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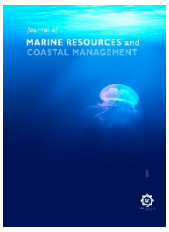

Determination of critical control points in the process of freezing whole gutted scale red snapper at PT Alam Jaya Surabaya

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ABSTRACT

Red snapper is a type of food that is easily damaged and rotten. To maintain the freshness of fish for a long period of time, preservation can be done, one of which is by storing the fish at a low temperature or called freezing. During the freezing process biological, physical and chemical changes occur. Control measures are needed to prevent and minimize damage to red snapper products by implementing Critical Control Points (CCP), namely a step where controls can be carried out to prevent or eliminate food safety hazards. The aim of this research is to determine the application of CCP in freezing red snapper at PT Alam Jaya Surabaya through interviews with the Quality Control section and employees of PT Alam Jaya Surabaya as well as direct observation within the scope of CCP. PT Alam Jaya Surabaya has two CCPs, i.e. raw materials receiving (sorting) and the metal objects checking using metal detector. Corrective action taken in the process of receiving raw materials is by carrying out laboratory tests and organoleptic tests, as a form of prevention, as well as rejecting raw materials that do not meet standards. In the metal objects checking process, the corrective action that must be taken is to carry out calibration if deviated results are found, repair by a technician if an error occurs in the detector machine, as well as rejecting and not sending the product if the product contains metal fragments.

Keywords: critical control point, food safety, freezing, red snapper

INTRODUCTION

Red snapper (*Lutjanus sanguineus*) has a lot of nutritional content. The dominant nutritional content found in red snapper is protein. If viewed from its nutritional composition, snapper is included in type A with a protein category of 15-20% and low fat <5% [1]. This fish has the potential to be developed in the fishing industry [2].

Fish and shrimp, and other fishery products, include foodstuffs that are easily damaged or rotten. In just a few hours after being caught and landed, a process of change will occur in the fish which will lead to damage. The process of deterioration in fish quality can be caused by three types of activity, i.e. autolysis reactions, chemical reactions, and the activity of microorganisms. The freshness of fish cannot be improved but can be maintained. Quality in fish freshness can be maintained by carrying out appropriate handling processes [3].

Deterioration of quality in fish can be differentiated into several stages, i.e. pre rigor, rigor and post rigor based on the rigor index equation. The pre-rigor stage occurs two hours after the fish is died or killed, characterized by the fish's flesh tissue being still soft and flexible and the presence of a clear layer around the fish's body which is formed by the release of mucus and glands under the skin. The next stage is rigor or rigor mortis which occurs 10 hours (2-12 hours) after the fish is died or killed with the flesh being stiff. The final stage is post rigor, after 12-24 hours after the fish is killed [3].

So that fish and other fishery products can be utilized as optimally as possible, the most common way to prevent damage is by preserving them using ice blocks [4]. Efforts that can be made to maintain the freshness of fish and other fishery products for a long period of time are by using preservation methods. One of the preservation methods that can be used to safely extend the shelf life of fish and other fishery products is by using low temperature storage. Low temperature storage is a safe and easy way to maintain the freshness of fish and other fishery products [5]. These methods can be classified into cooling and freezing.

Freezing has a basic principle, namely how to preserve food by freezing the food at the freezing point temperature of the food [6]. During the freezing process, many changes will occur, both physical, chemical and biological changes. The freezing process carried out on fish carries the risk of damage to the processed product and requires control measures to prevent this. Efforts that can be made to minimize product damage are by implementing Critical Control Points (CCP).

CCP is a stage where control measures can be taken in order to prevent hazards so as to produce food products that are truly safe and produce potential hazards up to acceptable limits. Determining this point starts with ensuring and seeing the importance of a manual that contains hazard analysis in a production process [7]. CCP are determined at each stage from the beginning of food production until the product is ready for consumption. At each stage, the number of critical microbiological, chemical or physical hazard points will be determined. In some food products, the food formulation affects the level

of safety, therefore the CCP in a product is needed to control several parameters such as pH, water activity, and the presence of other food additives. Therefore, this research aims to examine the determination of critical control points in each process of freezing red snapper (*Lutjanus sanguineus*).

METHODS

This study was conducted in September-November 2023 in PT Alam Jaya Surabaya, a company that operates in the field of fish processing and trading, especially fish freezing. The method used in this study is descriptive method. Descriptive method is the search for facts with proper interpretation. Descriptive research is defined as research that seeks to describe and interpret something, designed to obtain information about the status of a symptom when research is conducted [8].

The data collected can be classified into two, i.e. primary and secondary data. Primary data is a data source that directly provides data to data collectors. This data is obtained through information, explanations directly related to the research [9]. Primary data collection in this study is done by observation and interview. Secondary data is a data source that does not directly provide data to data collectors, for example through literature and literature studies [9]. Secondary data is generally in the form of evidence, records, or historical reports that have been arranged in published or unpublished archives (documentary data).

Observation techniques include various matters concerning the physical conditions and activities at the location of the research [10]. Observations carried out on various matters related to the application of critical point determination (CCP) at PT Alam Jaya Surabaya. Then, the interview technique is an activity of asking questions through interviews to obtain information through questions and answers directly with respondents and informants [10]. Interviews with Quality Control (QC) section and employees of PT Alam Jaya Surabaya were conducted by asking questions about the freezing process, problems in production, the process of applying CCP determination, and problems faced in the application of CCP determination carried out in freezing red snapper (*Lutjanus sanguineus*).

The determination of CCP in red snapper freezing is carried out using a decision tree of CCP which is monitored based on the 4W + 1H rule. There are components involved in the monitoring system based on the 4W + 1H rule, i.e. what, where, when, who, and how as shown in Table-1.

What rule contains an explanation of the type of monitoring to be carried out, including the type of measurement or observation. Types that can be monitored are coolant temperature, process time meter, observation of raw material supplier certificates, and so on. Furthermore, the *where* rule contains an explanation of where (point, stage, and procedure) will be monitored. This monitoring is carried out on each and every CCP.

After the *where* rule is determined, it is followed by the *when* rule which contains when monitoring will be carried out or the frequency of monitoring. This monitoring can be done continuously, for example on time, retort temperature or cold storage temperature. The monitoring can also be done with a certain frequency that is not carried out continuously. In determining the frequency of monitoring, it can be based on how far the data varies during the process. The greater the variation, the more frequent the monitoring frequency will be. If the normal value (the value obtained during the process) is closer to the critical limit, monitoring will be carried out frequently.

Then proceed with determining the *who* rule which contains who will carry out monitoring activities. This monitoring activity is carried out by personnel who have access to CCP determination, have skills, are trained, and experienced. The personnel in question are supervisors, machine operators, and process operators. Followed by the last one is the determination in the *how* rule, which is the explanation of how to carry out monitoring, checking and or measuring. The monitoring method that can be done should be a method that is fast, not difficult, and not an analysis performed by a laboratory. Physical and sensory testing is the preferred method.

In addition to the 1H+4W rule, there is also the determination of CCPs, significant hazards, critical limits, corrective actions, and verification that must be done (Table-1). CCP can contain information about the stages of the process that are identified as having critical points. After determining the identified stages, continue with identifying the types of significant hazards at the process stages. This significant hazard can contain the type of hazard, type of hazard, or information about the hazard at the process stage.

Determination of critical limits must be done on all CCPs that have been determined. This critical limit is a criterion that can separate safe products from unsafe products. Therefore, critical limits must be easy to identify and can be measured and maintained by the operator of a production process.

The instrumentation used for measurement is required to be able to describe the state of the benchmark quickly and easily. Decisions regarding correlation measures to be taken can be decided immediately, especially in mass production, where material movement will take place quickly. Followed by verification which is carried out by confirming through the provision of objective evidence, that the predetermined requirements have been properly met.

Table-1. Decision tree of Critical Control Points

CCPs	Significant Hazard	Critical Limit	Monitoring					Corrective Action	Verification
			What	Where	When	Who	How		

RESULTS AND DISCUSSIONS

Organoleptically, fishery raw materials must have freshness characteristics such as bright appearance, brilliant fresh smell, elastic, dense and compact texture in accordance with the requirements of fresh fish quality standards based on SNI 01-2729.1-2006. Microbiologically and chemically, it must also meet the eligibility standard requirements as explained in the quality and food safety requirements in accordance with SNI 2729:2013.

A critical control point (CCP) is defined as a location point, at each step or stage in a process or procedure, which, if not properly controlled or supervised, has the possibility of causing food insecurity, spoilage and risk of economic loss [11]. Once all CCPs and control parameters associated with each CCP are identified, the Hazard Analysis and Critical Control Point (HACCP) team must assign critical limits to each CCP. The critical limits for biological or microbiological, chemical and physical hazards for each type of product may differ from one another [12].

Critical control points are also steps where controls can be implemented and absolutely necessary to prevent and/or eliminate food safety hazards, or reduce them to an acceptable level [13]. Critical point control is a systematic approach to identify, evaluate and control food safety hazards [14].

The process of freezing whole gutted scale red snapper at PT Alam Jaya Surabaya has CCPs or critical control points that have been determined. The application of CCP or critical control points aims to ensure consumer safety in consuming frozen products produced by the company. The application of CCP or critical control points in the process of freezing whole gutted scale red snapper is in two processes, namely receiving raw materials and metal detectors. Table-2 shows the application of CCP in the process of freezing whole gutted scale red snapper at PT Alam Jaya Surabaya.

Table-2. CCP application in the process of freezing whole gutted scale red snapper at PT Alam Jaya Surabaya

CCPs	Significant Hazard	Critical Limit	Monitoring					Corrective Action	Verification
			What	Where	When	Who	How		
Raw material receiving (sorting)	Decomposition	No decomposed raw materials	Raw material quality (whether or not the raw material is decomposed)	Sorting room	Each arrival per fish	Staff	Physical checking	Reject raw materials that have decomposed	Review monitoring results and receipt results from suppliers
					Each lot of fish arrival	QC	Sampling using AQL (Acceptable Quality Limit) 6.5 method	Reject raw materials whose organoleptic value is less than 7	
Metal detection	Filth: metal fragments (fishing line eye)	No metal fragments in the product	Metal detector verification	Packing room	Before the process, once every 2 hours during the process, after the break, after the end of the process	QC	Checking using a standard metal fragment test kit	Repair or replace metal detector	Review of metal monitoring results
			The presence or absence of metal fragments in the product. Whole product test piece size; Fe: 2.5 mm, Non-Fe: 3.0 mm, Stainless steel: 3.5 mm	Packing Room	Every piece of product	Staff	Check using a metal detector	Holding and separating products detected on metal detector	

The hazards contained in the raw material receiving stage are biological hazards in the form of growth of pathogenic bacteria such as *Salmonella* sp., *E. coli*, and *Vibrio* sp.. Fish storage at low temperatures or refrigeration can inhibit the growth of spoilage bacteria because most bacteria cannot live at 5-10 ℃ and ice can extend the shelf life of fish [15]. So that the imported raw materials (fish) are always added with ice to maintain the cold chain to inhibit the growth of spoilage bacteria in the fish.

Biological hazards can be caused by biological activity, most commonly associated with the activity of microorganisms [16]. The danger of microorganisms is quite difficult to deal with because they are invisible and require laboratory tests. Table-3 shows the grouping of biological hazards which can be bacteria, fungi, viruses, parasites, protozoa, and worms, algae, and shellfish toxins.

Table-3. Biological hazard [16]

Group	Example
Bacteria	*Salmonella* spp. *Clostridium perfingens* *Clostridium botulinum* etc.
Fungi	*Aspergilus flavus* *Fusarium* spp. etc.
Viruses	*Hepatitis A virus* *Rotavirus*
Parasites, protozoa, and worms	Protozoa Tapeworms Flatworms etc.
Algae	*Cyanobacteria* etc.
Shellfish toxins	*Cyanobacterial toxins* etc.

Furthermore, the effect of chemical contamination on consumers can be short-term or acute, such as the effect of food containing allergens, and some have long-term or chronic effects, such as the effect of food containing carcinogenic substances. Chemical hazards that can contaminate food [16] shown in Table-4.

Table-4. Main hazardous chemicals that can contaminate food [16]

No.	Chemicals in food products
1.	Cleaning chemicals from food preparation areas such as detergents
2.	Pepticide-fungicide, insecticide, herbicide, rodenticide
3.	Allergens
4.	Nitrins, nitrates, and N-nitroso compounds

There is a risk of exposure to chemicals in fishery products, namely heavy metals such as Plumbum (Pb), Cadmium (Cd), and Mercury (Hg), so this hazard is significant and includes CCP. This is because if the raw material contains heavy metals, it cannot be overcome by the correct application of GMP (Good Manufacturing Practice) or SSOP (Standard Sanitation Operational Procedure) and must be rejected or returned. The quality control method carried out in the raw material acceptance stage includes checking the supplier's quality assurance letter regarding the raw material capture area by providing a form to the supplier which is then filled in by the supplier. Internal testing is also carried out at the PT Alam Jaya Surabaya laboratory and external testing is carried out at the UPT Pengujian Mutu dan Pengembangan Produk Kelautan dan Perikanan (PMP2KP) Surabaya.

Next is the metal detector, at this stage the potential hazard that may occur is metal flakes in the product. Hazards arising from metal flakes are classified as chemicals and cannot be overcome by the correct application of GMP and SSOP. The supervision carried out on this hazard is by checking each product produced by passing the product on a metal detector machine, with the specification of detecting the presence of metal fragments such as fishing rods, hooks, razor blades, and so on. If a product is found to contain metal fragments, it will be repeated three times and then separated and thawed. After that, the product will be returned to the process room and checked, if the metal fragments have been removed, re-freezing will be carried out. On the other hand, calibration is also carried out by verifying the metal detector using a test piece and checking the machine before use so that it can determine the accuracy of the machine.

The test pieces used in verification are Fe Φ2.5 mm, Non-Fe Φ3.0 mm, and Stainless Steel Φ3.5 mm. Checking the metal detector is by doing tera every 1 hour with a metal test by the quality control (QC) section and the corrective action that must be taken is to calibrate if the results deviate. If there is an error in the machine, the process will be stopped and then repairs will be made to the machine by the technician. This hazard is classified as a significant hazard or included in the CCP. If the product contains metal fragments, it will be rejected and no delivery will be made [17].

While hazards at the weighing, washing, weeding, drafting, sizing, glazing, packaging and labeling, storage, and stuffing stages are biological hazards. Biological hazards at these stages are the growth of pathogenic bacteria such as *Salmonella* sp., *Escherichia coli*, *Vibrio* sp., coliform, and spoilage bacteria. The growth of these bacteria can be handled by the correct application of GMP and SSOP, so at that stage it is not included in the CCP. Water quality and cleanliness of equipment to PPE (Personal Protective Equipment) used by employees must be considered clean. This is because the source of biological hazards comes from water and cleanliness in the production area.

At the freezing stage, the product will experience drip loss or shrinkage of meat weight due to the meat liquid that comes out during the storage process. Drip loss shows how much liquid and nutrients are lost during the storage process. Drip loss is one of the important parameters that affect the quality and quality of fish after experiencing the storage process. However, drip loss that occurs at the freezing stage is not included in the CCP because all products at the freezing stage will definitely experience drip loss and no other damage or contamination will occur at this stage except for the shrinkage of meat weight which can be handled by glazing each product.

Freezing means changing the liquid content in fish into ice. Fish begins to freeze at temperatures between -0.6°C to -2°C, or an average of -1°C. The first thing to freeze is free water, followed by bound water. Freezing

will start on the outside, the middle will freeze last. This freezing requires the release of heat from the fish's body. The process is divided into three stages, namely first, the temperature will decrease rapidly until it reaches freezing point. Second, the temperature will decrease slowly due to two things, namely 1) the withdrawal of heat from the fish which is not due to a decrease in temperature, but rather from freezing of the water inside the fish's body; 2) the formation of ice on the outside of the fish which is an obstacle to the cooling process of the parts inside. Third, if approximately ¾ of the water content has frozen, the temperature will decrease again quickly.

Based on the length and shortness of the thermal arrest time, freezing is divided into two, namely fast freezing and slow freezing. Quick freezing is freezing with a thermal arrest time of no more than two hours. Meanwhile, slow freezing (slow freezing or sharp freezing), namely if the thermal arrest time is more than two hours. Freezing fish must be done using quick freezing [18].

The ice crystals that form during freezing will differ in size, depending on the freezing speed. Rapid freezing will produce small crystals in the fish's flesh tissue. If frozen fish is thawed again, the crystals that come out will be reabsorbed by the meat and little will escape as drip. Meanwhile, slow freezing will produce large crystals which will damage the fish flesh tissue, so that the texture of the fish flesh after thawing will be poor because it will be hollow and many drips will form [18].

After the weeding process, the fish meat will experience drip loss due to the shrinkage of myofibrils, so that the water inside the fish tissue comes out. The value of drip loss can be affected by the length of storage, the humidity in the environment, and the rate of freezing. This freezing rate will have an impact on the formation of ice crystals in the muscle cell structure of fish meat. This drip loss value can also be used to measure the water binding capacity of fish meat [19].

CONCLUSIONS

Determination of CCP in red snapper freezing at PT Alam Jaya Surabaya is carried out using a decision tree of critical control point which is monitored based on the 4W + 1H rule. The red snapper freezing process which is included in the CCP, i.e. the process of receiving raw materials in raw materials and the process of metal objects checking using a metal detector.

In the process of receiving raw materials, prevention is carried out by laboratory tests and organoleptic tests, and rejection of goods that do not comply with standards. In the process of examining metal objects with a metal detector, the corrective action that must be taken is to carry out calibration if deviated results are found. If an error occurs on the machine, the process will be stopped and then repairs will be carried out on the detector machine by a technician. This is classified as a significant hazard or is included in the CCP so that if the product contains metal fragments it will be rejected and not sent.

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