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Implementation of hazard analysis and critical control point (HACCP) in dried anchovy production process

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Abstract. The aim of this study was to inspect the implementation of Hazard Analysis and Critical Control Point (HACCP) for identification and prevention of potential hazards in the production process of dried anchovy at PT. Kelola Mina Laut (KML), Lobuk unit, Sumenep. Cold storage process is needed in each anchovy processing step in order to maintain its physical and chemical condition. In addition, the implementation of quality assurance system should be undertaken to maintain product quality. The research was conducted using a survey method, by following the whole process of making anchovy from the receiving raw materials to the packaging of final product. The method of data analysis used was descriptive analysis method. Implementation of HACCP at PT. KML, Lobuk unit, Sumenep was conducted by applying Pre Requisite Programs (PRP) and preparation stage consisting of 5 initial stages and 7 principles of HACCP. The results showed that CCP was found in boiling process flow with significant hazard of *Listeria monocytogenesis* bacteria and final sorting process with significant hazard of foreign material contamination in the product. Actions taken were controlling boiling temperature of 100 – 105ºC for 3 - 5 minutes and training for sorting process employees.

1. Introduction

Indonesia is the largest archipelago in the world, therefore, fish become one of enormous marine commodities. Fish production in Indonesia is steadily increasing up to 2.87% annually [1]. Anchovy is one of the promising fish commodities. Anchovy production was increased up to 11.89% in 2000-2010. Moreover, exported anchovy was also elevated up to 50% in 2015 [2]. Anchovy contribute significantly to the economy [3]. It was due to its simple catching operation, processing, as well as a high selling price [4]. Anchovy is delicious and nutritious with a relatively high protein and calcium content [5]. Anchovy can be considered as perishable food. Its small size renders it to be more susceptible to contamination and quality degradation [6]. Furthermore, in order to assure the dried anchovy product's quality, good handling and proper processing methods are required [7]. Those are including raw material handling and production process. A proper production technique and knowledge are also required to prevent either harmful or deteriorating bacteria contamination in dried anchovy product [8]. Therefore, quality assurance system is important to be implemented. One of the widely used quality assurance system is Hazard Analysis and Critical Control Point (HACCP)

HACCP is a quality assurance system to identify, assess and control potential hazard as well as prevention-focused control system [9]. HACCP purpose is to prevent known potential hazard (biological, chemical and physical hazard) as well as hazard occurrence risk reduction by controlling

each critical point of production process [10]. HACCP is applied in every step of the production (process) of dried anchovy [11].

2. Materials and Methods

This research was conducted in PT. Kelola Mina Laut Lobuk, Sumenep in February 2017. Materials used were fresh anchovy, salt, ice block and plastic packaging (PP plastic). Equipments used were conveyor, steam boiler, boiler machine, vacuum machine, blower, dryer, vibrator, sizing machine, scales, trolley, basket, sorting desk, brush, pallet, tray, and cold storage. Methods used were consisted of: interview and observation, documentation for supporting data as well as microbiological and chemical assay. This study used HACCP method divided into initial and application stages. The initial stage consisted of 1. Creating a HACCP team. 2. Preparing a product description. 3. Identifying of consumer. 4. Arranging process flowchart. 5. Verifying process flowchart. The HACCP system was based on seven principles as follow: 1. Conduct a hazard analysis. 2. Determine the critical control points (CCPs). 3. Establish target levels and critical limit(s). 4. Establish a system to monitor the CCPs. 5. Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control. 6. Establish procedures to verify that the HACCP system is working effectively. 7. Establish documentation concerning all procedures and keep records in accordance to these principles and their application [12]

3. Results and Discussion

3.1. The initial stages of HACCP method in dried anchovy production

3.1.1. Assembling HACCP team

HACCP team members consisted of: food safety team leader, business manager, head of certificate and documentation, factory manager, production supervisor, head of quality control and sanitation, head of procurement division, head of Human Resource and Development and head of technical division. HACCP team is responsible for arranging HACCP plan, supervising HACCP implementation as well as verifying and implementing HACCP system.

3.1.2. Product description and identification of consumer

Product description of dried anchovy can be seen in Table 1.

Table 1. Description product of dried anchovy.

Product and Species Name	dried anchovy (*stolephorus sp)*
Composition	anchovy and salt
Processing Stages	reception, washing, boiling, drying, sorting, sizing, final sorting, product weighing, packaging and labelling, storing under low temperature (cold storage), loading and export
Packaging Type	packed in pp plastic bag (polypropylene) then put into master carton (mc), with packing 5 kg per mc
Storage and shelf life	the product is stored in cold storage (minimum temperature is -10^0c). the shelf life up to 24 months (at -10^0c)
Label Specification	company name, product type, product size, net weight, area code, and production date
Purpose of Product Use	general consumption (infant excluded)
Instructions for Use	ready to be cooked or fried before serving

Source: PT. KML unit Lobuk, Sumenep (2017)

3.1.3. Arranging process flowchart

Flowchart of dried anchovy production and the CCP determination is shown in Figure 1.

3.1.4. Verifying process flowchart

Verification was conducted by reviewing the production process, coordinating with production operator to adjust the flowchart with actual condition in the field as well as doing a sample assessment in order to confirm the arranged flowchart diagram precision as compared to actual condition in the field. If there is flowchart application unconformities found, then flowchart modification or refinement must be conducted. However, if the flowchart has successfully been applied to the process and verified, then the documentation process regarding the flowchart application should be made. Quality standard of semi-dried anchovy based on SNI 01-3461-1994 is shown in Table 2.

Table 2. Quality standard of semi-dried anchovy.

Type of Test	Unit	Quality Req
Organoleptic, min		7
- Mold		-
Microbiology		
- ALT, Max	colony/gram	$2x10^5$
- *Escherichia coli*	APM/gram	<3
- *Salmonella* and Vibrio cholera**	Per 25 gram	Negative
- *Staphylococcus aureus* positive coagulation, max	colony/gram	100
Chemical Content		
- Water	% weight / weight	30-60
- Ash content and Arsenic, max	% weight / weight	1
- Salt, max	% weight / weight	15
- Tin / Sn, max	mg/kg	40
- Lead / Pb and Mercury,max	mg/kg	0,5
- Zinc, max	mg/kg	100,0
- Copper, max	mg/kg	20,0
Physical : Net weight		In accordance with the label

Source: National Standardization Agency (1994) [13]

3.2 The application of HACCP principles in dried anchovy production

3.2.1 Hazard Analysis

HACCP team needs to consider the probability of each identified hazard and its severity level which can be determined by observing the effect to the consumer health or company reputation. The result of the identification will be used to determine the control action should be performed for each corresponding hazard possibilities. Since dried anchovy product is attached to an E hazard category, its hazard level can be categorized as low (Category 1). An E Hazard category is defined as every hazard occurrence due to the distribution or product handling errors by consumer. Potential hazard occurred in distribution process was caused by inappropriate storage temperature (-10 ^oC). This error may affect product freshness and shelf life. Inappropriate storage temperature may result in reduction in product shelf life and elevated deterioration level when the products reach the consumer due to product quality degradation.

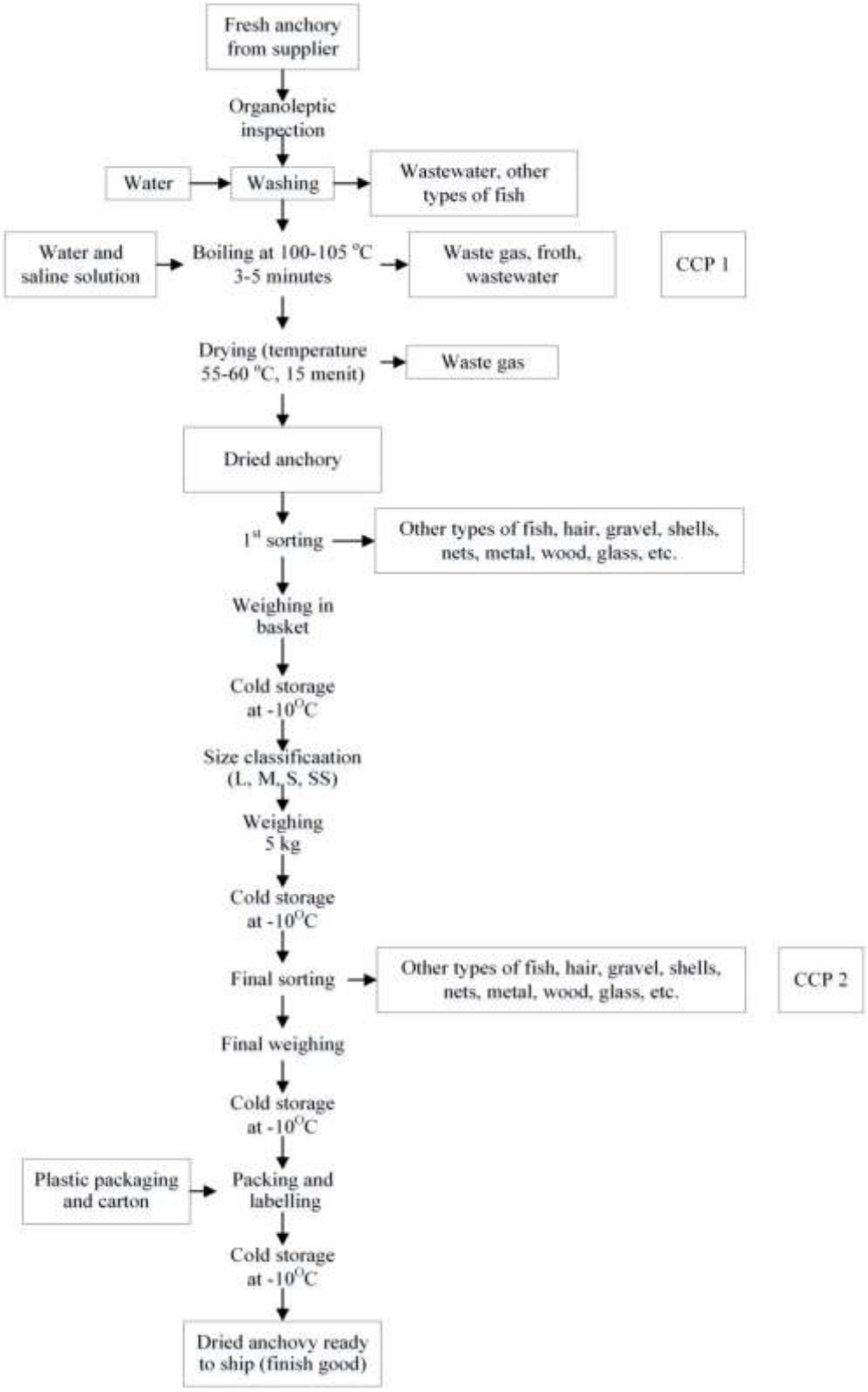

Figure 1. Flowchart diagram of dried anchovy production CCP determination

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Table 3. Hazard analysis of dried anchovy handling and processing.

CCP	Significant Hazard	Critical Limit	*Monitoring*					Correction action	Verification	Documentation
			What?	When?	Where?	Who?	How?			
Boiling	*Listeria monocytogenes*	boiling temperature not less than the standard (100 - 105ºC)	Boiling temperature and time	Every 1 hour	At boiling panel	QC Staff	Visual temperature and time monitoring in boiling panel	If the temperature and time used does not match to the standard, every batch production must be repeated	Review the monitoring process and final product pathogenic bacteria assessment as well as regular thermometer calibration	Control form of boiling and drying
Final sorting	Pebble, glass, plastic, metal, woods etc.	No foreign contaminant detected	Foreign contaminant	Continually as the process undergoes	Final assessment chamber	Examiner	Visually examining part by part of the product	Taking the foreign contaminant	Reviewing the data	Control form of foreign contaminant
	Residues from other types of fish	No mixed species	Mixed with other fish species	Every single *batch*	*Packing room*	Examiner	Visually examining	Taking the other types of fish	Reviewing the control data	Control form of foreign contaminant

Source: PT. KML Lobuk, Sumenep (2017)

3.2.2. Determining the Critical Control Point (CCP)

Based on the flowchart of dried anchovy production and its CCP determination (Figure 1), CCP of dried anchovy production process lies to its boiling and final sorting process. The potential hazard occurred at boiling process was microbiological contamination. Hazard may occur due to improper temperature of boiling process (standard: 100-105 ^{o}C for 3-5 minutes). If the temperature used less than 100 ^{o}C, it will lead to pathogenic bacteria growth, especially *Listeria monocytogenesis* [14]. This pathogen may cause listeria foodborne illness (listeriosis) [15]. If the temperature increases beyond 105 ^{o}C, the product may become mushy and fragile. In other words, it will be physically deteriorated. Proper controlling actions for this process are temperature and duration in hour basis. This controlling action will be conducted for every batch. This can be done by a proficient operator using temperature control instrument and thermometer at boiling machine.

In final sorting process, there is significant hazard in the form of foreign contamination to the product. The foreign contaminant can be found as metal flakes etc. If there is inconsistent process in the final sorting process, then it must be repeated by sorting operator. Sorting supervisor is responsible for checking the sorted product by analysing the sample. The dried anchovy was sorted on a white – coloured board to easily find and remove contamination.

3.2.3. Establishing critical limit, monitoring procedure determination, and establishing correction actions

CCP limit of the dried anchovy product is described in detail for each CCPs. Temperature and contaminants are the major factors which significantly affect the product quality and safety. Monitoring is done by using 4W+1H rule (*What, Where, Who, When (Frequency),* and *How*). Boiling temperature and time are supervised using temperature control and temperature measurement using thermometer in the boiling machine. Contamination of foreign materials is checked by contaminant documentation. Every contaminant must be documented as the evidence for the anchovy supplier. It must be conducted in order to evaluate the process as well as to prevent the similar incidence in the future. Correction actions are obligatory to be done when there is lost control found in monitoring process. Critical limit of boiling process is 100-105^{0}C and critical limit of final sorting process is that the products are free from contaminant, etc. If there are any unconformities in the process, for example boiling temperature deviation, the operator must be informed to do immediate adjustment. If the unconformities occur in the final sorting process, the sorting supervisor must order other sorting process until the products are free of contaminant. Limit determination of dried anchovy product, monitoring procedure determination, and correction actions are shown in Table 3.

3.2.4. Establishing procedure of HACCP verification process

Internal verification is done by food safety team leader every 6 months. Verification is conducted by examining the conformity between manual book and the actual condition in the field. External verification is conducted by the authority, or HACCP system certification agency in a year basis.

3.2.5. Establish proper documentation and record keeping

Documentation of dried anchovy product processing include every remark about CCP, critical limit, monitoring record, correction action conducted in response to occurred unconformities and remarks about verification process. The documentation is conducted in monitoring process. The documentation data are shown to the food safety inspector while the company undergoes external audit. These data may also be used by the operator to supervise the HACCP implementation process.

4. Conclusion

In order to maintain the dried anchovy product's quality and safety, PT. KML Lobuk Unit, Sumenep ensure the implementation of HACCP analysis. Based on the research, dried anchovy production process CCPs lies in the boiling and final sorting process. Prevention action are conducted by the

company using thermometer on the boiling machine and controlling temperature at 100-105^{o}C for 3-5 minutes, as well as ensuring the proper re-sorting process which is done by sorting operators.

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