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Application of Hazard Analysis and Critical Control Points (HACCP) on The Production Process Line of Noni Juice Drink (*Morinda Citrifolia L.*)

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ABSTRACT

Hazard analysis and critical control points (HACCP) is a preventive system to ensure food safety. It aims to protect the product, correct errors, reduce costs due to quality defects, and reduce excessive control over the final product. Applying the HACCP principle will enable more accurate control of the noni juice production process. A case study was conducted to implement the HACCP system in the noni juice production line at UD Manjur Makmur Lumajang. A small industry that is trying to get approval from the BPOM (Food and Drug Supervisory Agency). The data collected in this study were obtained through in-depth interviews, field observations, and the study of documents owned by the research object. Some changes to the production process are needed to ensure the safety of the food produced and aligned with the HACCP. Determining critical control points (CCPs) has focused on activities considered critical to cause hazards, where critical limits for each CCP have also been determined. It was found that the main hazard occurs in sorting, opening and pouring the seal into the press. Applying the HACCP principle will allow for more accurate control of the noni juice production process.

Keywords*: Food Safety; HACCP; Noni juice; Production process*

INTRODUCTION

One of the things related to food safety lately is food quality. Consumer demands for quality assurance and food safety continue to increase because consumers are aware of the importance of food safety and health for the food they consume (Prayitno, S.A and Restu T, 2018). It becomes crucial and requires particular supervisors and control systems. Hazard Analysis Critical Control Point (HACCP) is a prevention system that seeks to ensure food safety, identify specific hazards associated with food or beverages and establish control systems that focus on prevention and not on final product analysis (Alijoyo et al., 2019).

HACCP is a dynamic system that can overcome new hazards arising from the emergence of pathogens and food poisoning due to changes in habits and consumption patterns (Pardo et al., 2013). HACCP is an essential basic requirement for achieving good food production (Good Manufacturing Practice, GMP) or good hygiene practices (Good Hygiene Practice, GHP), which food businesses will fulfil (Cruz & Kale, 2018).

Apart from improving food safety, implementing the HACCP system can provide other significant benefits, such as ease of inspection by the authorities, reduction of final product losses and promotion of international trade due to increased consumer confidence in food safety (Bhernama, 2017). All international sanitation agencies consider this system in their programs, recommending its use not only for industry but throughout the food chain, from the producers of raw materials to the final consumer.

UD. Manjur Makmur is a small and medium-sized industrial company (SMI) in Lumajang with noni juice products, and it still seeks marketing approval from the BPOM (Food and Drug Supervisory Agency). However, based on the initial survey, SMIs have problems related to the production process system, such as buildings, production layout, employees,

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and other factors. Therefore, to follow the HACCP concept and ensure the safety of the food produced, some changes are required in the production process.

Noni juice is a drink made from ripe noni fruit. According to Sari (2015), this fruit contains scopoletin, which can reduce high blood pressure. It has antithrombotic, antioxidant, analgesic, and anti-inflammatory benefits and can lower blood pressure (Rosida et al., 2020). Consumers of this product generally like or have realized the importance of consuming healthy foods. The HACCP team has developed the product description by adjusting SNI 01-4852-1998. It explains the product's composition, physical/chemical structure, treatment and packaging (Wicaksani & Adriyani, 2017).

Table 1. Product description

Product name	**: Noni Juice Drink**
Composition	: Noni fruit (ripened)
Treatment	: Curing, Squeezing
Packaging	: Glass bottle 500ml, second pack: cardboard box, six bottles each
Distribution	: Hi-lift truck

Currently, UD. Manjur Makmur has not yet implemented the HACCP system. Recognizing the importance of guaranteeing the implementation of a quality management system and food safety in the company and responding to the widespread issue of the use of hazardous additives in the food industry and the demand for food safety assurance from customers based on the HACCP system (Perdana, 2018), the management of UD Manjur Makmur wishes to implement the HACCP system. The aim of this research is to establish a HACCP study in UD Manjur Makmur.

METHODS

This study was conducted in a Noni Juice Drink Plant in Lumajang, East Java. The case study company is categorized as a small-scale industry with a production capacity of under one ton per day and a total number of employees under 100.

The initial step to establish a HACCP system in the noni juice production line at UD Manjur Makmur Lumajang is to collect information related to the process, equipment and process conditions, physical, chemical, and microbiological properties of all raw materials used in the process to produce the final product. The essential step for establishing a HACCP system is the development of a flow chart of the production process (Figure 1).

Figure 1. Flowchart of Noni Juice Drink Production Process at UD Manjur Makmur Lumajang

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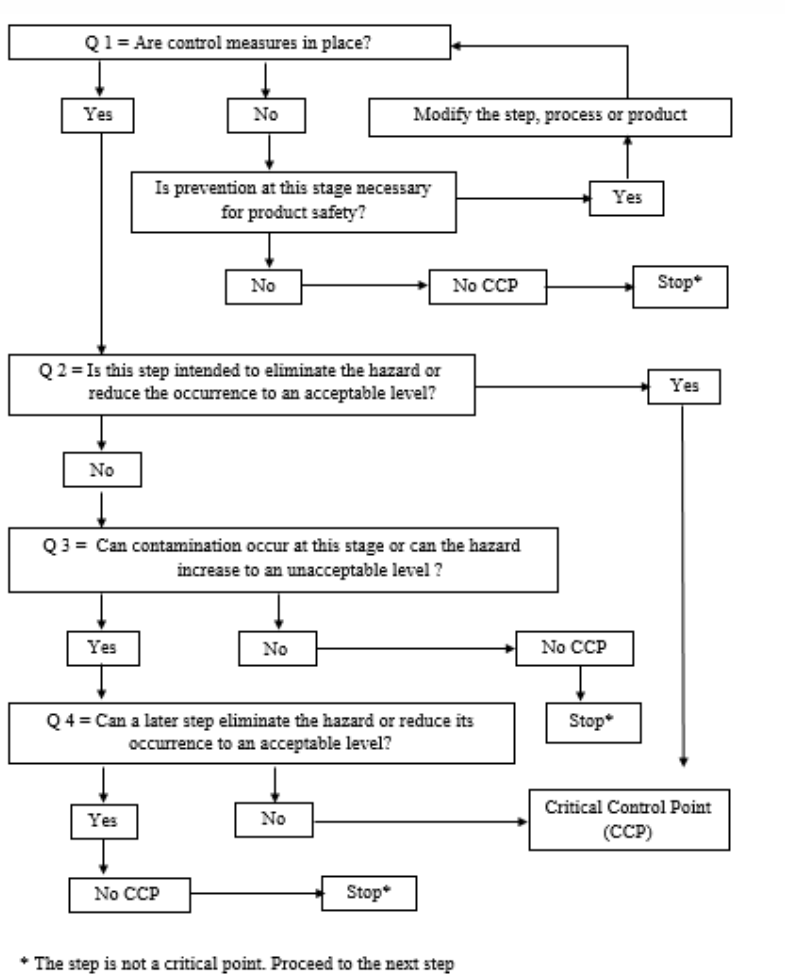

Figure 2. CCP Decision Tree (Jean-Marc et al., 2019)

After determining, reviewing and verifying this diagram, process revisions are carried out to reduce the possibility of contamination hazards that may arise, then determine the potential physical, chemical or biological hazards that can damage food safety. A set of precautions is defined to be implemented to reduce or eliminate the hazards identified in the previous step. After that, the critical control point (CCP) is determined using a decision tree or sequence showing a logical reasoning approach as a recommendation for improvement by the business owner. The decision tree (Figure 2) is used to identify the Critical Control point (CCP) (Alin & Siddika, 2014). CCP is the step where control can be applied and needed to eliminate the danger or reduce it to a safe point (Leuw & Widiawan, 2017).

The monitoring system is designed to make it possible to detect potential changes and to measure or schedule CCP observations according to their critical limits. A critical limit is determined for each stage that is considered a CCP. Above or below this limit, the process is considered unacceptable for ensuring food safety.

Further, specific corrective actions for each CCP are formulated to deal with deviations when they occur. Finally, a documentation and records system is established to document all procedures of the HACCP system and all records required to implement the HACCP system properly.

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RESULTS AND DISCUSSION

Hazard analysis, according to HACCP, has been applied to determine the food production chain that can cause food safety problems. The danger that can be caused is the presence of biological, chemical, or physical contamination in food. In addition, other hazards include the growth of microorganisms or unwanted chemical changes during the production process and cross-contamination of intermediate products, finished products, or the production environment (Saptoningsih, 2020).

Tables 2 and 3 have provided a summary of the main hazards that can occur at each stage of the manufacturing process. It has identified the nature of the hazard (physical, chemical, or microbiological) and precautions that should be considered to minimize or eliminate the hazard.

Following the implementation of the decision tree, the phases considered to be CCPs have also been presented, with crucial limitations, the necessary monitoring to demonstrate that the CCP is under control, specific corrective actions, and documented evidence to record. During the decision-making process, all incidents and corrective actions while monitoring CCP procedures were also logged, and the names of the responsible employees were recorded (Lesmana et al., 2019).

Table 2. Application of HACCP Concept in Noni Juice Production Line at UD. Manjur Makmur Lumajang (Hazard and Precautions)

Work Station	Stage	Hazard Type			Hazard	Precautions
		Physique	Chemistry	Biology		
Material Receipt	1. Noni fruit sorting			X	Presence of pathogenic microbes on noni skin	Sorting rotten, damaged and defective noni fruit
			X	X	Poor hygiene and sanitation conditions of the receiving room.	Implementation of the cleaning and disinfection plan
Raw Material Wash	2. Washing the sorting material		X	X	Contamination by inadequate water quality	Ensure the quality of PDAM water received
	3. Drain			X	Lack of cleanliness in personnel/container/buckets	Minimize personnel transit within plants, and use PPE
	4. Arrange noni fruit in pails/containers/buckets			X	Lack of cleanliness in personnel/container/buckets	Minimize personnel transit within plants, and use PPE
		X	X	X	Dirt (insects, dust, etc.)	Implementation of the packaging room cleaning and disinfection plan
	5. Bucket container closure			X	Lack of cleanliness in personnel/container/buckets	Minimize personnel transit within plants, and use PPE
Curing	6. Storage in the Curing/ Fermenting Room			X	Microbiological contamination of the product during ripening	Application of cleaning and disinfection and ignition of the UV lamp of the fermentation chamber
		Hazard Type				

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	Stage	Physique	Chemistry	Biology	Hazard	Precautions
	7. Harvesting			**X**	Lack of personnel cleanliness and skills	Minimize the number of personnel who participate in harvesting and are adequate in their harvesting skills, using PPE
	8. Sorting			**X**	Pail sorting can cause contamination	The application of rules that enter the process room only those who pass the sorting, those who do not pass remain outside the room
Squeeze/ Filtration	9. Open the seal / isolation tape	**X**		**X**	The fermented product may have been contaminated	Inspection of fermentation results according to the requirements of good fermentation results
	10. Pouring into the press	**X**	**X**	**X**	Heavy metal contamination, dirt and microbes from pressing equipment	Application of supervision of equipment and room conditions
	11. Extortion process			**X**	Microbial contamination can still occur	Application of supervision of equipment and room conditions
	12. Room & bottle sterilization with UV lamp					
Sterilizing & Packaging	13. Packaging	**X**	**X**	**X**	Inadequate cleaning of the installation and use of non-recommended products (settling chemical residues)	Implementation of an adequate cleaning and disinfection plan
	14. Brand labelling and expiration date	**X**	**X**	**X**	Lack of personnel cleanliness and skills	Minimize the number of personnel who participate in the packaging process and are adequate in their skills
	15. Packing in a carton container	**X**	**X**	**X**	Lack of personnel cleanliness and skills	Minimize the number of personnel who participate in the packaging process and are adequate in their skills
Warehousing / Display	16. Storage or Warehousing and Display	**X**	**X**	**X**	Unhygienic installation conditions and poor sanitation	Implementation of the cleaning and disinfection plan

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Table 3. Application of HACCP Concept in Noni Juice Production Line at UD. Manjur Makmur Lumajang (CCP, Critical Limit, Monitoring, Corrective Action and Record)

Work Station	Stage	Hazard Type			CCP	Critical Limit	Monitoring / Frequency	Corrective Action	Record
		Physique	Chemistry	Biology					
Material Receipt	1. Noni fruit sorting			**X**	Yes	- Mold: negative, - ALT max: 2x105 colony/gram, - *Escherichia coli*: <3 APM/gram, - *Salmonella* and *Vibrio cholera*: negative, - *Staphylococcus aureus*: max 100 colony/gram	Microbiological analysis of noni fruit	Dispose of contaminated fruit	Analysis completed
Raw Material Wash	2. Washing the sorting material		**X**	**X**	No	-			
	3. Drain		**X**	**X**	No	-			
	4. Arrange noni fruit in pails/containers/buckets	**X**	**X**	**X**	No	-			
	5. Bucket container closure			**X**	No	-			
Curing	6. Storage in the Curing/ Fermenting Room			**X**	No	-			
	7. Harvesting			**X**	No	-			
Squeeze/Filtration	8. Sorting			**X**	No	-			

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Work Station	Stage	Hazard Type			CCP	Critical Limit	Monitoring / Frequency	Corrective Action	Record
		Physique	Chemistry	Biology					
	9. Open the seal/ isolation tape	**X**		**X**	Yes	- Mold: negative, - ALT max: $2x10^5$ colony/gram, - *Escherichia coli*: <3 APM/gram, - *Salmonella* and *Vibrio cholera:* negative, - *Staphylococcus aureus:* max 100 colony/gram - Physical container deflates not inflated	Microbiological analysis and scent	Removing of damaged pail	Analysis complete
	10. Pouring into the press	**X**	**X**	**X**	Yes	- Mold: negative, - ALT max: $2x10^5$ colony/gram, - *Escherichia coli*: <3 APM/gram, - *Salmonella** and *Vibrio cholera*: negative, - *Staphylococcus aureus*: max 100 colony/gram - Arsen: max 0,1mg/kg, - Timah (Sn): max 40 mg/kg, - Timbal (Pb): max 0,5 mg/kg, - Mercury: max 0,5 mg/kg	Microbiological and chemical analysis of the extortion	Dispose of contaminated process batches	Analysis complete
	11. Extortion process			**X**	No	-			
Sterilizing & Packaging	12. Room & bottle sterilization with UV lamp				No	-			
	13. Packaging	**X**	**X**	**X**	No	-			

Work Station	Stage	Hazard Type			CCP	Critical Limit	Monitoring / Frequency	Corrective Action	Record
		Physique	Chemistry	Biology					
Warehousing/ Display	14. Brand labeling and expiration date	**X**	**X**	**X**	No	-			
	15. Packing in carton container	**X**	**X**	**X**	No	-			
	16. Storage or Warehousing and Display	**X**	**X**	**X**	No	-			

Minimize potential hazards to an acceptable level. Only stages 1 (noni fruit sorting), 9 (opening or separating the seal), and 10 (pouring into the press) can be considered CCPs. The next stage is to implement the HACCP system requirements properly: water management plan, cleaning and disinfection plan, management plan, maintenance plan, insect and rodent management plan, supplier management plan, traceability management plan, and waste management plan can help implement a prevention or waste management plan. The hazards, precautions, limits, monitoring, corrective actions, and notices associated with each layer considered a CCP are described below.

Stage 1: Noni Fruit Sorting

Noni fruit obtained from several suppliers has been sorted to ensure that only good noni fruit will be included in the production process. The characteristics of a good noni fruit as a raw material for noni juice drinks are the distinctive aroma of ripe noni fruit, such as rotten cheese or the smell of goats from mixing between capric acid (C10), caproic acid (C6). , and caprylic acid (C8). According to (Muslim & Habibi, 2020), noni fruit contains triterpenoid alkaloids, acubin, asperuloside, alizarin, ascorbic acid, caproic acid, capric acid (causes terrible odour in fruit), caprylic acid (causes bad fruit taste), anthraquinone substances, protein, proxeronine, xeronine, scolopetin substances, and damnachantal substances (anti-cancer substances). In addition to the distinctive odour of the noni fruit, the fruit must be unblemished, yellowish white or pale white, undamaged and without black spots due to rot.

The main danger at this stage is the presence of pathogenic microorganisms on rotten or physically deformed fruit. These microorganisms can come from soil or dirty transportation processes. Other hazards at this stage can be eliminated or minimized to an acceptable level through planning included in the HACCP system requirements. Precautions are required. It means that each supplier takes incoming noni-fruit samples for microbiological analysis. The

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reception must be held in a clean place. With this in mind, a proper hygiene and disinfection program should be implemented.

Critical limits have been set according to the type of pathogenic microorganisms present in the sample, namely: fungi must be negative, maximum plate number (ALT): 2x105 colonies/gram, Escherichia coli bacteria below 3 APM/gram, Salmonella and Vibrio cholera must be negative, and the presence of Staphylococcus aureus is a maximum of 100 colonies/gram.

Monitoring. Noni fruit samples were analyzed from a microbiological point of view before starting the cultivation cycle.

Corrective action occurs when a pathogenic microorganism is detected. Samples and all materials from the same supplier should be discarded and replaced with another noni fruit of acceptable microbiological quality. The establishment of verification measures is very helpful to ensure and ensure that the HACCP program is implemented according to the plan (Citraresmi & Putri, 2019).

Notes. The analysis carried out on the noni fruit was registered. Incidents during this stage and corrective actions that have been implemented should be recorded in full. A documented system is not only needed if the HACCP system can be implemented but is carried out or implemented for the company's verification and review process activities against the HACCP plan system (Prayitno & Tjiptaningdyah, 2018).

Stage 9: Sealing or Isolation

At this stage, the seal or isolation of each non-ripe container was opened, and the contents of the noni fruit were observed. Good noni fruit ripening characteristics can be seen from the container or pail; the container is shrinking or crumbling, not bubbling, producing gas caused by decay. Then the smell generated is a characteristic odour of ripening that is not sharp and tends to be fragrant. The colour of the liquid is black, with a small amount of sediment.

The main danger of this stage is that aberrant ripening products have been found, which can contaminate other ripening products. Contamination can come from the curing process due to leakage in the container and the curing temperature being too high. Alternatively, the effect of unclean cleaning is that microbial contaminants can thrive.

Preventive measure. If the container is swollen or the smell does not match the characteristic odour of ripe noni, a microbiological analysis should be conducted to detect pathogenic microbes. The noni fruit has been brushed and washed thoroughly before placing in the container to ensure optimal hygienic conditions, as well as the container, has been cleaned and disinfected. The seal opening or isolation has been avoided simultaneously by filling the noni fruit into the same container and in the same room so that cross-contamination can be prevented. Contamination rates will be significantly reduced when personnel in direct contact with materials in the process are concerned about maintaining clean conditions. The use of clean clothing and footwear will be a precautionary measure. The installation of insect traps that are applied will prevent the presence of pests in the process room. Adequate control of air temperature and humidity has been recorded regularly.

The critical limits were determined according to the type of pathogenic microorganism present in the curing container or sample, namely fungi must be negative, maximum total plate number (ALT): 2x105 colonies/gram, *Escherichia coli* bacteria below 3 APM/gram, *Salmonella* and *Vibrio cholera* must be negative and the presence of *Staphylococcus aureus*

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maximum of 100 colonies/gram. The possibility of heavy metal contamination from pressing equipment and machines has also been anticipated.

The recording of filling and pressing operations has been synchronized to avoid overlapping in the production process.

Monitoring. The curing results were analyzed microbiologically before starting the pressing process.

Corrective action. When pathogenic microorganisms are detected, the deviated press in one container must be discarded and replaced with another with acceptable microbiological quality.

Notes. Microbiological analysis results with unexpected results should be recorded appropriately over a regular period. Incidents during this stage and corrective actions implemented should be recorded clearly.

Stage 10: Pouring into the Press

At this stage, the fruit and the substrate that follows as a result of ripening were put into the press. Press tools in direct contact with the material being pressed must be made of rust and acid-resistant materials, non-porous and free from components that can quickly come off.

The main danger at this stage can come from the material of pressing tools and machines, supporting equipment such as filter cloths, oil and cleaning agents used for equipment maintenance. It is undeniable that because the curing process is open, contamination from the process room can occur, especially from the dangers of microorganisms.

Preventive measure. The application of pressing equipment maintenance and room sanitation must be planned, especially before the pressing process is carried out.

Critical limit. Recording of filling and discharging operations will synchronize these operations to avoid overlapping in the production process. The critical limits were determined according to the type of pathogenic microorganism present in the pressing device and the storage container for the pressing results, namely, fungi must be negative, maximum total plate number (ALT): 2x105 colonies/gram, Escherichia coli bacteria below 3 APM/gram, Salmonella and Vibrio cholera must be negative and the presence of Staphylococcus aureus maximum of 100 colonies/gram. The critical limits of heavy metal contamination were also determined as follows: the presence of metal arsenic (As), a maximum of 0.1 mg/kg; tin (Sn), a maximum of 40 mg/kg; lead (Pb): a maximum of 0.5 mg/kg and mercury or mercury (Hg) a maximum of 0.5 mg/kg.

Monitoring. The pressing results in a container of pressing results were analyzed for microorganisms and tested for heavy metal content before entering the next stage, namely the packaging stage.

Corrective action. When pathogenic microorganisms and heavy metals were detected, the deviated pressing product in one container must be discarded and replaced with another with acceptable microbiological and physical quality.

Notes. The results of microbiological analysis and heavy metal tests with unexpected results must be appropriately recorded over a regular period. Incidents during this stage and corrective actions implemented should be recorded clearly.

CONCLUSION

The application of food safety based on HACCP (Hazard Analysis Critical Control Point) has been carried out on the noni juice production line. It is so that these products can be sold on a broader scale, including online sales. Applying the HACCP principle will allow more accurate control of the noni juice production process and prevent excessive control of the final product. From all stages of the production process, critical control points (CCPs) to be considered are: sorting of material receipts (activity 1), washing of noni fruit (activity 2), arrangement in bucket containers (activity 4), harvesting (activity 7), sorting of crops (activity 8), opening the seal (activity 9), pouring into a press machine (activity 10), squeezing process (activity 11), packaging into bottles (activity 13), labelling (activity 14), carton packaging (activity 15) and storage (activity 16). The main hazards as CCPs have been found in activity 1 (sorting), activity 9 (unsealing) and activity 10 (casting in press).

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