

Physicochemical and Microbiological Contaminants in Pasteurized Canned Crab Meat at PT Pan Putra Samudra, Cirebon

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ABSTRACT

PT Pan Putra Samudra is a seafood processing company that produces Canned Pasteurized Crab Meat Product. This canned crab meat is made from boiled crab meat that comes from a mini plant and then processed further starting from receiving, sorting, mixing, canning, seaming, pasteurization and storage. These products have been exported to various countries such as the United States, Hong Kong, Thailand, and Singapore. In the production process of canning crab meat, there is a possibility of contamination that can be caused by physical, chemical, and microbiological contamination. Contaminants need to be identified because these have negative effect on health. The purpose of this study is to identify the potential contamination that occurs in canned crab meat products at PT Pan Putra Samudra, Cirebon. Method for identification physical contamination is organoleptic test, chemical contamination is ELISA (Enzyme Linked Immunosorbent Assay) method, and microbiological contamination are ALT, Escherichia coli, Staphylococcus aureus, and Colyform tests. The results showed that the contaminants found in PT Pan Putra Samudra's crab meat products were physical contamination in the form of the shell mixed with meat and chemical contamination in the form of chloramphenicol (CAP) content in the product exceeding > 0.150 ppb. For preventing contamination, PT Pan Putra Samudra applying food safety principles so that the finished products are safe to be consumed and have no harm on health. Moreover, for ensuring the quality of products, the company applying GMP, SSOP standards, and HACCP in production process.

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1. INTRODUCTION

The blue swimming crab (*Portunus pelagicus*) is one of Indonesia's export commodities, with the third-highest export value as a fishery product, behind shrimp and tuna. Total blue swimming crab exports in 2019 reached 12,749 tons and a value of over USD 259 million. The United States has become the largest market for Indonesian blue swimming crab exports, purchasing approximately 85% of Indonesia's total blue swimming crab exports. Other markets include European countries (France, the Netherlands, the United Kingdom, and Belgium) at 8%, and other countries at 7% [1].

Canning of blue swimming crab is done to preserve the meat and add value to the product [2]. In the canning process, there is the potential for contamination to arise, which can be caused by three groups of causes: physical, chemical, and biological contamination. These contaminants in food products need to be identified because their presence can have adverse health effects [3]. Furthermore, they can lead to a loss of consumer trust in the company, as the presence of these contaminants represents carelessness. Indonesian crabs are often exported fresh, frozen, and processed. One form of crab food is canned crab meat [4]. This can be

caused by unhygienic production processes. Efforts are needed to prevent physical, chemical, and biological contamination that can harm and endanger human health by implementing food safety principles to ensure safe food products are produced [5]. PT Pan Putra Samudra, as one of the exporters of canned chopped vegetables in Indonesia, must ensure the quality of its products to ensure they are suitable and safe for consumer consumption.

To ensure product quality, PT Pan Putra Samudra applies food safety principles to its production process. According to Government Regulation of the Republic of Indonesia Number 28 of 2004 concerning food safety, quality, and nutrition, food safety (food safety) is the condition and effort required to prevent food from potential biological, chemical, and other contaminants that can disrupt, harm, and endanger human health [6].

Food safety plays a crucial role in preventing foodborne illnesses [7]. This is because foodborne illness is a serious health problem in both developed and developing countries, such as Indonesia. WHO data from 2020 shows that approximately 600 million people fall ill globally due to contaminated food, claiming 420,000 lives each year [8]. In Indonesia itself, data obtained from the Food and Drug Authority (BPOM) in 2019 revealed that national food poisoning cases reached 20 million per year [9].

This high rate of food poisoning indicates that many food products still contain contaminants that are harmful to the body [10]. This indicates that food safety in Indonesia has not been properly implemented and is a significant problem in Indonesia. One effort Indonesia has made to address this problem is quality control through the implementation of quality management based on the Hazard Analysis Critical Control Point (HACCP) concept, adapted to Indonesian processing conditions [11].

PT Pan Putra Samudra has received HACCP certification. In implementing HACCP in a company, employees play a crucial role in implementing Good Manufacturing Practices (GMP) and Sanitation Standard Operating Procedures (SSOP), which are the basic requirements for implementing HACCP. A food safety system such as HACCP is essential to ensure product safety from potential hazards. According to Hermawan (2018), HACCP is a system designed to prevent food product quality problems caused by biological, chemical, or physical factors [12]. To ensure this, identification is necessary to identify potential contamination of canned crab meat at PT Pan Putra Samudra. This way, potential contamination can be prevented and safe and guaranteed products can be produced, thereby increasing product competitiveness in the market.

Previous studies in Indonesia have generally focused on contamination in seafood at the consumer or retail level [13], while investigations into contamination within specific processing facilities remain limited. Therefore, analyzing potential contamination in a HACCP-certified company like PT Pan Putra Samudra provides novel insights into how safety systems operate in practice and where gaps may still exist. The main contribution of this study is to identify potential sources of physical, chemical, and biological contamination in the production of canned crab meat at PT Pan Putra Samudra, highlighting critical control points and practical measures for food safety improvement. This study also provides evidence-based recommendations that can serve as a reference for other seafood processing industries in Indonesia to enhance compliance with international food safety standards.

2. MATERIAL AND METHOD

2.1. Materials

The materials used in the study were canned minced meat from PT Pan Putra Samudra, ethyl acetate, spiking solution, n-hexane, dilution buffer, enzyme conjugate, antibody, development solution, L-EMB medium, LSB medium, and distilled water.

2.2. Methods

Identification of contaminants in pasteurized canned minced meat products was carried out using three methods:

1. Organoleptic Testing

Several tests were conducted using parameters such as appearance, odor, taste, texture, and the number of shells and foreign objects. The organoleptic test assessment scores refer to the FDA, which are divided into three categories: 4-5 (pass), 3-3.5 (marginal), and <3 (fail) [14].

2. Chloramphenicol Test

CAP testing was conducted using the ELISA (Enzyme Linked Immunosorbent) method, referring to SNI 4224: 2015 [15][16]. First, the sample was prepared, then the enzyme conjugate, antibody, and developing solution were added. The CAP value was then analyzed using the Tecna AB660 Media ELISA Kit. The standard limit for CAP values in raw materials set by the company is <0.200.

3. Microbiological Testing

Microbiological testing was conducted on pasteurized canned chopped meat products. The parameters observed included the ALT test, which was tested based on SNI 01-2332.3-2015 [17], *Staphylococcus aureus*, and organoleptic testing based on SNI 01-2332.9-2011 [18], *Escherichia coli*, and Coliforms were tested in accordance with SNI 01 2332.1-2006 [19]. The types of samples tested microbiologically were primarily claw, special, and products containing specialty meat. This is because specialty meat has a finer texture, making it easier for bacteria to break down.

3. RESULTS AND DISCUSSION

3.1. Physical Contamination

Physical contamination is contamination that originates from physical contamination/objects that are visible. It can usually be caused by foreign objects such as metal fragments, wood, hair pieces, thread, gravel, staples, and parts of disease-carrying animals such as flies [20]. Identification of physical contamination in pasteurized canned minced meat products is carried out using organoleptic testing and counting the number of shells and foreign objects. The results of the organoleptic testing of the final product can be seen in Table 1 below.

Table 1. Results of organoleptic testing of final products

Types of product	Shell/ Certilage	Foreign Material	Score			
			Appearance	Smell	Flavour	Texture
Jumbo	4 soft	-	3	4	4	3
Jumbo lump	1 soft	-	3	4	4	3
Spesial	-	-	3	4	4	3
Colossal	5 tendon	-	4	4	4	4
Claw meat	2 hard	-	4	4	4	4
Cocktail	-	-	4	4	4	4

Notes:

4-5: Pass, 3-3.5: Marginal, <3: Fail

The results indicate that the physical contaminant still frequently found in the final product is the presence of shells. The results indicate that the highest number of shells is found in the colossal product, with 5 tendon shells. The presence of several shells in the final product is due to a lack of thoroughness by employees when sorting the meat. Therefore, repeated sorting is recommended to ensure the crab meat is completely clean and free of shells. No foreign material contamination was found in the final product. This is because the product has been sorted and foreign matter has been removed. These findings are consistent with research by Farag et al. (2023), who also reported shell residues as the most frequent form of physical contamination in processed crab products, mainly due to insufficient manual sorting. This indicates that repeated sorting procedures remain the most effective corrective action to minimize contamination [21].

Organoleptic testing of the final product was conducted using test parameters such as appearance, odor, taste, and texture. The appearance test results were scored in the range of 3-4. Meat with a score of 4 indicates a shiny white color. Meanwhile, a product with a score of 3 appears creamy white. The odor test results for all samples were scored 4, indicating the product has the sweet odor typical of crab meat. The taste test results for all samples were scored 4, indicating the product has the sweet flavor typical of crab meat. The texture test results were scored in the range of 3-4. Meat with a score of 4 indicates a dense texture that does not crumble easily. Meanwhile, a product with a score of 3 appears soft or moist. The results of organoleptic testing conducted on appearance, odor, taste, and texture parameters showed that the final canned crab meat product was safe for sale.

3.2. Chemical Contamination

Chemical contamination is contamination originating from chemical substances, either internal or external to food. For example, it can arise from the use of non-food preservatives such as formalin and borax [22]. The chemical contaminant identified in canned chopped meat products is chloramphenicol (CAP).

The results of the CAP test of the final product of pasteurized canned crab meat of various types can be seen in Table 2. The test results were compared to the company's standard, which sets a maximum CAP limit of 0.200 ppb for products, and the FDA's standard of 0.300 ppb for CAP content. The results showed that five samples had an "OK" status. These samples were jumbo meat with a CAP value of 0.053 ppb, jumbo lump with a CAP value of <0.025 ppb, lump with a CAP value of 0.062 ppb, colossal with a CAP value of 0.065

ppb, and special with a CAP value of 0.041 ppb. However, there is one product with a "Hold" status, namely claw meat, with a CAP value exceeding the limit of 0.468 ppb.

Table 2. Chloramphenicol (CAP) test results in final products

Sample	Result (ppb)	Status
Jumbo	0.053	OK
Jumbo lump	<0.025	OK
Lump	0.062	OK
Colossal	0.065	OK
Special	0.041	OK
Claw meat	0.468	Hold

Notes:

OK: <0.100 ppb, Retest: 0.100-0.149 ppb, Hold: >0.200 ppb

This CAP contamination can be caused by contamination from employees who do not adhere to the company's GMP and SSOP standards. Furthermore, CAP contamination can also originate from the crab's habitat, making CAP testing crucial for crab meat products. Compared to previous studies, CAP contamination exceeding permissible limits has also been linked to aquaculture environments exposed to antibiotic residues, highlighting that the problem may not only stem from poor handling practices but also from environmental bioaccumulation [23]. Therefore, corrective actions should include not only stricter GMP and SSOP compliance but also regular monitoring of crab harvesting areas to detect and mitigate environmental antibiotic contamination.

3.3. Microbiological Contamination

Identification of microbiological contamination in the final canned crab meat product was carried out using the parameters of ALT, *Escherichia coli*, *Staphylococcus aureus*, and Colyform. The results of the microbiological contamination testing can be seen in Table 3 below.

Table 3. Microbiological Test Results on Final Products

Parameter	Type of meat	Result	Standard
ALT	Claw meat	20	Maximum 10 ³
	Spesial	25	
	Lump	40	
<i>Staphylococcus aureus</i> (cfu/g)	Claw meat	Negative	0 cfu/g (Negative)
	Spesial	Negative	
	Lump	Negative	
<i>Escherichia coli</i>	Claw meat	Negative	<3 (Negative)
	Spesial	Negative	
	Lump	Negative	
Colyform	Claw meat	Negative	<3 (Negative)
	Spesial	Negative	
	Lump	Negative	

The results of microbiological contamination testing on all product samples were compared against SNI 6929:2016 and FDA standards [24]. The results showed that the ALT contamination parameter in none of the products exceeded the standard limit. The highest ALT value was found in the lump product, at 40 cfu/g, and the lowest value was found in the claw meat product, at 20 cfu/g. Testing for *Staphylococcus aureus*, *Escherichia coli*, and Coliform bacteria all samples returned negative results, indicating the absence of these bacteria.

Based on these test results, it can be concluded that all products are safe for consumption and can be marketed to consumers. This is because the production process involves pasteurization, which kills bacteria found in the meat. These results align with the findings of Dima et al. (2016), who also reported that pasteurization effectively suppresses microbial growth in crab meat products, thereby ensuring compliance with international food safety standards [25]. This reinforces that maintaining strict time-temperature control during pasteurization is critical to product safety.

3.4. Analysis of Causal Factors for Contamination in Products

Food contamination is the presence of undesirable substances found in food ingredients. Contamination in food products can include physical, chemical, and microbiological contaminants. Summarizing the results, physical contamination was predominantly due to shell residues, chemical contamination was marked by CAP exceeding limits in claw meat, and microbiological contamination remained within safe limits. This suggests that while microbiological risks are well controlled through pasteurization, the company must strengthen corrective actions for physical and chemical contamination, particularly through enhanced sorting protocols and environmental monitoring programs. These measures are crucial to align with international best practices in seafood safety management.

In crab meat products, physical contamination can include the presence of shell residue in the meat and foreign matter contamination. Shell residue in crab meat is caused by a lack of employee care in the meat sorting process. Therefore, employees are expected to be more careful in sorting crab meat and to perform the sorting process repeatedly to minimize the presence of shell residue mixed with the meat. Other physical contamination, in the form of foreign objects in crab meat, is caused by contamination between employees and the product or environmental contamination with the product. Contamination between employees and the product was found in the form of hair fragments in the meat. This was caused by employees working at the mini-plant not wearing head coverings. This contamination can be prevented by employees wearing hats [26]. Another foreign object contamination was the presence of nets in the meat. This can be caused by contamination of the meat with the environment or equipment, such as fishing net residue [27].

Chemical contamination in crab meat products is the presence of CAP (a type of toxic chemical) in the meat that exceeds the standard limit. CAP contamination can be caused by employees using cosmetics or medications containing CAP, which contaminates the crab meat [28]. Furthermore, CAP can also originate from the crab's aquatic habitat. In its habitat, crabs obtain food from contaminated seafood, which can lead to CAP contamination [29]. Microbiological contamination in crab meat can be caused by a lack of cold chain implementation, allowing bacteria to grow in the crab meat [30]. CAP contamination in meat can be caused by a lack of hygiene and sanitation practices in the production process at the mini-plant. Therefore, companies need to conduct regular checks at various mini-plants to ensure better products. CAP contamination can also originate from the aquatic habitat of the crabs, so CAP testing on crab meat products is essential to prevent such contamination. Furthermore, CAP contamination can be caused by employees who fail to adhere to the company's GMP and SSOP standards. Therefore, companies need to be more assertive in emphasizing employee adherence to GMP and SSOP standards during the production process.

4. CONCLUSION

Potential contamination in canned crab meat products at PT Pan Putra Samudra, Cirebon City, can include physical contamination such as the presence of shells mixed with the meat and foreign objects such as hair and nets. Chemical contamination includes chloramphenicol (CAP) content in the product exceeding >0.150 ppb. Actions that PT Pan Putra Samudra, Cirebon City, can take to prevent potential contamination in canned crab meat products include implementing and disciplining employees in adhering to the company's GMP and SSOP standards to ensure that the production process complies with HACCP standards. In addition, the company should strengthen supplier audits, raw material monitoring, and traceability systems to reduce the risk of contamination. Future work is recommended to focus on validation of processing parameters, integration of rapid detection methods, and continuous training programs to enhance employee awareness and compliance with international food safety standards.

Author Contribution

All authors contributed equally to the main contributor to this paper. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest

The authors declare no conflict of interest.

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