



# **Application of Hazard Analysis and Critical Control Point on Processed Fish Nugget Products in CV Sakana Indo Prima, Depok, West Java**

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## **ABSTRACT**

CV Sakana Indo Prima is a company that produces various frozen fish products, including fish nuggets, located in Depok, West Java. Fish nuggets are a perishable fishery product. Hazard Analysis and Critical Control Point is a system that ensures food safety in Fish Nuggets. The purpose of this research is to identify and analyze the Hazard Analysis and Critical Control Point that has been applied to the processing of fish nuggets in CV Sakana Indo Prima. This research is descriptive with the method used is a case study. The application of Hazard Analysis and Critical Control Points at CV Sakana Indo Prima includes the formation of a Hazard Analysis and Critical Control Point team, product descriptions, identification of uses, preparation of process flow diagrams, an inspection of process flow diagrams, hazard analysis, determination of Critical Control Points (CCP), determination of critical limits, determination of monitoring procedures, corrective actions, verification actions, and determination and documentation have been implemented. The Hazard Analysis and Critical Control Point result at CV Sakana Indo Prima shows that quality safety is maintained. Critical Control Points are at the stages of receiving raw materials, steaming, fast freezing, final storage, and distribution.

**Keywords:** Hazard analysis and critical control point; critical control point; fish nugget; process.

## 1. INTRODUCTION

Fish nuggets are one of the fish jelly products that all people with fish like as the essential ingredient with protein and high water content. Fish are known to have high nutrition but are highly perishable food. The nutritional content of fish, such as protein, essential amino acids, unsaturated fatty acids, carbohydrates, and air can be the advantage of products made from fish. Disadvantages in fishery products are quality degradation in fast and perishable products. Microbial spoilage in fish will multiply rapidly which causes fish to easily experience a decrease in quality during storage. The decline in fish quality can occur from catching and processing to serving.

Fish that have died will experience a decline related to physical, chemical, enzymatic, and microbiological changes leading to decay. Fish that experience quality deterioration will cause unattractive odors, textures, colors, mucus, and patches [1]. The freshness and quality of fish can be maintained by specific processing such as making fish nuggets. In the process, the filleted fish meat will be ground and seasoned and mixed with a binder, then printed, steamed, cut, and covered with dough (adhesive) and then covered with breadcrumbs (breading) before being stored in the freezer [2].

The quality of the fish nuggets produced to be safe for consumption and according to the National Standardization Agency (2013) concerning Fish Nuggets requires a system that can provide quality assurance for the product. The system that can prevent the potential risk of contamination and control it during the processing is the Hazard Analysis and Critical Control Point system. Hazard Analysis and Critical Control Point directly assess hazards and establishes prevention and control systems [3]. The approach through Hazard Analysis and Critical Control Points can assist in planning and operations in every process of fish nugget processing activities. Hazard Analysis and Critical Control Points also focus on food safety and health risks. An exemplary Hazard Analysis and Critical Control Point implementation will produce a final product that is safe for consumption by consumers. Food safety guarantees make product distribution more comprehensive in area coverage [4].

CV Sakana Indo Prima is a company engaged in processing fishery products, one of which is fish

nuggets. Fish nuggets are distributed to the islands of Java and Sumatra. The company is committed to selling final products that are safe for consumption without using preservatives. The Hazard Analysis and Critical Control Point system must be implemented in the processing process to ensure the food safety system of the products produced. This research aims to identify and analyze the Hazard Analysis and Critical Control Point that has been applied and to obtain information on critical control points in the processing of fish nuggets in CV Sakan Indo Prima.

## 2. METHODOLOGY

This research was conducted in July 2022. This research was conducted at CV Sakana Indo Prima which is located on Jl. Parung Poncol No. 35, Duren Mekar, Bojongsari, Depok City, West Java, Postal code 16518. The method used in this research is a qualitative case study method and is presented descriptively by describing and explaining the conceptual study of the theory based on the literature. The research was carried out by following the direct flow of the fish nugget processing process from the initial stages of production to distribution. The data obtained consisted of primary data and secondary data. Primary data is obtained from direct observation in the field, interviews with quality control staff, and food quality testing. Secondary data is obtained from literature studies such as the National Standardization Agency, books, and related journals.

## 3. RESULTS AND DISCUSSION

### 3.1 Fish Nugget Processing Flow

CV Sakana Indo Prima is a fishery company that was founded in 2009. CV Sakana Indo Prima currently produces frozen processed products, such as fish nuggets. The process of processing fish nuggets in CV Sakana Indo Prima consists of 15 stages of the process. Each stage of the process must be carried out sequentially and according to company, SOPs to avoid cross-contamination of the product. Process of processing fish nuggets in CV Sakana Indo Prima receives raw materials, thawing, pulverizing, mashing, mixing dough, printing, coating flour, steaming, draining, sorting, weighing, packaging, fast freezing, final storage, and distribution.

The raw material for fish nuggets at Sakana Indo Prima is tilapia supplied by Aquafarm Nusantara in a frozen fillet state. The transportation of tilapia fillets using a car with a temperature control system to the central warehouse in Muara Angke, North Jakarta, before being transported using a pickup truck to CV Sakana Indo Prima. The incoming raw materials will be stored in cold storage at a temperature of  $-18^{\circ}\text{C}$  using the FIFO (first in, first out) system. Setting cold storage at  $-10^{\circ}\text{C}$  serves to stop microbial activity. The FIFO (first in, first out) system minimizes damage to the quality of raw materials during storage [5].

Tilapia before being made into fish nuggets, a thawing process is carried out—the thawing method used at CV Sakana Indo Prima is the thawing method using running water plus ice for 2 hours. The thawing method using water and air has a maximum standard temperature ranging from  $12^{\circ}\text{C}$  to  $25^{\circ}\text{C}$  [6]. Ideally, it should be done quickly at temperatures below  $15^{\circ}\text{C}$  [7]. The time required in the thawing process is influenced by the heat transfer rate from the thawing media, fish meat, and environmental temperature. The running water method is faster than the method left at room temperature [6].

Thawing raw materials will undergo a pulverizing process. The crushing of tilapia fillets is done by adding ice cubes. The pulverizing process takes  $\pm 10$ – $15$  minutes in the grinder. Adding ice cubes in the meat refining process aims to facilitate the formation of emulsions and maintain a low temperature of the meat which can prevent the denaturation of actomyosin proteins from heat [8].

Making fish nuggets dough by mixing tilapia meat, carrots, flour, spices, and ice in a food processor for 15 minutes. Mixing the ingredients is done according to the ratio of the dough ratio. Adding ice cubes in the mixing process aims to give a chewy texture and distribute the spices evenly [8].

The nugget dough is then molded into a fish shape. The use of molds will produce nuggets of uniform size. The mold is first moistened with water before application so that the dough does not stick to the mold. Spreading bread flour to cover the entire surface of the dough is done after the dough is printed. Breading can give texture to fish nuggets [9]. Giving shape to nuggets can increase consumer attractiveness [10].

The printed dough is put in a steamer at a temperature of  $100^{\circ}\text{C}$  for 15-20 minutes. Steaming aims to increase the shelf life of fish nuggets. High temperature and proper steaming time can reduce microorganisms and produce an ideal texture [11]. Setting a high temperature for a relatively long time can make the texture of the meat hard, tough, and dry, and the fat content will decrease [12]. Using temperatures that are not optimal in a relatively short time causes gelatinization to be less than optimal [11].

Fish nuggets removed from the steamer are cooled using a fan for 15 minutes. Cooling fish nuggets using a fan or blower aims to reduce the temperature of fish nuggets before the packing process [13].

Packing fish nuggets begins with sorting fish nuggets that pass to be packaged. Fish nuggets are packed in polybags made of PE (polyethylene), weighing 500 grams per pack. Packaging is one way to maintain consumer product quality. Standardized packaging (food grade) can maintain product quality from potential contamination and physical damage and can withstand the movement of gas and water vapor. Packaging made from PE has water vapor permeability that can maintain moisture content. Besides that, it has elastic and easy-to-adjust properties [14].

The packaged fish nuggets were put in an air blast freezer at  $-21^{\circ}\text{C}$  for 12 hours for fast freezing. Rapid freezing aims to provide a shock temperature to microbes so that microbes have not adapted to temperature changes and have no potential for microbial growth [15]. Fast freezing can minimize texture damage because the ice crystals formed are tiny and evenly distributed [16]. Using temperatures below  $-30^{\circ}\text{C}$  affects the cessation of biochemical processes. Air blast freezer is a freezing method by flowing cold air toward the product which aims to get a maximum product center temperature of  $-18^{\circ}\text{C}$  [3].

Fish nuggets were transferred to cold storage at  $-18^{\circ}\text{C}$  for 24 hours before being distributed. Frozen storage at a temperature of  $-18^{\circ}\text{C}$  will prevent microbiological damage and changes in the shape of food, provided that there is never a significant temperature change [15]. Storing below freezing point can extend the shelf life, prevent changes in color, taste, and juiciness after steaming, and kill heat-resistant microbes during the steaming process [17]. The

arrangement of goods in cold storage pays attention to the distance from the wall to avoid moisture which can cause damage to the packaging [18].

Fish nuggets are distributed using a 6-ton vehicle equipped with a thermoking system. The temperature was set at  $-18^{\circ}\text{C}$  to maintain the quality of the fish nuggets during the distribution process. Distribution of fish nuggets using the FIFO (first in, first out) system. Fish nuggets stored below the freezing temperature of nugget acceptability will be the same as freshly produced nuggets. The FIFO (first in, first out) system is the first product to be distributed, the product stored in the first cold storage [18]. Temperature and duration of storage are essential factors in maintaining the quality of nuggets during distribution [14].

### **3.2 Application of Hazard Analysis Critical Control Point**

Application of Hazard Analysis and Critical Control Point in CV Sakana Indo Prima as a food safety system to ensure the quality of the fish nuggets. Hazard Analysis and Critical Control Point is a system used to assess hazards and establish a control system that focuses on prevention by setting a Critical Control Point (CCP) using a Critical Control Point Decision Tree Diagram and determining a Critical Limit (CL) to control each Critical Control Point. The application of this Critical Control Point aims to ensure the safety of consumers in consuming the processed products produced [3]. The application of Hazard Analysis and Critical Control Points shows the potential dangers of food products, so that the commitment to food safety and consumption suitability for consumer health can be realized [11]. Application of Hazard Analysis and Critical Control Point in CV Sakana Indo Prima as follows :

#### **3.2.1 Formation of the hazard analysis and critical control point team**

Team formation is the first step in implementing the Hazard Analysis and Critical Control Point system [19]. The organizational structure in the CV Sakana Indo Prima does not have an official Hazard Analysis and Critical Control Point team. However, in overall product manufacturing activities, quality control leaders, quality control staff, production leaders, and technicians are responsible for the processing process. States that the Hazard Analysis and Critical Control

Point team consists of 3–10 people with multi-part, disciplined, trained, competent, and precise duties and authorities [20]. The Hazard Analysis and Critical Control Point team is in charge of quality supervision and assurance, food processing, GMP (Good Manufacturing Practices), food microbiology, process handling, and equipment maintenance, as well as carrying out Hazard Analysis and Critical Control Point steps [21]. The formation of the Hazard Analysis and Critical Control Point team aims to make the company firmly committed to the food safety of the products produced [19]. This commitment is made to the company's quality policy focusing on product safety and hygiene.

#### **3.2.2 Product description**

Fish nuggets are products made from diversified fish. CV Sakana Indo Prima produces fish nuggets with the raw material of tilapia which has been separated from the skin and bones and mixed with other supporting materials. Description of fish nuggets CV Sakana Indo Prima can be seen in Table 1.

The product description in CV Sakana Indo Prima complies with National Standardization Agency (2011). Product description aims to collect complete information on a product, such as composition, physical/chemical structure (aw, pH), microbicidal/static treatment (heating, freezing), packaging, storage, shelf life, and distribution to perform hazard analysis and determination of critical limits [19]. Companies with various products, such as CV Sakana Indo Prima to effectively develop the Hazard Analysis and Critical Control Point plan, could have product groupings with similar process stages [22].

#### **3.2.3 Product user identification**

Fish nuggets product CV Sakana Indo Prima can be used as a complementary food or side dish. The serving of fish nuggets is done by frying the fish nuggets using medium heat for a few minutes until they turn brown. The composition of fish nuggets uses safe ingredients and no preservatives so that they can be consumed by all levels of the population except infants [23] the identification of product use is in the form of consumer information that is allowed to consume the product and how the product is used. User identification aims to determine specifications and product quality standards that are expected to avoid and prevent potential hazards that can risk consumer health [21].

**Table 1. Product description fish nugget**

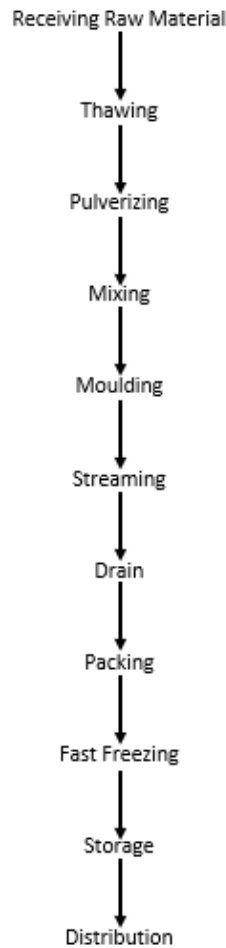
No	Category	Description
1.	Product name	Fish Nugget
2.	Name of raw material	Tilapia ( <i>Oreochromis niloticus</i> )
3.	Origin of raw material	Cultivated in Lake Toba, North Sumatra
4.	Acceptance of raw materials	<ol style="list-style-type: none"> <li>1. Organoleptic quality test</li> <li>2. Handled quickly, carefully, and sanitary with a maximum temperature of 15°C</li> <li>3. FIFO (first in, first out) storage</li> </ol>
5.	Additives	Tapioca, sugar, salt, pepper, ice cubes, shallots, sesame oil, vegetable oil, neriplus, ISP, carrots, and monosodium flavoring
6.	Process category	Steaming
7.	Packaging	Polybag @500 gram (Food Grade)
8.	Storage	Freezer/cold storage at -18°C
9.	Shelf life of	1 year with storage at -18°C
10.	Shipping	Transport vehicles with a cooling system (thermoking) or insulated boxes
11.	Requirements	<p>NATIONAL STANDARDIZATION AGENCY 7758-2013 :</p> <ol style="list-style-type: none"> <li>1. ALT (30°C, 72hours) max 5x10<sup>5</sup> colonies/g</li> <li>2. E. coli &lt; 3 APM/g</li> <li>3. <i>Salmonella</i> sp. (-)/25 g</li> <li>4. <i>Staphylococcus aureus</i> max 1x10<sup>3</sup> colonies/g</li> <li>5. <i>Vibrio cholerae</i> (-)/25 g</li> </ol> <p>Technical Requirements:</p> <ol style="list-style-type: none"> <li>1. ALT (30°C, 72 hours) max 1x10<sup>4</sup> colonies/g</li> <li>2. E. coli APM &lt; 3 APM/g</li> <li>3. <i>Staphylococcus aureus</i> max 1x10<sup>2</sup> colonies/g</li> <li>4. Mold max 5x10<sup>1</sup> colony/g</li> </ol> <p>Customer Requirements:</p> savory taste, chewy and soft texture, and a distinctive aroma of fresh fish
12.	How to use	Ready to cook, fry on medium heat
13.	Product ser	General public users except for babies
14.	Label	Company name, product name, net weight, expiration date, Food and Drug Supervisory Agency, National Standardization Agency, presentation suggestion, and storage advice
15.	Regulation related to	National Standardization Agency (2013)

### 3.2.4 Preparation the flow chart

The flow chart describes the stages of the production process, from receiving raw materials to becoming a finished product or distribution, containing detailed information to identify potential hazards [19]. A flowchart of the process of making fish nuggets at CV Sakana Indo Prima can be seen in Fig. 1.

The production process of fish nuggets at CV Sakana Indo Prima begins with receiving raw materials, other additives, as well as packaging and labels. After receipt of raw materials and other additives, tilapia is stored in cold storage before being processed into raw materials. Other additional materials are stored in cold storage or

storage warehouses. Packaging and labels will be stored in the warehouse. Tilapia as a raw material will go through a thawing process for 2 hours in cold water that is added with ice. Crushing and mashing the tilapia fillets using a grinder machine while the carrots are mashed using a blender. Mixed tilapia fillets with other ingredients using a food processor machine for 15 minutes. The dough that has been mixed evenly will be printed using a nugget mold which is then coated with breadcrumbs to cover the entire surface of the dough. The printed dough will be steamed with a streamer machine for 10 minutes at a temperature of 95-100°C. Fish nuggets are drained and cooled for about 10-15 minutes before finally being packaged. The packaged nuggets will be frozen in an air blast



**Fig. 1. A flowchart of the process of making fish nuggets at CV Sakana Indo Prima**

freezer for 12 hours at  $-21^{\circ}\text{C}$  before being put into cold storage at  $-18^{\circ}\text{C}$ . Nuggets in cold storage will be distributed after 24 hours. Distribution of fish nuggets using a thermoking car to maintain the temperature at  $-18^{\circ}\text{C}$ .

The flow chart made by the Hazard Analysis and Critical Control Point team was prepared following National Standardization Agency (2013) concerning Fish Nuggets. a Flow chart is prepared by the Hazard Analysis and Critical Control Point team and covers all stages in the production process for a particular product [22]. The same flow chart can be used for any number of products produced. The preparation of a diagram by grouping the stages in the production process facilitates the identification of hazards from the beginning to the end of production [23].

### 3.2.5 Verification the flow chart

Quality control team CV Sakana Indo Prima verifies the flow chart every day to ensure whether each process is running well or not.

Verify the flow chart to re-check the stages of the production process while production is in progress [23]. Flow chart verification is used to see the facts that occur in the manufacturing process, as well as facilitate quality control to take corrective and corrective actions if deviations occur. Verification of flowcharts is prioritized based on each process in different shifts, monitoring systems and recording procedures, operator understanding of how the machine is operated, and implementation of the agreed program [19]. Activities such as observation, interviews, and laboratory tests are one of the methods of verification of flow-chart.

### 3.2.6 Hazard analysis

Identifying hazard analysis is collecting and assessing information on potential hazards and their causes to determine the hazards that will have a real impact and how to control them. Hazard analysis in CV Sakana Indo Prima is as follows.

The potential danger of receiving raw materials is contamination from pathogens (ALT, coliform, *Escherichia coli*, and Salmonella), heavy metals, and filth. Hazards can be caused by low fish freshness, microbial decomposition, decreased fish center temperature during distribution, cross-contamination during the reception process, and inappropriate activities. The hazard category includes a food safety hazard with a medium severity and a medium chance of occurrence. Hazards can be controlled and prevented by implementing GMP (Good Manufacturing Practices). Prevention can be done by checking information related to the fish supplier, using fresh fish as raw material, checking organoleptic on fish (smell, texture, and appearance), controlling the central temperature in fish ( $\leq 4.4^{\circ}\text{C}$ ), laboratory checking for heavy metal levels, sorting using the FIFO (first in, first out) system, clean and fast, as well as cold storage at a temperature of  $\pm -10^{\circ}\text{C}$  to  $20^{\circ}\text{C}$ .

The potential danger at the thawing stage is contamination from pathogenic bacteria (ALT, coliform, *Escherichia coli*, and Salmonella). Hazards can be caused by the use of water and ice that have been contaminated and raw materials that have deteriorated due to inappropriate thawing time and temperature. The hazard category is a food safety hazard with a low severity level and a medium chance of occurrence. Hazards can be controlled and prevented by implementing SSOP (Sanitation Standard Operational procedure). Prevention is carried out by controlling temperature and thawing time, checking water quality and ice quality, applying a cold chain of  $\pm 0^{\circ}\text{C}$  to  $5^{\circ}\text{C}$ , and using clean and sanitary tools.

The potential danger of pulverizing meat is contamination from pathogenic bacteria (ALT, coliform, *Escherichia coli*, and Salmonella) and rust. Hazards can be caused by the contamination of raw materials and unclean tools. The hazard category is a food safety hazard with a low severity level and a medium chance of occurrence. Hazards can be controlled and prevented by implementing SSOP ((Sanitation Standard Operational Procedure). Prevention is carried out by checking the cleanliness of the equipment, applying a cold chain of  $\pm 0^{\circ}\text{C}$  to  $5^{\circ}\text{C}$ , and practicing good personal hygiene.

The potential danger of mixing the dough is contamination from pathogenic bacteria (ALT, coliform, *Escherichia coli*, and Salmonella),

borax, formalin, and foreign matter. Mixing foreign objects can cause danger to the dough, the quality of additives that are not fresh, and harmful chemicals mixed. The hazard category is a food safety hazard with a low severity level and a medium chance of occurrence. Hazards can be controlled and prevented by implementing SSOP (Sanitation Standard Operational procedure). Prevention is carried out by checking the tool's cleanliness, checking the BTP to be added, and applying the cold chain.

The potential danger at the dough molding stage is contamination from pathogenic bacteria (ALT, coliform, *Escherichia coli*, and Salmonella). Hazards can be caused by the growth of pathogenic bacteria, cross-contamination of tools and dough, as well as carriers such as flies that perch on the dough. The hazard category is a food safety hazard with a low severity level and a medium chance of occurrence. Hazards can be controlled and prevented by implementing SSOP (Sanitation Standard Operational procedure). Prevention is done by using UV light, maintaining the cleanliness of tools, and personal hygiene.

The potential danger at the dough molding stage is contamination from pathogenic bacteria (ALT, coliform, *Escherichia coli*, and Salmonella). Hazards can be caused by the growth of pathogenic bacteria, cross-contamination of tools and dough, and carriers such as flies that perch on the dough. The hazard category is a food safety hazard with a low severity level and a medium chance of occurrence. Hazards can be controlled and prevented by implementing SSOP (Sanitation Standard Operational procedure). Prevention is done by using UV light, maintaining the cleanliness of tools, and personal hygiene.

The potential danger at the steaming stage is contamination from pathogenic bacteria (ALT, coliform, *Escherichia coli*, and Salmonella). Hazards can be caused by the growth of pathogenic bacteria and improper temperature and time setting on the steamer. The hazard category is a food safety hazard with a high severity level and a medium chance of occurrence. Hazards can be controlled and prevented by implementing GMP (Good Manufacturing Practices) and SSOP (Sanitation Standard Operational procedure). Prevention is done by using a steamer temperature at  $\pm 98^{\circ}\text{C}$  to  $100^{\circ}\text{C}$ , steaming time of 15 minutes, and checking the cleanliness of the tool before use.

The potential danger at the draining stage is contamination from pathogenic bacteria (ALT, coliform, *Escherichia coli*, and Salmonella), dust, and dirt. Hazards can be caused by not maintaining the cleanliness of the surfaces in direct contact. The hazard category is a food safety hazard with low severity and low probability of occurrence. Hazards can be controlled and prevented by implementing SSOP (Sanitation Standard Operational procedure). Prevention is done by using fans and clean and sanitary equipment.

The potential danger at the sorting, weighing, and packaging stages is contamination from pathogenic bacteria (ALT, coliform, *Escherichia coli*, and Salmonella), dust, dirt, and label errors. Hazards can be caused by the presence of dirt and dust attached to the table, cross-contamination of tools with nuggets, and negligence of workers. The hazard category is a food safety hazard with moderate severity and a moderate probability of occurrence. Hazards can be controlled and prevented by implementing GMP (Good Manufacturing Practices) and SSOP (Sanitation Standard Operational procedure). Prevention can be done by using food-grade packaging, good personal hygiene practices, re-checking the packaging label, and sealing the packaging at a temperature of  $\pm 175^{\circ}\text{C}$  to  $200^{\circ}\text{C}$ .

The potential danger in the rapid freezing stage is the presence of contamination from pathogenic bacteria (ALT, coliform, *Escherichia coli*, and Salmonella) and an increase in temperature. Danger can be caused by the growth of *Escherichia coli* bacteria due to unsanitary packing processes and temperature fluctuations due to excess storage capacity. The hazard category includes food safety hazards with moderate severity and high probability of occurrence. Hazards can be controlled and prevented by implementing GMP and SSOP (Sanitation Standard Operational procedure). Prevention can be done by setting a temperature of  $\pm -20^{\circ}\text{C}$  to  $-30^{\circ}\text{C}$  for 14 hours and monitoring the entry and exit of products in the air blast freezer with the FIFO (first in, first out) system.

The potential danger at the final storage stage is contamination from pathogenic bacteria (ALT, coliform, *Escherichia coli*, and Salmonella) and excess capacity. Temperature fluctuations and improper sorting can cause hazards. The hazard category includes food safety hazards with moderate severity and high probability of occurrence [24,25]. Hazards can be controlled

and prevented by implementing GMP (Good Manufacturing Practices) and SSOP (Sanitation Standard Operational procedure). Prevention can be done by setting the temperature  $\pm -18^{\circ}\text{C}$  to  $-20^{\circ}\text{C}$  during storage and monitoring the entry and exit of products with the FIFO (first in, first out) system.

The potential danger at the distribution stage is contamination from pathogenic bacteria (ALT, coliform, *Escherichia coli*, Salmonella, and *Staphylococcus aureus*) and delivery errors. Temperature fluctuations and improper sorting can cause hazards. The hazard category includes food safety hazards with moderate severity and high probability of occurrence. Hazards can be controlled and prevented by implementing GMP (Good Manufacturing Practices) and SSOP (Sanitation Standard Operational procedure). Prevention can be done by using a car equipped with a temperature setting that can reach  $\pm -18^{\circ}\text{C}$  to  $-20^{\circ}\text{C}$  during distribution and re-checking the product to be sent to the distributor.

Hazard analysis in CV Sakana Indo Prima is appropriate. The steps carried out in the hazard analysis are by making a list containing the stages of the process according to the flow chart, identifying potential hazards and their causes, making hazard categories, determining the relationship of hazards to GMP (Good Manufacturing Practices) and SSOP (Sanitation Standard Operational Procedure), determining hazard significance, hazard justification, and establish preventive measures [19]. The dangers contained at the stage of receiving raw materials are biological hazards in the form of the growth of pathogenic bacteria (Salmonella, *Vibrio cholera*, and *Escherichia coli*) and the presence of chemical hazards, namely heavy metals (Cd, Pb, and Hg) [3]. The danger in the distribution stage is microbial growth and damaged product packaging due to human negligence which can be prevented by maintaining a temperature of  $-20^{\circ}\text{C}$  [26].

### 3.2.7 Determination of critical control point (CCP)

A critical Control Point is a stage of the process that in case of deviation will cause a food safety hazard that affects consumers' health. Determination of Critical Control Points is absolute and must be done to prevent, reduce, or eliminate potential hazards to an acceptable level. The method of determining a Critical



**Table 2. Determination of critical control point at the process stage**

<b>Process Stage</b>	<b>P1</b>	<b>P2</b>	<b>P3</b>	<b>P4</b>	<b>CCP</b>
Receiving raw materials	Yes	Yes	-	-	CCP
Thawing	Yes	Not	Yes	Yes	Not CCP
pulverizing	Yes	Not	Tidak	-	Not CCP
Mixing	Yes	Yes	Tidak	-	Not CCP
Moulding	Yes	Not	Yes	Yes	Not CCP
Steaming	Yes	Yes	-	-	CCP
Drain	Yes	Not	Yes	Yes	Not CCP
Packing	Yes	Not	Yes	Yes	Not CCP
Fast freezing	Yes	Yes	-	-	CCP
Storage	Yes	Yes	-	-	CCP
Distribution	Yes	Not	Ya	Not	CCP

Control Point generally uses a decision tree in which some questions will refer to a process that is included in the Critical Control Point or not [19]. In the fish nugget process activities at CV Sakana Indo Prima, the process stages included in the Critical Control Point can be seen in Table 2.

In the fish nugget process activities at CV Sakana Indo Prima, the process stages included in the Critical Control Point are receiving raw materials, steaming, fast freezing, final storage, and loading and distribution. The process of receiving raw materials is included in the Critical Control Point due to the early stages of checking the quality of raw materials, if the raw materials contain pathogenic bacteria and heavy metals, they will be rejected to avoid contamination. At the thawing stage, pulverizing, mixing, and molding are not included in the Critical Control Point because potential hazards can be prevented by maintaining a cold chain at 3°C, using clean and sanitary tools, applying good GMP (Good Manufacturing Practices), and at a later stage, it can reduce hazards potential. At the steaming stage, it is included in the Critical Control Point because an inappropriate temperature will make the fish nuggets not have the desired maturity and cannot stop or reduce the growth of pathogenic bacteria effectively. At the draining and packing stages, they are not included in the Critical Control Point because the potential hazards can be prevented by maintaining the cleanliness of the table, and tools, proper use of gloves and masks, and applying good SSOP (Sanitation Standard Operating Procedures). In the fast freezing and cold storage stages, they are included in the Critical Control Point because the increase in temperature can have an impact on the growth of pathogenic bacteria, besides that, at this stage,

there is no product inspection. At the distribution stage, it is included in the Critical Control Point because temperature fluctuations can cause bacterial growth and delivery errors, and there is no further stage that can reduce bacteria.

Acceptance of raw materials including Critical Control Point is due to significant hazards such as the growth of pathogenic bacteria (Salmonella, Vibrio cholera, and E. coli) and heavy metal contamination (Cd, Pb, Hg) [3]. Receiving raw materials is a Critical Control Point because there are chemical and biological hazards that cannot be eliminated at a later stage [27]. The frozen storage process is a Critical Control Point because there is no product checking during storage. The process of separating meat, mixing, printing, packaging, packing, and labeling are not included in Critical Control Point because the hazard can be eliminated by implementing good sanitation and training for employees. The process flow can be said to be excluding Critical Control Point if, in the subsequent process flow, the elimination of hazards can be carried out.

**3.2.8 Setting critical limits (CL) for each critical control point**

A critical limit is a tolerance separation between acceptable and unacceptable conditions. Critical limits must be met at each Critical Control Point specifically and validated to ensure the effectiveness of biological, chemical, and physical hazard controls. Critical limit criteria generally use temperature, time, aw, humidity level, chlorine, foreign bodies, and organoleptic [19]. In the fish nugget process activities at CV Sakana Indo Prima, the critical limit for each Critical Control Point can be seen in Table 3.

**Table 3. Potential hazard of the critical control point real critical limit**

CCP	Potential Hazard	Critical Limit
Receiving raw materials	ALT Coliform <i>Escherichia coli</i> Salmonella Temperature rise	ALT max 5,0 x 10 <sup>5</sup> col/g E. coli < 3 APM/g Salmonella Negative/25 g Thermoking car temperature -18°C Minimum organoleptic 7
Steaming	ALT Coliform <i>Escherichia coli</i> Salmonella	The temperature setting on steaming ± 95°C to 100°C for 10 minutes
Fast freezing	ALT Coliform <i>Escherichia coli</i> Salmonella temperature rise	Temperature rise Temperature set at air blast freezer -20°C to -30°C
Storage	ALT Coliform <i>Escherichia coli</i> Salmonella temperature rise	Temperature rise Temperature set in cold storage -18°C to -20°C
Distribution	ALT Coliform <i>Escherichia coli</i> Salmonella <i>Staphylococcus aureus</i> Temperature drop Delivery error	ALT max 5,0 x 10 <sup>4</sup> col/g E. coli < 3 APM/g Salmonella Negative/25 g Thermoking car temperature -18°C Minimum organoleptic 7. Product checking

The potential hazards in each Critical Control Point are related to bacterial pathogens and temperature rises. The critical limit in receiving raw materials is the quality of the raw materials such as ALT max 5.0 x 10<sup>5</sup> col/g, E. coli < 3 APM/g, Salmonella Negative/25 g, Thermoking car temperature -18°C, and organoleptic minimum 7. The critical limit at the steaming process is the steamer temperature and steaming time (± 95°C to 100°C for 10 minutes). The critical limit on the quick action is the air blast freezer temperature (-20°C to -30°C). The critical limit for product storage is the cold storage temperature (-18°C to -20°C). Critical limit on distribution to ensure the quality of fish nuggets and product checking before shipping.

Organoleptic checking of raw materials has a standard organoleptic value of 7-8 with a minimum of 7 [27]. In frozen storage, surimi is stored at a temperature of -22°C with a minimum temperature fluctuation of 3°C. The critical limit with the maximum temperature of the fish center is 3°C and the loss of natural odor in raw materials. Bacteria will die or stop their activity if the temperature is lowered to 0°C and raised above 100°C [26]. The critical limit for dough cooking uses a temperature of 100°C to kill bacteria maximally [28]. Organoleptic specifications on frozen raw materials with a minimum of 7 such as less bright appearance

and fresh smell leading to a neutral, less brilliant cut of meat with a less compact and less elastic texture [29]. The distribution must be done carefully to protect the product from high temperatures during loading and unloading. The vehicle used must be able to maintain cold temperatures to preserve frozen products [18].

### 3.2.9 Establish monitoring of each critical control point

Critical Control Point monitoring is shown to assess whether each Critical Control Point is still or not controlled according to critical limits, in addition to monitoring GMP (Good Manufacturing Practices) and SSOP (Sanitation Standard Operational procedure). Critical Control Point monitoring must be documented, such as ensuring critical limits are met, and complied with, and identification when there is a deviation at the Critical Control Point so that the data can be used as verification data in the future. Critical Control Point monitoring must be carried out quickly so the production process does not experience interruptions for a long time because the handling must be fast and precise. Quality control staff generally prefer to take physical and chemical measurements to save time [19].

CV Sakana Indo Prima does good monitoring. Monitoring the receipt of raw materials by

checking the organoleptic quality and the temperature at each arrival of raw materials carried out by quality control. Steam monitoring by checking the temperature of the steamer and the level of product maturity at each production is carried out by quality control. Fast freezing monitoring with air blast freezer temperature checking carried out by quality control. Storage monitoring by checking the cold storage temperature on each production is carried out by quality control. Distribution monitoring by noting that the products that come out are by FIFO (first in, first out) rules and the number of requests, as well as checking the temperature of the product at -18°C for each product that comes out, which quality control carries out.

Monitoring the receipt of raw materials by checking the temperature of the fish center on each incoming raw material by the quality control staff and requesting a letter from the lab results from the supplier explaining that the incoming raw materials are free of pathogenic bacteria and heavy metals [21]. Monitor the dough cooking process by implementing good SOPs [28]. Monitor raw materials by checking supplier quality assurance letters [3]. monitoring of raw materials with laboratory analysis by quality control [26].

### **3.2.10 Determination of corrective action**

Corrective action is taken if there is a deviation in the Critical Control Point. Corrective action aims to eliminate the causes of deviations, restore process control, identify final products when deviations occur, prevent the circulation of products that do not meet qualifications, and determine corrective actions [19].

CV Sakana Indo Prima takes corrective action if there is a deviation during production. Corrective action at the stage of receiving raw materials by returning raw materials if they do not match the quality of the supplier. Corrective action at the steaming stage is to re-steam if there are immature nuggets. Corrective action on rapid freezing and storage if the product temperature does not match -18°C, re-freezing is carried out. Corrective action on distribution by replacing box cars whose cooling system is damaged.

Corrective action is the rejection of raw materials if the central temperature of the raw materials is above 3°C and the fish has lost its specific odor [26]. Corrective action by returning raw materials to suppliers in case of deviations [21]. Raw

materials containing heavy metals that cannot be overcome by implementing GMP (Good Manufacturing Practices) and SSOP (Sanitation Standard Operational procedure) will be rejected [3]. Everyday corrective actions are release, rework, redistribution, and rejection [19]. The steps before taking corrective action are to withhold the product, determine the level of product safety if consumed, release the product if the product is safe for consumption, and determine the next step (rework, redistribution, or reject) if the product has the potential to harm consumers. Every corrective action must be documented and recorded.

### **3.2.11 Establishment of verification procedure**

Determination of verification procedures is shown to validate the effectiveness of the Hazard Analysis and Critical Control Point system that has been implemented, evaluate the Hazard Analysis and Critical Control Point system from the results of monitoring the production process, conduct final product tests, and as an act of internal auditing the production process to assess the production process is appropriate and consistent with the applied Hazard Analysis and Critical Control Point system. Verification procedures must be carried out regularly and regularly at least once a year [23].

CV Sakana Indo Prima has carried out verification actions properly. Verify the stage of receiving raw materials by checking records of the amount and origin of raw materials and organoleptic quality results. The steaming stage is verified by checking the fish nuggets' temperature and maturity. The fast cooling and storage stages are verified by checking the air blast freezer and cold storage control forms. The distribution stage is verified by checking the outgoing product tally form.

Verification is divided into Critical Control Point verification, Hazard Analysis and Critical Control Point verification, and government agency verification [19]. The procedure for verifying the receipt of raw materials at Tridaya Eramina is by checking records of quantities, the origin of raw materials, and results of chemical and microbiological tests of raw materials [21]. The raw material verification procedure is by checking the supplier's quality assurance letter regarding the catchment area for raw materials and testing the quality of raw materials [3].

### 3.2.12 Establishment of documentation and records

The principle of establishing recording procedures in the form of documentation and records intended to verify and review the Hazard Analysis and Critical Control Point system applied at UPI [23]. The procedure for recording in CV Sakana Indo Prima has been implemented well, and it can be seen that there are Hazard Analysis and Critical Control Point manuals, GMP (Good Manufacturing Practices), SOPs (Standard Operational Procedures), recording forms, and supporting documents for quality guidelines.

Documentation and recording at Tridaya Eramina Bahari include the Hazard Analysis and Critical Control Point team, product descriptions, process diagrams, monitoring records of all process stages, corrective action records, verification action records, recordings of each stage in a certain period, and notes on the results of improvements at each Critical Control Point [21]. Monitoring Critical Control Points by recording reports such as reports on the receipt of raw materials, laboratory results, and metal detection, which are checked by quality assurance [26]. The documents are in the form of references in the application of the Hazard Analysis and Critical Control Point systems, such as Hazard Analysis and Critical Control Point manuals, GMP (Good Manufacturing Practices), SSOP (Sanitation Standard Operational procedure), work instructions, and forms, while the records are written evidence that UPI has implemented Hazard Analysis and Critical Control Point according to standards and procedures [19]. Records can show the level of operational effectiveness of Hazard Analysis and Critical Control Point implementation. Records can be in the form of a Hazard Analysis and Critical Control Point plan, Critical Control Point monitoring, corrective and verification actions, as well as sanitation and amendments.

## 4. CONCLUSION

CV Sakana Indo Prima has implemented the Hazard Analysis and Critical Control Point system to maintain the safety of fish nugget products. Process steps that need to be considered to prevent food safety hazards are receiving raw materials, steaming, fast freezing, final storage, and distribution.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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