# FOOD SAFETY AND HACCP SYSTEM IN THE MULTI-BERRY BLENDED JUICE PRODUCTION

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## *ABSTRACT*

The processing of fruit and berry raw materials assume a presence of the critical control points that will affect a quality of the final product. The production of Multi-berry blended juice on the base of loganberry, strawberry, black currant berry and stevia, by using the principles of the HACCP system, technological processes are analyzed. As natural antioxidants, loganberry, strawberry, black currant berry have high nutritional value and medicinal properties. For instance, they have antiinflammatory, antidiabetic, and anticarcinogenic effects against various cancer types. Their health protecting effects are due to their various bioactive components, mainly high amounts of anthocyanins, giving blue, red, and purple color to berries. Besides they contain phenolic acids, tannins, vitamins, and minerals. In this regard, it is important to preserve all the benefits of these berries in the production of juice. Each technological process is analyzed step by step, and critical control points are determined. The most important production steps are: reception and sorting, cleaning and sterilization. As the checking operations are necessary visual inspection and laboratory analysis of all berries and stevia. For the avoiding of negative factors, monitoring, control and preventive corrective actions based on the HACCP / ISO 22000: 2018, analyze of food safety management system is proposed.

**Keywords:** food safety, HACCP, berry juice, loganberry, strawberry, black currant berry antioxidants, hazards

## *INTRODUCTION*

Currently, for the supporting of the specified concept and regulations of the harmless productions [4], a safety management system of food is important [14,15]. Investments into safety management systems of food are key prerequisite of reliable and stable supply of safe food products and growth of international trade [11, 16]

HACCP (Hazard Analysis and Critical Control Points) is a simple and logical control system based on the concept of preventing problems by identifying hazards, establishing critical control points and developing measures for monitoring, preventing and correcting them [1, 2]. It should be developed taking into account seven basic principles [12]:

1. Conduction of possible hazards analysis;
2. Identification of Critical Control Points (CCPs).
3. Determination of Critical Limits for CCPs.
4. Establishment of a monitoring system for control on CCPs.
5. Setting of corrective actions.

6. Fixing of verification procedures.
7. Establishment of principles for maintaining records and documentation [13].

HACCP system must to identify and to assess all types of hazards, including biological, physical, chemical, and to identify all possible hazardous factors that may be contained in the production processes [5-7].

For each potential factor, a risk analysis is carried out by taking into account of its significance consequences and identifying a list of factors for which the risk exceeds the permissible level. The HACCP system must to discovery the preventive actions that eliminate risks or reduce them until an acceptable level [2, 7].

Thus, the preventive actions consist in [10]:

• Control of the parameters of the technological process for the production of juice;
• Heat treatment;
• Periodic control of the concentration of dry substances;
• Washing and disinfection of equipment.

The critical control points are determined by analyzing separately for each hazard and by sequentially considering all operations included in the flow diagram of the production process [12]. The main condition for a critical conditional point is the presence of risk signs on the analyzed control operation [13].

## *MATERIALS AND METHODS*

The following raw materials were used in the technology of Multi-berry juice: loganberry, strawberry, black currant berry, drinking water and stevia [3].

Loganberry (Rubus × Loganobaccus) is a hybrid of blackberries and raspberries. It was accidentally created in 1881 in Santa Cruz, California USA, by the American judge and gardener James Harvey Logan [18].

Rubus fruits (raspberry, blackberry, red raspberry, strawberry, gooseberry, loganberry, boysenberry, etc.), which are defined as functional food because of their protective and enhancing effects on health, have more 200 different types. These fruits have strong antioxidant, antiinflammatory, antidiabetic, and anticarcinogenic effects against various cancer types. Their health protecting effects are due to their various bioactive components, mainly high amounts of anthocyanins, giving blue, red, and purple color to berries which differ them from other fruits. Besides they contain phenolic acids, tannins, vitamins, and minerals. Most of the previous studies have focused on the effect mechanisms of the anthocyanins [17].

For the development a HACCP plan, a list of all possible dangerous factors is considered, such as: physical, chemical and microbiological. Due to these circumstances, it is important a carefully to analyze each stage of the production process that has the potential hazardous risks in the technological line: from raw materials and ingredients reception, storage, processing until a final product issue. Each risk should be assessed according to the severity of the consequences of adverse effects for the consumers' health [13].

In this regard, a risk can be determined by the following formula:

**Risk** = **Probability** of a hazardous factor realization **x Severity** of the consumers' consequences in the food product consumption.

Mostly, the analysis of the available CCPs should be based on the international standard ISO 22000: 2018 Food safety management systems - Requirements for any organization in the food chain [10].

## *RESULTS AND DISCUSSION*

Mostly, an analysis of the likely hazardous factors in the production of Multi-berry blended juice is carried out. All stages of production were considered as sources of hazards: Reception of raw materials, Inspection, Washing berries, Pressing, Juice blending, Ultrafiltration, Cooling, Packaging, Sterilization and Storage [3].

**Reception** of raw materials is provided by groups. Berries must be fresh, ripe and meet the requirements of standards. The use of fruits with fungal diseases, mold and other types of spoilage is not allowed.

**Washing** berries is supported by hydraulic conveyor in a stream of water at pressure is 4.5 bar. At the same time, the berries are washed while passing through the hydraulic channel and the hydraulic pipe before they enter the mud bath. Water for hydraulic supply is used repeatedly and must meet sanitary requirements for water supply, that is, it must contain 5-6 mg of active chlorine in 1 liter. Berries from the upper raw material platform are fed through a hydro tube to the bath located at the lower raw material platform to trap heavy impurities according to the principle of the difference in specific gravity. In the lower part of the bath there is a grate and an outlet of circulating water through a pipeline with a diameter of 300 mm, which supplies the latter to a tank for collecting circulating water.

**Inspection** is carried out for the removing unsuitable for processing berries that may be affected by agricultural pests, rotten ones, as well as foreign impurities and objects. Inspection is one of the technological processes, the quality of which further depends on the quality of the final product.

**Pressing** is done in the closed system, its advantages are that the obtained juice is clean, the loss of aroma is insignificant and the possibility of subsequent processing of the pomace. Due to the presence of a self-cleaning filter system, a minimum penetration of turbidity is achieved, due to a high recovery is reached.

**Ultrafiltration** is related to the membrane technology. Dissolved low-molecular organic compounds (sugar, aromatic substances, etc.) contained in the un-clarified juice pass through the membranes. High molecular organic compounds (starch, proteins, pectin, etc.) and suspended particles are retained and concentrated during the passage of the juice through the membranes. In the ultrafiltration module, under constant pressure, a raw juice is separated into two parts by means of tubular membranes: permeate and retentate. Permeate is a part of the flow of the purified liquid that passes through the membranes as a clear juice. The retentant is the portion of the fluid flow that is retained and does not pass through the membranes. Some of the high-molecular compounds accumulate on the upper surface of the membranes and act as “secondary membranes”, notably additional filtration occurs through them. This layer is removed during each cleaning, and at the beginning of filtration a new layer is formed again. The layer thickness depends to the micro-area.

All possible hazardous factors in the production are analyzed in the Table 1.

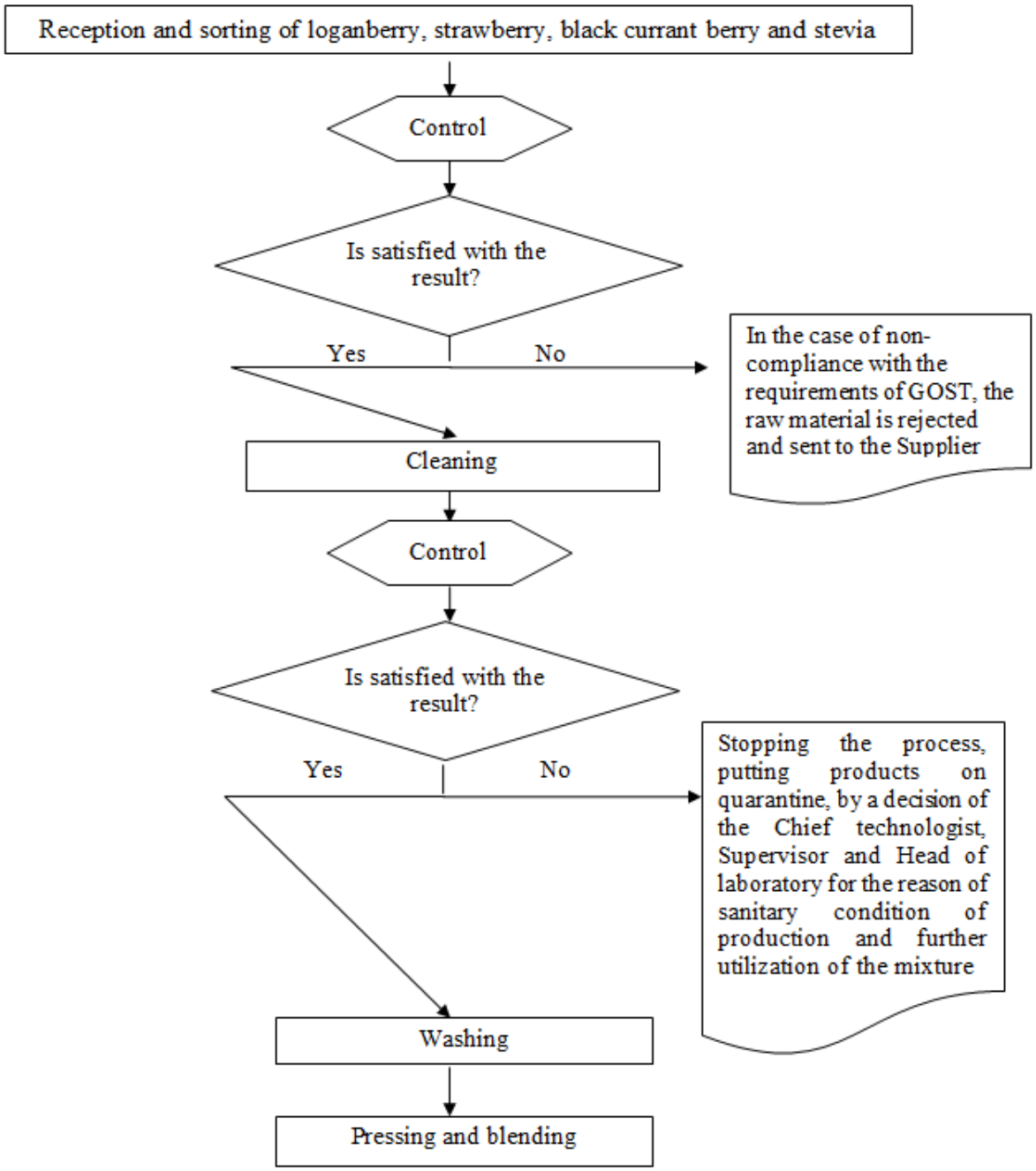
Table 1 - Hazard analysis in the production of Multi-berry juice.

| Name of operation | Process parameters | Considered factors | Controlled hazards | Preventive action | Responsible person |
|---|---|---|---|---|---|
| 1. Reception of berries and ingredients | Loganberry, strawberry, black currant berry must be fresh or frozen, quite ripe, clean, without foreign smell, without peduncles, heterogeneous in size and color, without any damages and diseases. | Microbiological | a) bacteria of the group of *Escherichia coli* (BGEC), b) pathogenic microorganisms | Control at the reception | Head of Laboratory |
| | | Chemical | a) pesticides b) herbicides c) plant growth regulators | Input control | Head of Laboratory |
| | | Physical | a) glass b) metal c) plastic | Control at the reception | Head of Laboratory |
| | Presence of microorganisms in stevia | Microbiological | Pathogens | Control at the reception | Head of Laboratory |
| | | Chemical | a) mercury b) arsenic c) copper | Input control | Head of Laboratory |
| | | Physical | a) glass b) metal c) plastic | Input control | Head of Laboratory |
| | Analyze of a drinking water | Microbiological | Pathogens | Control at the reception | Head of Laboratory |
| 2. Cleaning | The remains of unsuitable parts of raw materials | Microbiological | Bacteria, viruses, yeasts, moulds and viruses | Cleaning process control | Supervisor |
| 3. Washing | Detergent residues | Physical | At non-observance of the washing process, the berries which are not completely cleared from strangers can remain | Control of washing process | Supervisor |

Table 1 continuation

| | | | | | |
|---|---|---|---|---|---|
| 4. Pressing and blending | Metal fragments, personal belongings of staff | Physical | If the grinding and mixing processes are disregards, foreign objects or particles can input into the finished product | Control grinding and mixing processes | Supervisor |
| 5. Ultrafiltration | Contaminated particles | Microbiological | Pathogens | Control of ultrafiltration process | Supervisor |
| | Residues from equipment cleaning solutions | Chemical | Separation of dissolved and solid particles | Rinsing by pure water in the membrane apparatus | Supervisor |
| 6. Packaging | The remains of unsuitable parts of packaging | Microbiological | Sterilizing | Control of the filling process into the packaging, the creation of aseptic conditions | Supervisor |
| | Presence of foreign objects | Physical | If the packing process is disregard, foreign objects or particles can input into the finished product (rubber from the cover, glass, plastic). | Control of the packing process | Supervisor |
| 7.Sterilization | Incorrect compliance of the sterilization process | Microbiological | *Escherichia coli* bacteria | Creating aseptic conditions | Supervisor |
| | | Physical | Impurities Metal parts of equipment | Use of metal detector | Supervisor |
| 8. Storage | Package integrity | Microbiological | Temperature,ºC Duration, h | Control of temperature-time variation | Supervisor |

The technological scheme for the production of Multi-berry blended juice with the identification of possible CCPs (Critical Control Points) is presented in Figure 1.



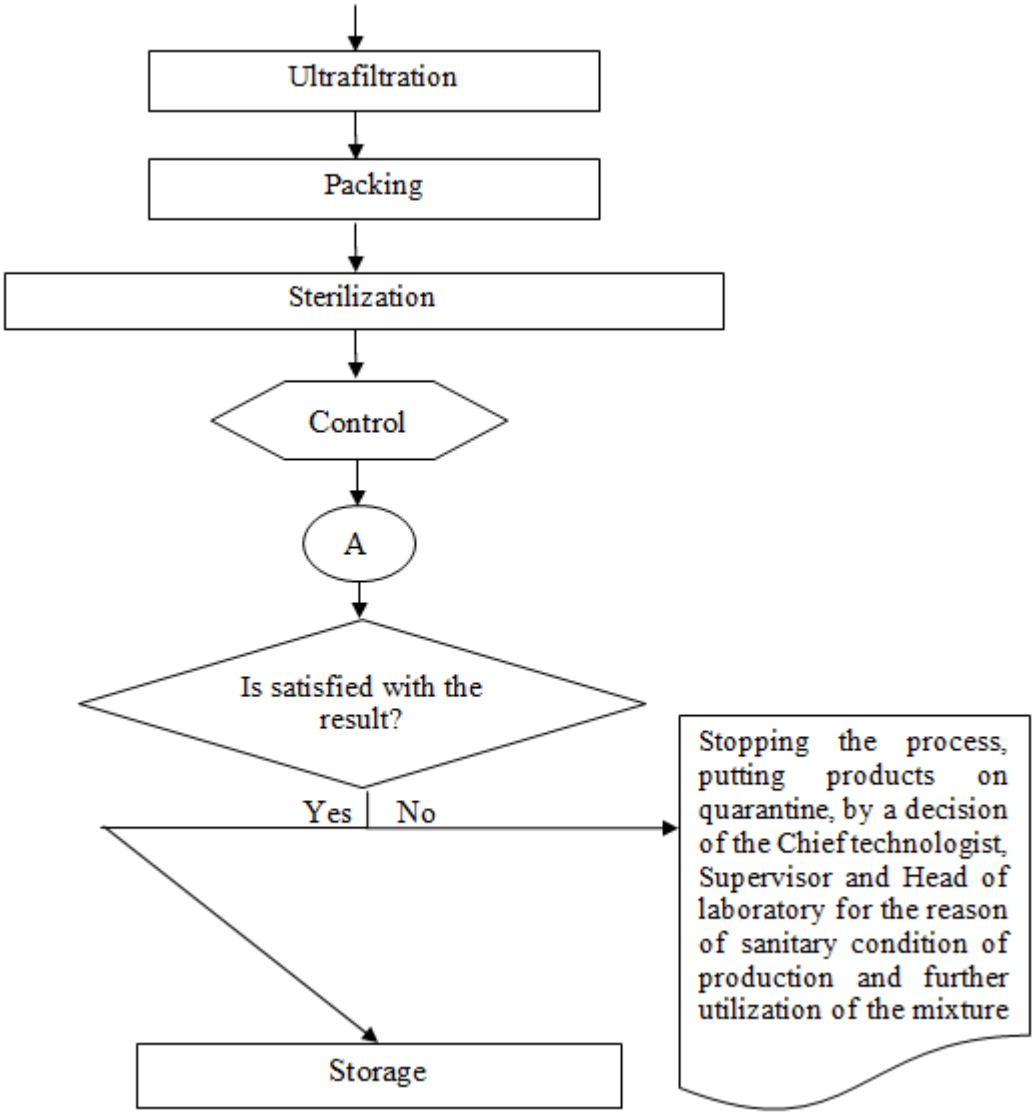



Fig. 1. Technological scheme of Multi-berry juice production and CCPs

By analyzing of the Figure 1, three CCPs with high risks are identified: reception and sorting, cleaning and sterilization. These production stages and offered control actions are presented in the Table 2.

Table 2 - CCPs risk assessment and control actions in the production of Multi-berry juice

| Prerequisite | Risk | Control actions | Risk degree |
|---|---|---|---|
| CCP 1 | Reception and sorting of loganberry, strawberry, black currant berry and stevia | Loganberry, strawberry, black currant berry must be fresh or frozen, quite ripe, clean, without foreign smell, without peduncles, heterogeneous in size and color, without any damage and disease.<br>Stevia leaves are dried and purified, without any mechanical damages by pests and diseases, with a stems evenly cut off at the base of the fruit.<br>More thorough visual inspection and laboratory analysis of all berries and stevia. | High |
| CCP 2 | Cleaning | Visual cleaning and rinsing by pure water raw materials and ingredients from the foreign objects in the microbiological, chemical and physical actions. | High |
| CCP 3 | Sterilization | Control of sterilization parameters in the autoclave at 120 °C within 10-15 min. | High |

## *CONCLUSION*

In the future, HACCP will increasingly be adopted by the food industry and state agencies. This approach can be extended to other aspects of food production. Mostly, HACCP is a means of controlling the production process based on the combination of scientific approach with common sense, the methods used to control food safety can be applied to health and safety and the assessment of production systems.

Thus, the analysis of the most possible dangers in the production of Multi-berry blended juice carried out with potential prerequisites of the CCPs (Critical Control Points) is taken into account: biological, chemical, and physical risks. The dangerous factors and critical control points are determined. The most important production stages are: reception and sorting, cleaning and sterilization. As the checking operations are necessary visual inspection and laboratory analysis of all berries and stevia. Production monitoring of available CCPs and corrective actions have essential value in the keeping of the safety and quality indicators. For the avoiding of the negative factors, monitoring system, control and corrective actions on the base of the HACCP / MS ISO 22000:2018 Food safety management systems standard are offered.

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