HACCP Plan of Frozen Milkfish Satay for Supporting Cold Chain Management in PT. Agrobisnis Banten Mandiri (Perseroda)

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Abstract. Banten has abundant fish resources with 499.62 km coastline length. Fish is perishable food with short shelf life. Freezing is alternative process to maintain quality of fish. PT. Agrobisnis Banten Mandiri (PT. ABM) has a mission to be distribution center in Banten Province. One of distributing commodity PT. ABM is frozen fish (frozen milkfish satay). Good practices of processing and distributing were needed to maintain quality. Hazard analysis critical control point (HACCP) management system can be applied to prevent damage due to improper production process. Cold chain management can maintain quality in distributing frozen fish. This researched was aimed to design HACCP plan of frozen milkfish satay for supporting cold chain management in PT ABM. The collecting data was done by observation, in-depth interview, documentation review, and literature review. Results of this study are hazard analysis and determine critical control point (CCP) for the product.

Keywords: Cold Chain · Frozen Fish · HACCP · Milkfish satay

1 Introduction

Banten Province has a strategic marine position with three different types of waters, namely the Java Sea, the Sunda Strait, and the Indian Ocean. Banten Province is very potential in its fisheries sector with a coastline length of 499.62 km [1]. Fishery productivity in Banten Province reached 142,861,451 tons/year in 2018 by the Department of Marine Affairs and Fisheries [2]. One of the leading fish in Banten Province is milkfish. The productivity of milkfish in Banten province reached 3,553.59 tons in 2018 [3]. Milkfish can be processed into various foods, one of which is milkfish satay. Milkfish

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satay is a typical food of Banten made from mashed milkfish meat with a mixture of herbs and spices. Milkfish satay emerged from the era of the Banten sultanate with the intention of entertaining the guests, so that they could eat milkfish without having to bother with the thorns [4]. Milkfish satay is one of the fishery products that have juicy characteristic even though it has been burned in its processing, so this milkfish satay will be easily rotten [5]. Milkfish satay has water content of 44.89% and contains nutrients that can be a good substrate for the growth of spoilage microbes [4]. Quality of milkfish satay can be maintained with proper handling.

Proper handling from the process of selecting raw materials to industrial or household processing is very necessary. Knowledge of the condition of fish is one of the basics in maintaining the quality of fishery products. Proper handling must be done, to ensure the shelf life of milkfish satay to keep the supply chain cold [5]. Cold Chain is part of the supply chain which aims to maintain the temperature so that the product is maintained during the distribution. In getting a good cold chain system, the following four criteria must be met, including Handling during initial processing, Storage and processing upon arrival on land, Handling during transportation to the destination, and handling during loading and unloading and distribution systems to consumers. Freezing is one of the efforts used in the cold supply chain management system [6].

Freezing is a method of storing food stuffs in a frozen state, to suppress enzymatic and chemical reactions that cause spoilage in foodstuffs. Freezing can inhibit the decay process, where this method can inhibit the activity of microorganisms [7]. During freezing, the water contained in the fish meat is converted into ice crystals. In practice, it is very difficult to freeze all the liquid in the fish's body because some of the liquid has a very low freezing point, which is between -55°C to -65°C. Freezing to - 12°C or -30°C is generally considered sufficient, depending on the planned timeframe [5]. In carrying out the freezing stage of fish products in the industry, we must pay attention to the food safety system to maintain the quality of the frozen fish products produced, one way to ensure that the product has food safety and high quality is in the production stage to implement the HACCP system.

HACCP (Hazard Analysis Critical Control Point) is a food safety assurance system based on an awareness that hazards can arise at various points or stages of production, and control must be carried out to prevent these hazards from occurring [8]. The main keys to HACCP are hazard anticipation and identification of critical control points [9]. The purpose of this research is to design a frozen milkfish satay HACCP plan to support cold chain management at PT ABM.

2 Method

A. *Time and Place*

This research was conducted in October 2021, which was conducted at PT. Agribusiness Banten Mandiri (PT.ABM) in a warehouse and distribution center located on the highway Cilegon, Drangon, Taktakan District, Serang City, Banten Province. The research method used is a descriptive method with a qualitative approach. Qualitative research is the result of research and is descriptive in nature, the data results are in the form of interview transcripts, notes, and field documentation. Qualitative research can clearly describe the problems contained in the study [10].

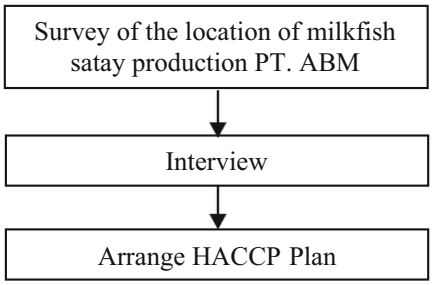

Fig. 1. Flow diagram of research design

B. *Research Design*

This research was carried out with the initial stages of field observations, interviews and surveys of the suitability of the location with several aspects that had been prepared (Fig 1).

C. *Collecting Data*

The stages of data collection include observation, interviews, and documentation [11]. Observation was held in warehouse location and distribution of the Agro-hub Serang. Then, interview was held with department from PT. ABM that handle the production of frozen milkfish satay. Documentation of the conditions and activities that will be carried out in the location of frozen milkfish satay production.

3 Result and Discussion

PT. ABM or PT. Banten Mandiri Agribusiness (Persero) is domiciled as a BUMD of Banten Province. PT. ABM was established based on the Banten Province Regional Regulation Number 11 of 2019 with the aim of improving the character, capacity, and standard of living of farmers/breeders as well as the Banten community by way of downstream processing of Banten food products, downstreaming of Banten food products with agro- industry, and increasing the Banten Regional Budget. The core business of PT, ABM consists of three elements including Farm, Food, and Mart. ABM Farm creates agricultural and livestock production infrastructure to produce sustainable and empowering food commodity production in a business ecosystem, one of which is integrated fisheries.

In integrated fisheries, PT. ABM has frozen fish products (frozen milkfish satay). In order to maintain quality and safety, frozen milkfish satay must be treated properly. One of the treatments is applying the HACCP system to frozen milkfish satay.

The HACCP system was first developed by three food company institutions including the Pillsbury Company in collaboration with NASA (The National Aeronautics and Space Administration) and the US Arm's Research and Development and Engineering Center around the 1960s. The initial project of the HACCP concept was carried out in order to ensure the food supplies for the (Daulay) residents. The initial concept of HACCP

was developed foods that are free from pathogenic and spoilage bacteria and are also known as the "zero-defects" program [12]. The implementation of the HACCP system in the food industry requires a high commitment from the management of the company. In addition, in order for the implementation of HACCP to be successful, companies need to meet the basic prerequisites of the food industry, such as Good Manufacturing Practices (GMP) and Standard Sanitation Operational Procedure (SSOP). The implementation of HACCP must require cooperation and a strong commitment from all elements to realize the right HACCP goals [13].

The HACCP system has been widely adopted worldwide by organizations such as Codex Alimentarius (UN commission) and European Union (European Union) and by several countries including Canada, America, Australia, New Zealand, and Japan. In 2005, ISO published the ISO 22000 standard which contains clauses on a HACCP-based security assurance system [8]. The Codex Alimentarius Commission in 1993 adopted this HACCP system which was later refined in 1996, has compiled guidelines for implementing HACCP with systematic implementation steps in 12 steps, consisting of five initial steps of preparation and followed by seven subsequent steps (Fig 2).

Step 1, Assemble HACCP Team and Identification of Scope. The HACCP team usually consists of 6 people. Team members are selected based on their competence and are involved in routine food production activities. Team members according to educational/academic/skills background (multidisciplinary): may consist of personnel from production, sanitation, QA, lab, engineering department, and so on. HACCP team in ABM already formed.

Step 2, Describe the product. A complete description of the product should be described, including relevant safety information such as composition, physical or chemical characteristics of the product either physical or chemical processing method or technology used in production, packaging, durability or shelf life, storage conditions, and distribution methods. Frozen milkfish satay, consist of milkfish, spices, and egg. This product had 2 allergen ingredients (milkfish and egg). This product is vacuum packaged and have one week shelf life, distributed with cold system. Step 3, Identifying users of the product needs. Frozen milkfish satay can be consumed by all ages.

Step 4, A flow chart, covering all the steps in the production, including applicable rework, should be drawn up. The flow chart should show all inputs, including food, water, and air contact materials and materials where relevant. Complex manufacturing operations can be broken down into smaller, more manageable modules, and multiple interconnected flowcharts can be developed. Flowcharts should be used when conducting a hazard analysis as control of possible hazards that can occur. The flow chart must be clear how the activities of the production process from start to finish.

Step 5, verification of the flow chart as the next step to confirm all real time processing activities against the flow chart during the production process. Flow chart can be changed if it is not appropriate. Confirmation of the flow chart should be carried out by a person that had knowledge of processing operations. The flow chart that already verified of making this milkfish satay can be seen in the following flow chart in Fig 3.

Step 6 goes to principle 1 which is hazard analysis which consists of identifying potential hazards and evaluating these hazards to determine which ones are significant for a particular food business operation. All potential hazards at each stage of the process

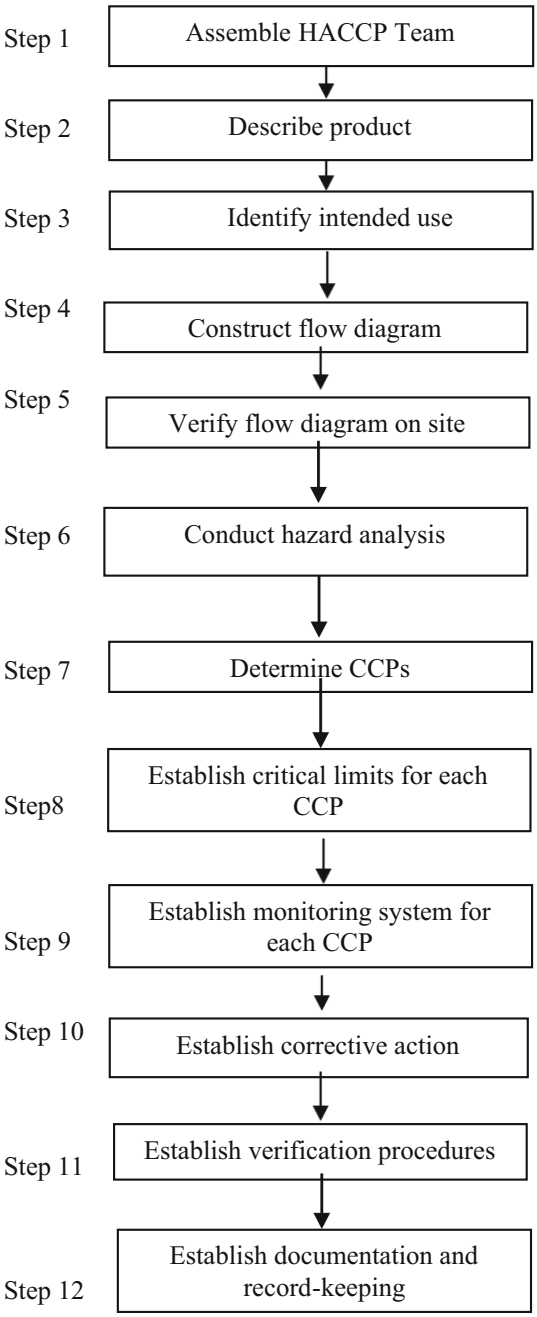

Fig. 2. Flowchart of HACCP analysis stages

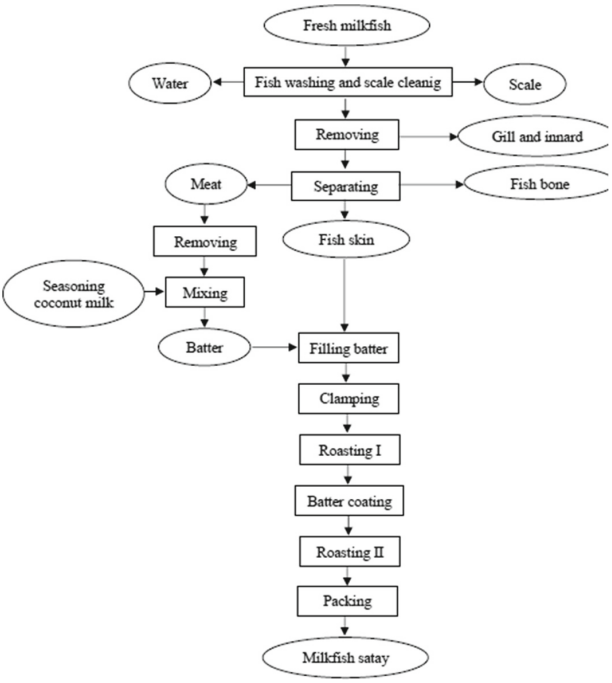

Fig. 3. Flow diagram milkfish satay

must be identified by the HACCP team, as well as identified precautions. There are several types of hazards that may be present in food and can harm consumers if consumed. The microbiological hazards, for this product can be identified such as *Escherichia coli, Salmonella sp, Vibrio sp,* and *Aeromonas sp.* Histamine and heavy metals identified as chemical hazards. Physical hazards are foreign objects which are usually made from food handling processes such as gravel, and iron [9]. The HACCP team list all potential hazards that may arise in materials and processes. The flow chart used as a reference in determining the hazard to see materials and processes that can cause hazards and cross-contamination.

Step 7 (principle 2) Determined critical control points (CCP) for significant hazards. Control measures at the CCP must produce an acceptable level of hazard. In determining CCP, it can be assisted by the use of a decision tree.

Step 8 (principle 3) Determined critical limit of CCP. Critical limits can be used to separate acceptable products from unacceptable ones. This critical limit must be measurable or observable. Critical limit validation may include conducting studies for example microbiological inactivation studies. Critical limits can be based on existing literature, regulations, or guidelines from competent authorities, or studies conducted by third parties. Further validation of control measures is described more fully in the Guidelines for the Validation of Food Safety Control Measures (CXG 69- 2008) [14]. The CCP on frozen milkfish satay products include Salmonella sp from raw material that can be controlled with a supplier guarantee. The next CCP is histamine due to environmental

contamination, lack of handling when milkfish is caught until distribution can be controlled by supplier guarantees internal laboratory tests every 3 months. Production must implement GMP and SSOP to prevent all physical hazards [15] [16].

Step 9 enters the fourth principle of establishing monitoring procedures. With the monitoring process, it is possible to detect deviations that exist in the CCP. Monitoring procedures for CCPs should be capable of detecting deviations from critical limits to allow isolation of the affected product (defect products). Personnel who conducting monitoring should be instructed on the appropriate steps periodically. All data and documentation must be approved and signed by the person that conducting the monitoring. Step 10 (principle 5) is Determination of Corrective Action. Specific written corrective actions must be developed for each CCP in the HACCP system in order to respond effectively to deviations that occur.

Step 11 (principle 6) is determination verification procedures. Verification activities must be carried out on an ongoing basis to ensure the HACCP system functions as intended and continues to operate effectively. The last or 12th step is included in principle 7, documentation and recording. Documentation and recording data must be accurate in accordance with the conditions and conditions in the field because these data are essential for implementing the HACCP system.

PT. ABM is currently still in the stage of development planning for milkfish satay product. Before producing and distributing this product, HACCP plan was needed for ensure that flow process and target production place can maintain quality and safety of frozen milkfish satay. The standard used to ensure this product safety is SNI (Indonesian standard) for frozen fish (Table 1). In previous study that analysis hazard in milkfish satay, there is two processing methods (traditional and modern). In modern method, GMP already had implemented. Milkfish satay which is processed with modern method considered safe based on BPOM standard (Table 2).

Milkfish satay has chemical hazards such as Pb, Cd, acrylamide (benzo (a) pyrene) and microbiological hazards such as E. coli, S. aureus, Salmonella sp, Vibrio cholerae Vibrio P [9] while for physical hazards can be handled with GMP and SSOP [16]. Corrective action that can be taken to minimize possibility of chemical hazards is by choosing a certified supplier of raw materials. Supplier must ensure that all materials was free from chemical hazard with certificate of analysis (CoA). Temperature roasting must be controlled properly to avoid the substance acrylamide (benzo (a) pyrene) [17]. The stages of making milkfish satay are starting from receiving ingredients, separating meat from other parts of milkfish, washing, grinding meat, mixing with spices, adding dough, and roasting [17]. The steps that are considered to have the greatest chance of causing harm are the washing, filling, and baking steps.

Washing can create cross-contamination of heavy metal residues originating from water due to the material in contact with water. Corrective action that can be taken is by selecting a water source and ensuring that the source of clean water is free from microbiological contamination as evidenced by laboratory tests on the water that will be used during the production of milkfish satay. The filling of the dough can be easily exposed to cross-contamination because in the filling of the dough the ingredients interact a lot with activities, the environment, and people. Contaminants that can presence are foreign objects from tools that are not in good condition, fish bones and scales that

Table 1. SNI (Indonesian standard) for Frozen Fish

Test	Parameters	Requirements
a. Sensory	SNI 2346:2011	Min 7 (Skor 1 - 9)
b. Chemical* - Histamine***	mg/kg	Max. 100
c. Microbiological hazards - ALT - Escherichia coli - Salmonella - Vibrio cholerae	colony/g APM/g - -	Max 5,0x105 <3,0 Negative/25 g Negative/25 g
d. Heavy metal* - As - Cd - Hg - Sn - Pb	 mg/kg mg/kg mg/kg mg/kg mg/kg mg/kg mg/kg	 Max 1,0 Max 0,1 Max 0,5 ** Max 0,5 Max 1,0 ** Max 40,0 Max 0,3 Max 0,4**
e. Chemical residue**** - Chloramphenicol -Malachite green -Metabolite nitrofurans (SEM, AHD, AOZ, AMOZ)	 - - -	 Not detected Not detected Not detected
f. Toxin* -Ciguatoxin*****	 -	 Not detected
g. Physical: - Temperature	 °C	 Max -18
h. parasite*	-	none

* if needed

** for predatory fish

*** for scombroidae (scombroid), clupeidae, pomatomidae, coryphaenedae

**** if needed, for freshwater aquaculture

***** for reef fish

Source: [17]

have not been filtered properly, and pests and dust from the environment. Biological contaminants can be presence because interaction food with caries (people) who can transfer bacteria from their bodies to the ingredients. Corrective action that can be taken is to apply SSOP and GMP strictly. Over-roasting will form acrylamide compounds (benzo (a) pyrenes), which are marked with black color (burnt) on milkfish satay, acrylamide (benzo (a) pyrenes) are substances that cause chronic cancer, so they should be avoided.

Table 2. Hazard Analysis of Milkfish Satay

Hazard	Processing Method		BPOM Standard
	Traditional	Modern	
Chemical			
- Pb	0,14 mg/kg	0,18 mg/kg	0,20 mg/kg
- Cd	< 0,07 mg/kg	< 0,07 mg/kg	0,10 mg/kg
Biological			
- TPC	50 x 10^4	8,2 x 10^4	10^4 colony/g
- E. coli	<3	<3	<3 APM/g
- S. aureus	-	-	10^2 colony/g
- Salmonella sp	Negative	Negative	Negative
- Vibrio cholerae	Negative	Negative	Negative
- Vibrio P	Negative	Negative	Negative
Physical			
- Bone	Positive	Negative	-
- Dust	Positive	Positive	-
- Ash	Positive	Negative	-

Source: [18]

Corrective action that can be taken is by controlling the temperature during the roasting process.

While the critical point for frozen fish is the freezing stage using the right temperature and good temperature control so that the freezing process can occur optimally that can minimize possibility of hazards. The critical points in the fish freezing process are CO injection, cooling, vacuuming, freezing, packaging, and storage [15]. Some of these steps must be maintained and controlled during the implementation process to avoid any possible hazards.

The way that can be applied is the application of good GMP according to standards, periodic inspection of the vacuum machine and the supervisor inspects and controls during the vacuum process, the temperature of the cooling room is at -35 °C with monitoring the temperature of the cooling room every hour. Maintaining a maximum production room temperature of 18 °C, maintaining the temperature of the cooling room at -20 °C during the storage process, and maintaining the cleanliness of employees and the environment during the packaging stage.

From the results of the HACCP analysis of milkfish satay and the HACCP analysis of frozen fish, it is possible to plan the possibility of CPP that will arise from frozen milkfish satay products. Pb Cd and acrylamide will make foodborne serious illnesses in a certain period of time. To avoid heavy metal contaminants, it can be done by checking

the hazards of raw milkfish, choosing milkfish that have been certified so that they are safe from heavy metal contamination. Heavy metal contamination is generally due to a polluted aquaculture environment. Microbiological hazards that can arise in frozen milkfish satay products are Salmonella, Coliform, and Vibrio. Controlling temperature and time for stage roasting and freezing can prevent microbiological hazards. However, cross- contamination can occur both from the environment, labor and packaging, therefore the cleanliness of the process of making frozen milkfish satay must be maintained to meet SSOP standards and apply strict GMP. The physical danger of this frozen milkfish satay product is the presence of cross-contamination such as dirt, the rest of the milkfish body parts such as scales and fishbone as well as other foreign objects such as iron from the tools used, gravel to dust. The same as mitigating microbiological hazards, these physical hazards can also be prevented by applying hygiene according to SSOP standards and implementing strict GMP.

4 Conclusion

Making milkfish satay consists of several stages including receiving raw materials, cleaning, separating meat and skin, trading milling, dough filling, roasting, packaging, and storage, while if you want to make frozen milkfish satay, after roasting, the freezing stage is added then packaging and storage. In ensuring the quality of frozen milkfish satay in order to maintain the cold supply chain of fishery products, PT. ABM will plan the implementation of HACCP in the production of this frozen milkfish satay. In implementing this HACCP, commitment from PT. ABM to carry out 5 stages and 7 basic principles of HACCP so that the quality and food safety of this frozen milkfish satay can be maintained. The main hazard that had to be concern are histamine, heavy metal residue, acrylamide, Salmonella, Coliform, and Vibrio. CCP in this process are receiving raw materials (Pb, Cd, histamine, microbiological hazards), roasting (acrylamide, microbiological hazards) and freezing (histamine, microbiological hazards).

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