



PENGENDALIAN KUALITAS MUTU PADA *TUNA CUBE* BEKU MENGUNAKAN METODE *SEVEN TOOLS*

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ABSTRAK

Analisis pengendalian mutu dilakukan pada proses produksi *tuna cube* dengan tujuan untuk memastikan bahwa produk akhir dapat memenuhi tujuan dan spesifikasi yang ditetapkan oleh suatu perusahaan. Metode penelitian yang digunakan adalah *seven tools* yang berguna bagi perusahaan dalam menyelesaikan masalah dan memperbaiki proses. *Seven tools* tersebut antara lain *check sheet*, *control chart*, *flow chart*, diagram *pareto*, dan diagram *fishbone*. Hasil pengamatan selama sepuluh hari ditemukan produk cacat, meliputi *tuna cube* bertekstur lembek (45,45%), berbentuk segitiga (29,13%), dan salah ukuran (25,43%). Analisis diagram kendali menunjukkan bahwa selama sepuluh hari pengamatan tidak terdapat titik produksi yang melampaui *Upper Central Line* (UCL) dan *Lower Central Line* (LCL). Nilai CL sebesar 0,087835, nilai UCL tertinggi sebesar 0,314291 dan nilai UCL terendah sebesar 0,148615. Sedangkan nilai LCL tertinggi adalah 0,027055 dan nilai LCL terendah adalah -0,13862 dengan nilai *r* 5,29. Hasil pengamatan menunjukkan proses produksi *tuna cube* berada dalam batas kendali, dan tidak terjadi penyimpangan.

Kata kunci: Cacat, Pengendalian Mutu, *Seven Tools*, Tuna

QUALITY CONTROL OF FROZEN TUNA CUBE PROCESSING USING SEVEN TOOL METHODS

ABSTRACT

Quality control analysis was carried out in the *tuna cube* production process with the aim of ensuring that the final product can meet the objectives and specifications set by a company. The research method used was *seven tools* which is useful for companies in solving problems and improving processes. *Seven tools* include *check sheets*, *control charts*, *flow charts*, *pareto diagrams*, and *fishbone diagrams*. The results of observations for ten days found defects product, including *tuna cube* with mushy texture (45.45%), triangular shape (29.13%), and wrong size (25.43%). The control chart analysis shows that during the ten days of observation, there were no production points that exceeded the *Upper Central Line* (UCL) and *Lower Central Line* (LCL). The CL value is 0.087835, the highest UCL value is 0.314291 and the lowest UCL value is 0.148615. While the highest LCL value is 0.027055 and the lowest LCL value is -0.13862 with *r* value 5,29. Observation results show the production process of *tuna cube* is within the control limits, and there are no deviations.

Keywords: *Defect, Quality Control, Seven Tools, Tuna*

PENDAHULUAN

Tuna is one of the leading commodities in the industrialization program. This is because tuna is a type of fish with high economic value and is the largest foreign exchange earner from the fisheries sector, with the second number after shrimp. Indonesia in 2011 had tuna production of 6.8 million tons and increased the following year to more than 7 million tons. Tuna also has a reasonably high consumer demand (Yusuf et al, 2017). Tuna is a popular fishery commodity. Besides being delicious, tuna also has benefits for the health. Tuna has different nutritional content such as vitamin A (36.66 IU/100 g), vitamin B6 (2.48 mg/kg), omega-3, high in protein (28.34%), and rich in minerals such as selenium, phosphorus, and magnesium (Afifah, 2021).

On the other hand, fish is a food product prone to deterioration or perishable food. The decrease in the quality of fresh fish can be caused by the performance of enzymes and microbial growth. Careless handling of fresh fish and the application of poor sanitation can accelerate the deterioration of fish quality (Tatontos, et al).

The increasing development of fishing companies makes a company have

to achieve its target by making products that can compete for both qualities to meet consumer needs. In addition, it can also provide customer satisfaction by producing products according to predetermined standards. Therefore, it is necessary to carry out quality control in producing products according to standards. The seven tools method aims to determine the most dominant defects product and find out the cause of defect product.

METHODS

The method used in this research is quantitative descriptive. The data used in this study were sourced from primary data and secondary data. Primary data is data obtained through direct observation at PT ABC. Primary data was obtained through interviews and observation. Observation is done by observing and recording the behaviour patterns of subjects, objects, and recurring events. Interviews were conducted by collecting data through questions about the subject. Secondary data is data obtained in the form of notes and reports. Secondary data needed in this study is the amount of production of tuna cube products. Analysis data of this research using the seven tools method. The seven tools method is one of the simplest

graphical methods to solve problems. The Seven Tools method consists of flow chart, fishbone diagrams, pareto diagrams, check sheets, scatter diagrams, and control charts (Prasetyo et al, 2018). The seven tools method can identify improvement options in achieving a consistent and controlled production process.

(a) Check Sheet

The check sheet is the first step is to collect data using the check sheet. The data obtained are production data, and defects product data will be presented using a check sheet table. So it is easier to understand the data.

(b) Control Chart

Make a defects product control diagram by calculating the percentage of defects (p), calculating the centre line (CL), calculating the upper control limit or Upper Control Line (UCL), and calculating the lower control limit or Lower Control Line (LCL). The formula for calculating CL, UCL, and LCL is as follows (Bakhtiar et al, 2013):

1. Calculate the percentage of defects (p)

$$p = \frac{np}{n}$$

np = number of failures in sub group

n = amount checked

2. Calculate the *Central Line* (CL)

$$CL = \frac{\sum np}{\sum n}$$

np = total number of defects

n = total number checked

3. Calculate the *Upper Central Line* (UCL)

$$UCL = p + 3 \sqrt{\frac{p(1-p)}{n}}$$

p = average product nonconformity

n = total of production

4. Calculate the *Lower Central Line* (LCL)

$$LCL = p - 3 \sqrt{\frac{p(1-p)}{n}}$$

p = average product nonconformity

n = total of production

(c) Pareto Diagram

Determine the priority of repairs to product defects using the Pareto diagram.

(d) Fishbone Diagram

Find the dominant cause of defects product using a fishbone diagram.

(e) Repair Recommendation

Make recommendations related to product quality improvement.

RESULT AND DISCUSSION

Quality Control of Raw Material

During transportation, the fish were transported using a cooler box containing ice. This aimed to keep the low temperature of the tuna fish so that the

quality is maintained. The receiving of tuna raw materials begins with quality checks, namely checking the temperature of the raw materials, checking the grading of tuna, microbiological tests, and histamine tests. The Quality Control (QC) team carried out this quality inspection. The maximum critical temperature limit for tuna is 4.4°C. **Tuna is high in histidine. After the death of the fish, if the room temperature and the temperature of the fish are not immediately lowered, the bacteria will break down histidine into histamine** (Alexander, 20120. The average temperature of the raw materials received was below 4.4°C.

The raw materials must pass microbiological testing. The microbiological testing of tuna included total bacteria, *Escherichia coli*, *Salmonella* sp., *Vibrio* sp., and *Coliform*. The quality standard for microbiological examination for ALT is 5×10^5 colonies/g, Coliform is <3.0 MPN/g, *E.coli* is <3.0 MPN/g, *Vibrio* sp. was <3.0 MPN/g, as well as for *Salmonella* sp. is negative. The results of microbiological testing can be seen in the table. Based on the results of microbiological testing, it was known that the raw materials had met the requirements.

Table 2. Raw Material Microbiological Test Results

No	Sample	Parameter				
		SPC (colonies/g)	Coliform (MPN/g)	<i>E. coli</i> (MPN/g)	<i>Salmonella</i> sp (MPN/g)	<i>Vibrio</i> sp (MPN/g)
1	Raw material	1×10^3	0	0	Negative	0
2	Raw material	2×10^3	0	0	Negative	0
3	Raw material	$1,3 \times 10^3$	0	0	Negative	0

In addition to microbiological testing, raw materials must also pass histamine testing. Histamine is the primary chemical hazard that causes histamine poisoning. Histamine formation mainly occurs in fish due to fish muscle's time and temperature abuse. The FDA sets the maximum histamine level limit as 50 ppm

to ensure safety (Mohan et all, 2015). The maximum histamine level based on the standard SNI 7530.1:2009 is 50 ppm. While the standard PT. ABCused for maximum histamine levels is 50 ppm. The histamine test results in the table show that histamine levels are below the established standard.

Table 3. Level of Histamine

No.	Sample	Level of Histamine (ppm)	Industrial Standard	SNI	FDA
1		0.1	Max 50		

2	Raw	1.4	ppm	Max 50	Max 50
3	material	8.2		ppm	ppm

Quality control of Final Product

In order to determine the quality of the final product before being marketed, the tuna cubes were subjected to microbiological testing, including SPC, *Coliform*, *E. coli*, *Salmonella* sp., and *Vibrio* sp. The quality standard for microbiological examination for total bacteria is 5×10^5 colonies/g, *Coliform* is <3.0 MPN/g, *E. coli* is <3.0 MPN/g, *Vibrio* sp. was <3.0 MPN/g, as well as for *Salmonella* sp. is negative. Control activities are aiming at prevention or reduction of a food safety hazard and are typically related to product and process controls. Microbial test mostly expressing the safety or hygiene of the product present on the finished product (Zwietering et al, 2016).

Based on the test results in Table 4, it can be seen that the tuna cube product meets the microbiological testing standards. If the product is contaminated with *E.coli* it can cause watery diarrhea, *Salmonella* sp causes diarrhea, malaise, nausea and *Vibrio* sp causes diarrhea, nausea, and sunken eyes (Hui, 2014). Therefore, a microbial test was carried out on the product. The tuna cube product is packaged using PE plastic and put in a cardboard box. This finished product will be stored in cold storage at a temperature of -25°C to -45°C . Low-temperature storage is done so that the product does not experience quality deterioration. Storage in cold storage is carried out until the product is distributed.

Tabel 4. Final Product Microbiological Test Results

No.	Sample	SPC (colonies/g)	<i>Coliform</i> (MPN/g)	<i>E. coli</i> (MPN/g)	<i>Salmonella</i> sp (MPN/g)	<i>Vibrio</i> sp (MPN/g)
1		7×10^2	0	0	Negative	0
2	<i>Tuna</i>	3×10^2	0	0	Negative	0
3	<i>Cube</i>	2×10^3	0	0	Negative	0
4		$1,7 \times 10^3$	0	0	Negative	0

Flow Chart

A flowchart is a graphical representation that contains inputs, activities, decision points, and outputs to achieve the main objectives of the process.

This flowchart is a problem-solving tool that visualizes the sequence of steps and decisions needed to carry out a process. In addition, flowcharts help to study, plan, improve, and communicate complex

processes in dealing with product breakdowns and process problems (Abdel-Hamid and Abdelhaleem, 2019). Flowcharts use symbols that describe the type of activity in each process. The

rectangular symbol represents the process and the diamond symbol represents the decision point (McCormick and Sanders, 2022).

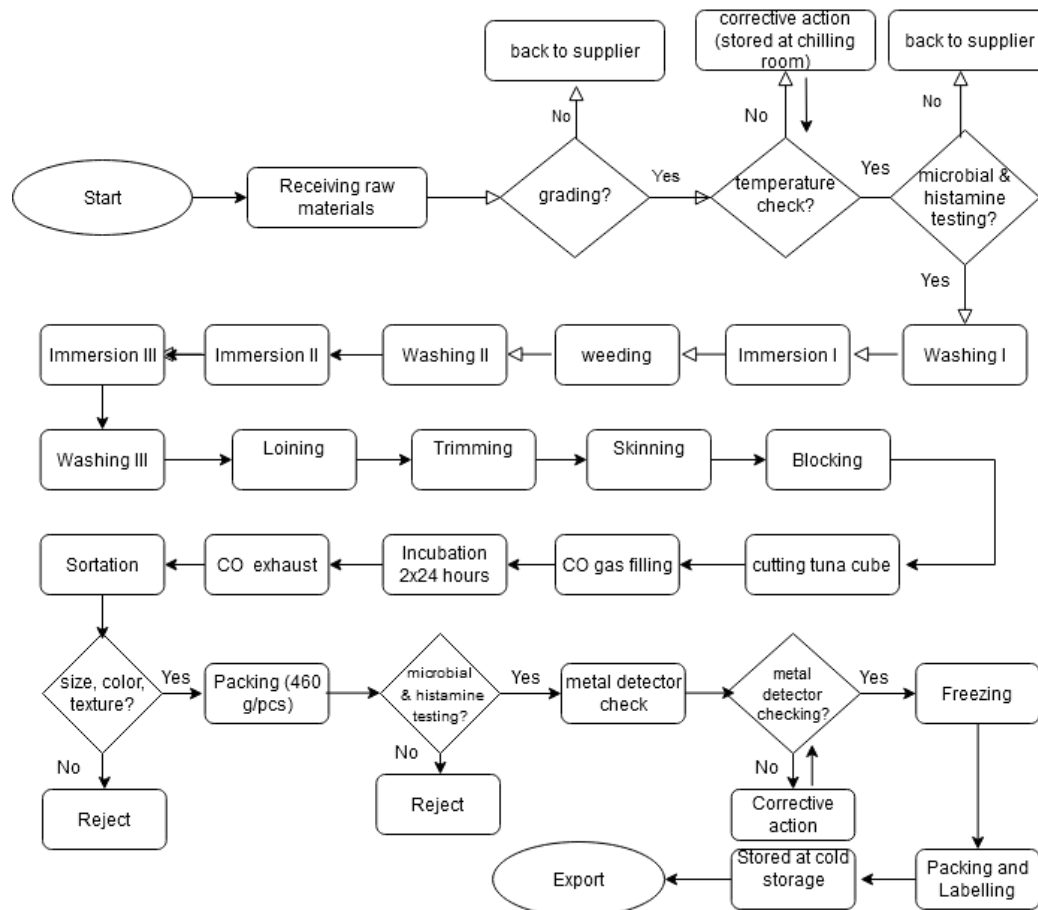


Figure 1. Flow Chart of Tuna Cube Production

Check Sheet

The check sheet is a simple sheet containing a list of things needed to record data. So that data collection can be done quickly, systematically, and regularly when the data appears during the research (Rachmawati and Ulkhaq, 2016). A check

sheet is an essential tool in collecting data. This data can be used in pareto diagrams (Muhammad, 2015). Data collection of defects to tuna cube products was carried out for ten days. The following (table 5) are the results of observations of defects product during the processing:

Tabel 5. Check Sheet of defects product

No	Total Production (kg)	Defects Product			Defect Product (kg)	% Defect
		Wrong Size (kg)	Triangular Shape (kg)	Mushy Texture (kg)		
1	115,49	2,656	2,887	3,465	9,008	8%
2	195,19	4,880	4,099	5,758	14,737	8%

3	37,72	0,377	0,868	1,735	2,98	8%
4	35,74	0,536	0,715	1,5	2,751	8%
5	155,94	3,432	3,89	6,861	14,183	9%
6	139,36	2,788	4,18	7,246	14,214	10%
7	26,92	0,533	0,188	1,357	2,078	8%
8	14,061	0,479	0,394	0,768	1,641	12%
9	113,16	2,544	3,209	3,179	8,932	8%
10	65,32	1,85	2,567	4,014	8,431	13%
Total	898,901	20,075	22,997	35,883	78,955	9%

The observations showed that the total defects to tuna cube products for ten days was 78.955 kg from the total production of 898.901 kg. The most defects of tuna cube products was products with a mushy texture, as much as 35,883 kg, followed by products with a triangular shape of as much as 22,997 and products with inappropriate sizes, as many as 20.075 kg. The average percentage of defects product for ten days is 9%.

The defect product (Figure 2) with a mushy texture occurred because the raw materials undergo repeated thawing so that the raw material undergoes sensory

changes. Apart from changes in texture, raw materials also have a pale color that is less attractive. The tuna cube product with a triangular shape occurs because the raw material has black spots, so it must be disposed of. As a result, when the tuna cube is cut, some of the raw materials are produced in a triangular shape. Tuna cube product with the wrong size. A tuna cube has a size of 2 cm. Raw materials that do not always have the same side can produce several tuna cubes with a size of less than 2 cm and were the result of worker negligence.



Figure 2. The type of defect product (a) mushy texture (b) triangular shape (c) wrong size

Fishbone Diagram Analysis

Fishbone diagram is one of the methods of Seven Quality Tools that is used to find the cause of a problem on the production floor. Fishbone diagram is a

type of flowchart used for analyzing the root cause of defects in a manufacturing process (Jeff, 2014). Fishbone diagram, there are two methods, namely 4M's method, and 6M's method. If the problem is

small, then in the search for cause and effect, it is enough to use the 4M's method (Men, Material, Machine, and Method). At the same time, complex problems use the 6M's method, namely the addition of Money and Management (Muhammad,

2015). Quality control of the tuna cube was to conduct an objective assessment to determine the factors that are suspected to be factors of quality control through the following cause-and-effect diagram:

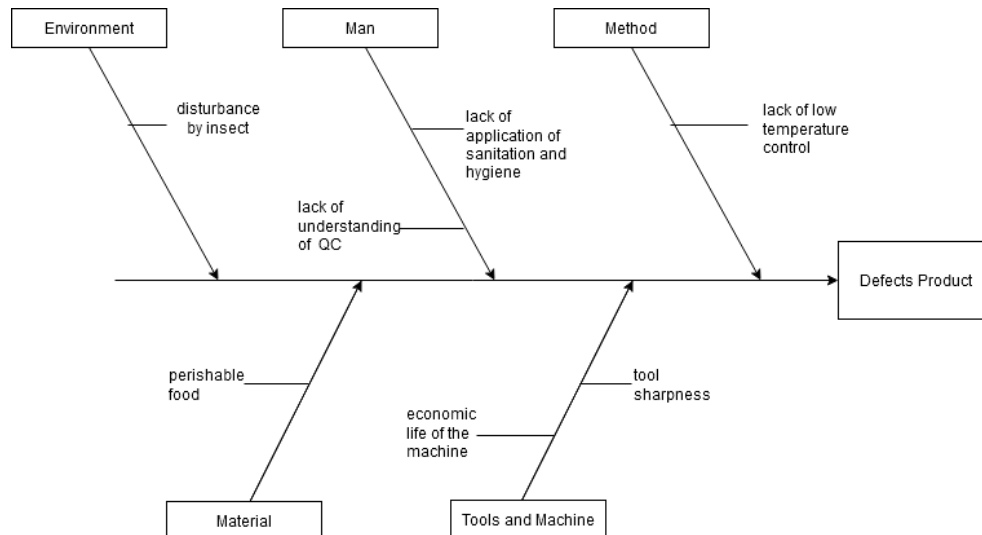


Figure 4. Fishbone Diagram

Based on the fishbone diagram, it is known that several external and internal factors cause the cause of the decline in the quality of tuna cube products. These factors include the following:

1. Material

The material used has a significant influence on product quality. As raw material, tuna is categorized as a perishable food which quickly deteriorates or declines in quality. Fish that have died will undergo a process of reducing various components and the formation of new compounds. This will result in changes in smell, taste, and texture. This defects will take place quickly because the mechanism is triggered by microbial and enzymatic

activity (Tavares, 2021). So in the management process, extra attention is needed to fast and precise handling and low-temperature treatment. Prolonged handling of raw materials can increase the histamine content. The high histamine content in tuna is due to temperature, time, and storage conditions (Yusni et all, 2019). So it can affect the final product quality of tuna cube. Raw materials that have not been finished handling will be put into the freezing room and handled the next day. Furthermore, the thawing process will be carried out before processing the raw materials. Food can be damaged by chemical, physical, and microbiological changes during the thawing process.

Freezing and thawing processes in meat and fish result in protein denaturation, weight loss, lipid oxidation, and changes in texture (Baygar and Alparslan, 2015). Repeated freezing-melting treatment in the samples studied experienced a decrease in the meat's organoleptic value with pale meat color and soft, rancid odor (Tatontoe et al, 2019). the texture of the raw material becomes mushy. So that the resulting tuna cube product has a mushy texture.

2. Method

The method is a set of justified ways of carrying out the manufacturing process. The most important thing in fish handling is low-temperature control to maintain fish quality. Fish meat can change and cause a rancid odor. Fish contain high protein, high water content, and easily damaged tissue (Wang et al, 2022). The application of low-temperature control in the production process starts from receiving raw materials using ice and using central cooling to keep the room temperature low. However, in the production room, sometimes the room temperature does not match the standard, which is a maximum of 21°C, so the product's texture can become mushy.

3. Man

The cause of decline in product quality can be caused by humans. This is related to the lack of information related to quality control, where workers sometimes

do not apply the applicable SOP. One of the cases was workers dropping fish and products. Workers do not immediately wash using water added with chlorine but only with fresh water. This will result in product contamination.

On the other hand, fish and falling products can be bruised. Physical defects to fish causes fish to bruise so that the texture of the meat becomes mushy (Lestari et al, 2015). Workers negligent during the tuna cube cutting process will produce products of inappropriate sizes. Another factor is the lack of sanitation and hygiene. Workers in the production process sometimes do not pay attention to sanitation and hygiene properly, even though facilities that support sanitation and hygiene have been provided. This may result in cross-contamination of the product.

4. Environment

The production environment is threatened by insects such as flies, moths, and the like, which are attracted to the fishy smell of fish and their waste. Insects can cause contamination, so product quality decreases, and food safety is not guaranteed. In dealing with this matter, the factory Chas installed insect killers at the entrance to the production room and the reception room for raw materials. Insect eyes are susceptible to UV rays. Insect killer that utilizes UV rays will attract the attention of insects such as

moths. So that insects do not enter the production room (Shimoda and Honda, 2013). There is also a blower in the production room so that the liquid waste produced will be disposed of directly.

5. Tools and Machine

ABF machines and vacuum machines have an important role in the continuity of the production process. Each machine has an economic life that can make products with maximum capacity. The economic life of the ABF engine and vacuum engine is 5 years. If the machine is used beyond its economic life, it will have an impact on the production process, and production costs will increase (Tajudin et al, 2019). In addition, the sharpness of tools such as knives is essential. If the knife is not sharp, the production process can take a long time and cause product defects,

such as the wrong size or the production of a tuna cube in the shape of a triangle. Before doing the cutting process, PT. ABC will sharpen the knife first.

Pareto Diagram

Pareto chart is a chart that contains a bar chart and a line chart. The bar chart shows the classification and value of the data, while the line chart represents the total cumulative data (Rachmawati and Ulkhaq, 2016). Pareto diagrams are used for further analysis of various problems both before and after corrective actions are implemented (Djekic et al, 2013). Classification of sorting data based on the frequency of the problems that occur the most to the problems that occur the least. The frequency and percentage of causes of defects to tuna cube products are as follows:

Table 6. The Frequency and Percentage of Defects Product Tuna Cube

Defect of Product	Frequency	Percentage	Cumulative	% Cumulative
Mushy texture	35,883 kg	45,45%	35,883 kg	45%
Triangular shape	22,997 kg	29,13%	58,880 kg	75%
Wrong shape	20,075 kg	25,43%	78,955 kg	100%
Total	78,955 kg	100%		

Based on the table, the frequency and cumulative percentage of the production of tuna cube products for ten days of production. The following analysis

will process the data into a Pareto diagram. The Pareto diagram regarding the defect to tuna cube products was as follows.

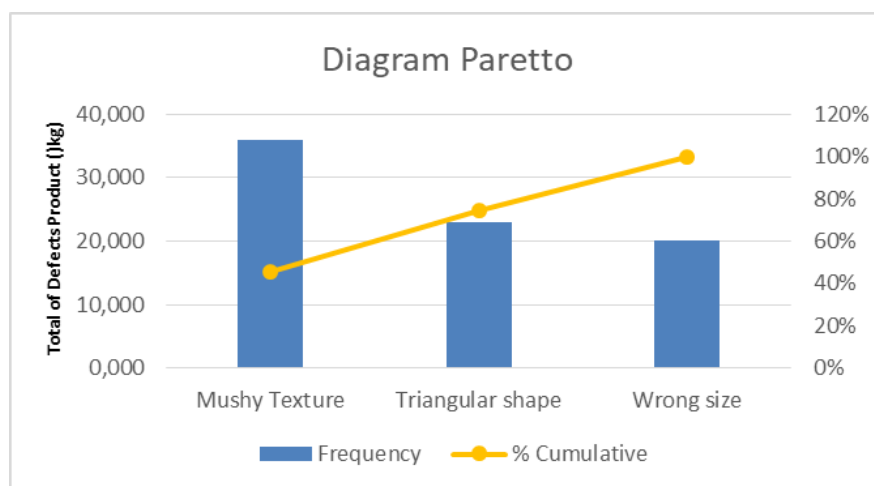


Figure 5. Pareto Diagram

A Pareto diagram is used in obtaining the leading cause of defects to be treated first. In a bar graph, the highest graph is on the far left, which represents the highest product breakdown. Based on the results of the pareto diagram analysis, it can be seen that the production of tuna cube has the highest type of defects, which was a product with a mushy texture with a percentage of 45.45%, followed by a product that had a triangular shape with a percentage of 29.13% and then a product with an inappropriate size of 25.43%.

Control Chart Analysis

The control chart is a map used to study how the process changes over time.

Through this picture, it will be detected whether the process is running stable or not. The characteristic of this chart was the existence of a pair of upper and lower control limits (upper and lower limits). So, from the data collected, it was possible to detect trends in the actual process conditions (McCormick and Sanders, 2022). During ten days of production of tuna, the cube obtained a central line (CL) level of defects product was at 0.087835. The highest UCL value was 0.314291, and the lowest UCL value was 0.148615. The highest LCL value was 0.027055, and the lowest LCL value was -0.13862.

Table 7. Upper, Lower and Central Control Limit of Defects Tuna Cube Product

No	Date	Total Production (kg)	Defect Products (kg)	p	CL	UCL	LCL
1	05/07/2024	115,49	9,00822	0,078	0,087835	0,166852	0,008818
2	06/07/2024	195,19	14,73685	0,0755	0,087835	0,148615	0,027055
3	07/07/2024	37,72	2,98	0,079003	0,087835	0,226098	-0,05043
4	08/07/2024	35,74	2,751	0,076973	0,087835	0,229876	-0,05421
5	09/07/2024	155,94	14,183	0,090952	0,087835	0,155836	0,019834
6	11/07/2024	139,36	14,214	0,101995	0,087835	0,159767	0,015903
7	12/07/2024	26,92	2,078	0,077192	0,087835	0,2515	-0,07583

8	13/07/2024	14,061	1,641	0,116706	0,087835	0,314291	-0,13862
9	14/07/2024	113,16	8,932	0,078932	0,087835	0,167661	0,008009
10	15/07/2024	65,32	8,431	0,129072	0,087835	0,192903	-0,01723
Total		898,901	78,95507				

$$p = \frac{np}{n} = \frac{9,00822}{115,49} = 0,078$$
$$CL = \frac{\Sigma np}{\Sigma n} = \frac{78,95507}{898,901} = 0,087835$$
$$UCL = p + 3 \sqrt{\frac{p(1-p)}{n}} = 0,087835 + 3 \sqrt{\frac{0,08783511 (1-0,08783511)}{115,49}} = 0,166852$$
$$LCL = p - 3 \sqrt{\frac{p(1-p)}{n}} = 0,08783511 - 3 \sqrt{\frac{0,08783511 (1-0,08783511)}{115,49}} = 0,008818$$

The following is a control chart of tuna cube production for ten days:

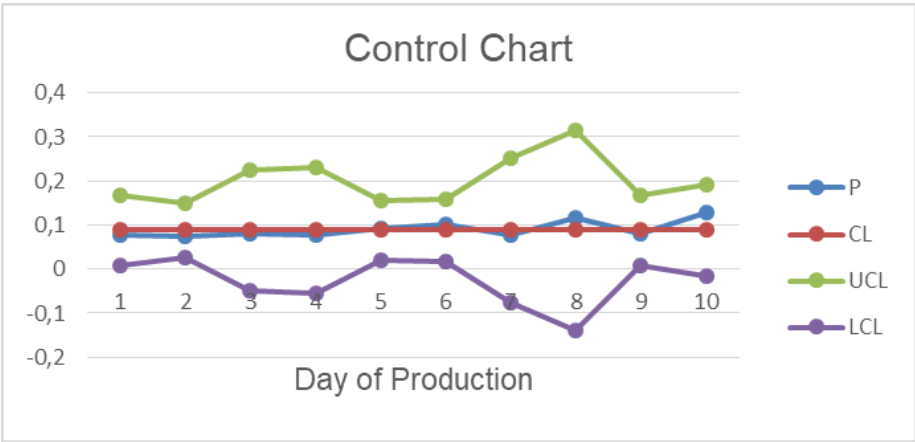


Figure 6. Control Chart

Based on the analysis using the control chart, it could be seen that the graph above shows that there was no out-of-control limit for UCL and LCL. The point that was within the limit, it could be seen that the process was under control. If the point was outside the limit, then the process was out of control (Ginting and Malik, 2020). Some points in or near the center line or Central Line (CL) are points 1,2,3,4,5,6,7,8,9. While point 10 was above

the central line (CL). Based on this, it was known that the production of tuna cubes for ten days was still under control. This is because no point goes out of the control limit that has been determined.

Recommendations

As for some suggestions for improvement or input that can be given based on the factors causing defects to tuna cube products, it could be seen in Table 7 below.

Table. 8 Recommendation to Deal with Defect Product				
Problem			Suggestions	
Low	temperature	control	during	Keep the central cooling machine or blower in each production room running. Re-closing the chiller

	and cold storage doors so that heat does not enter the chilling room and cold storage
Lack of information regarding QC	The quality control team conducts direction and provides training to workers.
Lack of application of sanitation and hygiene	More supervision when workers enter the production room
Economic life of the machine	The technician considers the machine's good economic life and performs maintenance and checks on the machine.

CONCLUSION

Based on the data processing results using seven tools for ten days of observation, no production exceeded the upper and lower limits. So, it could be concluded that the production of tuna cubes was under control. Types of defects to tuna cube products encountered included products with a soft texture (45.45%), triangular shape (29.13%), and wrong sizes (25.43%). During ten days of observation, it was known that the CL value was 0.087835, the highest UCL value was 0.314291, and the lowest UCL value was 0.148615. While the highest LCL value was 0.027055 and the lowest LCL value was -0.13862. Factors causing product defects could come from the environment, materials, humans, machines, and methods.

ACKNOWLEDGEMENT

We would like to thank the Faculty of Fisheries and Marine Sciences, Brawijaya University, for facilitating this research activity.

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