Average hazard level (loss of efficiency within a few days, but the effects will be shown)
3	Severe hazard level (long-term disability, getting 3-rd group disability)
4	Critical Severity (getting 1st or 2nd group disability, death)

The severity of consequences of hazard implementation has been evaluated in points according to the criteria shown in Table 2.

Degree of accountability has been evaluated in accordance with the diagram (Figure 3) which is a dependency graph of the probability of hazard implementation on the severity of the consequences of its implementation.

On the qualitative diagram, the boundary of critical values of hazard risks has been built separating acceptable and unacceptable risk areas. Depending on the area of potentially

dangerous factor, it shall be determined as accountable or not. If a potential hazard was located on the boundary, it had been considered to be taken into account. The use of risk analysis chart in the management of quality of grain crisp breads enriched with herbal supplements reveals potentially dangerous risks of their production, which must be considered further CCP determining.



**Figure 3. Diagram of risk analysis in the production of grain crisp breads**

**Table 3. Safety management plan for grain crisp breads production (HACCP-plan)**

Process stage	CCP	Description of unsafe factor	Critical limits	Monitoring procedures	Corrective actions	HACCP protocols
Basic and additional raw materials for grain crisp breads production	CCP-1 (Ch)	Pesticides, aflatoxins, toxic elements	As per DSTU EN 12393-1:2003, DSTU 4990:2008, DSTU 7670:2014, DSTU GOST 31262:2009	Verification of certificates in admission of raw materials	Refusal of acceptance/return of raw material batch. Check the raw material suppliers	Certificates of analysis
Heat treatment	CCP-2 (B)	Violation of process conditions can lead to microbial contamination of the product	Heat treatment for 3s at 140 °C	Continuous monitoring by equipment operator and personnel control to ensure quality	An operator adjusts time and temperature of the process and informs the quality control operator	1. Logbook of operations 2. Logbook of production batches
Storage of grain crisp breads	CCP-3 (B)	Mesophilic aerobic and facultative anaerobic microorganisms, coliforms, b.r. Salmonella, Bacillus subtilis and mold	Storage time of the product - not more than 6 months temperature - not higher than 20°C relative humidity - not more than 75%	Continuous personnel monitoring to ensure quality	Reduction of storage time. Adjust temperature and humidity maintaining system .	Logbook of product batches

As we can see at Figure 3, potentially dangerous biological and chemical factors (B, Ch) occurred in acceptable risk areas in acceptance of raw materials, and chemical factor (C) after washing of equipment and physical (F) under poor manufacturing

practices at the points of the production chain. Potentially dangerous biological factor (B) occurred in the area of unacceptable risks while storage of products; moreover, potentially dangerous chemical and biological factors (Ch, B) are located at the boundary while heat

treatment. Therefore it is necessary to take into account these factors in production of grain crisp breads, as well as to establish more strict control over them.

The next step was to develop a corrective action, i.e., safety management plan for grain crisp breads (HACCP plan) (Table 3). Deviations and corrective actions should always be documented; there is a column for description of the corrective action in a monitoring sheet thereof.

#### 4. CONCLUSIONS

Proposed actions for the implementation of HACCP system at the plant will avoid the possible risks of danger in the production of grain crisp breads of wellness purpose, thereby ensuring the consumer with friendly and high-quality products.

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