AGROIndustrial

Volume 11
Issue 2
2024

ISSN 2252-6137 (print)
ISSN 2302-3848 (online)
Available online at www.jurnal.ugm.ac.id/agroindustrial

Department of Agro-Industrial Technology
Faculty of Agricultural Technology
Universitas Gadjah Mada
in collaboration with APTA

APTA

AGROINDUSTRIAL JOURNAL

Published By

Department of Agroindustrial Technology

Faculty of Agricultural Technology, Universitas Gadjah Mada

Indonesia Association of Agro-Industry Technologist

(APTA)

Mailing Address

Editorial Office of Agroindustrial Journal (AIJ)
Faculty of Agricultural Technology, Universitas Gadjah Mada
Jl. Flora No.1 Bulaksumur, Yogyakarta 55261, Indonesia
Telp. (0274) 551219, Faks. (0274) 551219
E-mail: agroindustrial-journal.tp@ugm.ac.id
Website: https://jurnal.ugm.ac.id/agroindustrial/

Table of Content

Development of Packaging Design and Shelf-Life Determination for Rendang Powder Seasoning at UD Serba Guna Abadi

Zahra Faradisyi*,[1], Guntarti Tatik Mulyati[1], and Arita Dewi Nugrahini[1]
[1]Department of Agroindustrial Technology, Faculty of Agricultural Technology
Universitas Gadjah Mada, Jl. Flora No.1 Bulaksumur 55281, Indonesia.
Email: zahrafdisyi@gmail.com*

Received: February-12-2024; Accepted: September-26-2024; Published: December-31-2024

Abstract
According to the National Socio-Economic Survey (SUSENAS) in 2020, the average consumption of packaged seasoning from 2016 to 2020 grew the highest compared to other types of food at 9.13%. One of the most popular packaged seasonings is rendang powder, often accompanied by problems such as easily torn primary packaging, poor packaging, and incomplete packaging label information. To overcome these problems, developing a packaging design and determining the shelf-life is necessary. This research aims to create a concept for packaging powdered rendang seasoning that offers the highest value and to determine the product's shelf-life using the chosen packaging. The packaging design for powdered rendang seasoning was developed using value analysis and shelf-life was determined using the Arrhenius model through Accelerated Shelf-Life Testing (ASLT). Based on the research, out of five packaging concepts tested, it was found that packaging concept 2 has the highest value of 1.31 with packaging specifications using a packaging material of aluminum foil combined with plastic. A stand-up bag with a rectangular clear section, the package has a notch, zipper, and full labeling. Packaging concept 2 is the chosen packaging concept that meets the research objectives. It addresses the issue of easily torn packaging and includes improvements in packaging quality and more comprehensive packaging labeling. Based on the shelf-life determination of 3 packaging that has the highest values and 1 control package, packaging concept 2 has the longest shelf-life of 131 days, and based on the results of the proximate test conducted, packaging concept 2 is packaging with a sample that does not differ significantly (p value>0.05) with the control sample for all parameters quality.

Keywords: *packaging; proximate; seasoning; SNI; value analysis*

1. INTRODUCTION

Indonesia is one of the largest producers of spices in the world. Data from the Food and Agriculture Organization (FAO) in 2016 showed that Indonesia is the fourth-largest spice-producing country, with a total production of 113.649 tons. Many people use spices as essential in cooking. According to the National Socio-Economic Survey (SUSENAS) (2020), the average consumption of condiments per inhabitant in annual consumption, condiments/packages of prepared foods grew the most from other food types, which is 9.13%. The average consumption of other spices per inhabitant is shown in Table 1.

Table 1. Average consumption of spices per capita

Utensils	Unit	Year					Average growth (%)
		2016	2017	2018	2019	2020	
Cooking flavoring	Grams	339.87	340.69	366.04	362.54	360.01	1.51
ready-made chili sauce/ketchup	140 ml	-	-	2.00	3.00	4.00	-
Ready-to-eat seasonings/package	Ounces	1.57	1.65	2.00	2.02	2.21	9.13
Other kitchen seasonings	-	5.90	5.28	6.23	6.69	7.25	5.81

Source: National Socio-Economic Survey (SUSENAS) (2020)

ISSN 225-6137 (print), ISSN 2302-3848 (online), doi: 10.22146/aij.v11i2.94027

The quality requirements of the product must be considered to maintain the quality of the packaged product. SNI is used to assess and test a product owned by a business or trademark owner. SNI encourages the creation of products with certain standards, which can only be produced if the production process meets certain criteria (Sujayanto, 2016). Based on SNI 01-3709-1995 for powdered spices, powdered spice products must meet some quality requirements, as shown in Table 2.

Table 2. SNI 01-3709-1995 for powdered spices

No.	Test Criteria	Unit	Requirement
1	Condition		
1.1	Odor	-	Normal
1.2	Taste	-	Normal
2	Water	%b/b	Max 12.0
3	Ash	%b/b	Max 7.0
4	Acid Insoluble Ash	%b/b	Max 1.0
5	Smoothness escapes sieve No.40		Max 90.0
6	Metal Contamination		
6.1	Lead (Pb)	mg/kg	Max 10.0
6.2	Copper (Cu)	mg/kg	Max 30.0
7	Arsenic contamination (USA)	mg/kg	Max 0.1
8	Microbial contamination		
8.1	Total plate numbers	colony/g	Max 10^6
8.2	*Escherichia coli*	APM/g	Max 10^3
8.3	Mold	mg/kg	Max 10^4
9	Aflatoxin	mg/kg	Max 20

One of the most popular seasoning powders is rendang powder seasoning. Rendang was voted the most delicious food in the world by more than 35000 CNN Travel readers in a poll in 2011 (Benayoun, 2014). In the preliminary research, at least 10 samples were collected from packages of rendang spice bought at mini markets from traditional markets to commercial places, and then the packages were grouped. The grouping is done independently based on the package's realization from the package's functional and visual appearance. According to Cenadi (2000), it is stated that the functional/practical aspects of packaging are the effectiveness and efficiency of packaging, which consists of the ability to protect the package, the ease of opening the package, the ease of closing the package, can be carried, or held, can be reused. Visual aspects include colors, shapes, illustrations, package charts, layouts, and package label integrity. All packages that mainly correspond to the functional and visual aspects of the package are grouped in Class I. All packages that meet only 5-7 functional aspects and the visual aspect of the package are grouped in class II. All packages that do not meet the functional and visual aspects of the package or that only meet up to five functional and visual aspects of the package are then grouped in Class III. The resulting sample class grouping is shown in Table 3.

Table 3. Sample class grouping

Class	Fulfillment of Packaging Aspects (%)	Percentage (%)
Class I	> 70	20
Class II	50-70	60
Class III	<50	20

One of the classes II rendang powder seasoning is from UD Serba Guna Abadi. The main packaging used for rendang powder seasoning from UD Serba Guna Abadi is a plastic stamp doll made of polypropylene (PP) with a thickness of 0.3 mm and a size of 12 x 20 cm. Samson paper is used as a secondary packaging material. In addition, there have been several complaints about seasoning powder packaging circulating in the market, including primary packaging that was torn during transport, causing spillage of spices, incomplete packaging labels such as use, expiration date, and production code, and seals on the main package are not tight enough.

Therefore, it is necessary to develop a packaging design for rendang powder seasoning that can functionally protect and preserve the packaged product and can visually contain packaging labels. This research aims to produce a packaging design concept for powdered rendang seasoning products that has the highest value, can maintain the quality of the packaged product, and can determine the shelf-life of the packaged product from the selected packaging.

Three methods can be used in packaging design development, including Quality Function Deployment (QFD), Value Engineering (VE), and Value Analysis (VA). Quality Function Deployment (QFD) can translate consumer needs into technical characteristics of the company. However, this QFD method makes it difficult to distinguish the many different needs of consumers and the conceptual differences between consumers and companies. Value Engineering (VE) can also be used for product development, but the value engineering method requires more time in the product development process and is more suitable for products that are still in the development stage. Value Analysis (VA) is an effective method to improve product performance by reducing costs while maintaining the quality of the product itself. Packaging development can also be done by knowing the packaging specifications desired by consumers, which can later be developed into packaging that has high performance at minimal cost.

Shelf-life was determined using the Arrhenius model through Accelerated Shelf-Life Testing (ASLT). Shelf-life calculations were carried out to evaluate the packaging, and whether the 3 packages with the highest values could store the product properly or not. Proximate analysis was conducted after the product was packaged using the 3 highest-value packages to ensure that there is no significant difference between the product quality using the 3 highest-value packages and the control sample.

2. MATERIAL AND METHODS

This research was conducted in June-December 2022, and the subject of the study was 250g packaged rendang powder seasoning produced by UD Serba Guna Abadi. The respondents of this study are packaging experts and consumers of UD Serba Guna Abadi rendang powder. Expertise is a person who has competence in a field. In this study, filling out the questionnaire by expertise was carried out by 5 people, including 2 academics and 3 people from the Agriculture and Food Security Service. Furthermore, the consumers in question were people who have bought powdered rendang seasoning products within the last 6 months. As well as 100 consumers of powdered rendang seasoning participated in filling out the questionnaire. The research was conducted by going through 5 steps of value analysis, after which the shelf-life and close testing of the three highest-value packages continued.

2.1 Value Analysis

There are 5 steps in value analysis to find the most valuable result of packaging design.

1. Information Phase
   The information phase is the phase where the necessary information is collected. Part of the things done in the information phase are preliminary observations, the purpose of which is to find out information related to the product used as a research object, formulation of the problem and definition of the goal, literature studies that help the research process, and data analysis and the basis for finding out the quality indicators of the package, the purpose of which is to find out the quality indicators to be developed.

2. Creation Phase
   In the creation phase, priority is developed by package functions. The priority of the development of the packaging functions is carried out through the expert evaluation method using a questionnaire, where experts in the packaging industry are asked to answer the survey by choosing one answer from the three existing scales, i.e., important, useful, and unimportant. A Content Validity Ratio (CVR) test is performed to test the content validity of the claim using the following formula:

$$CVR = \frac{\left(ne - \frac{N}{2}\right)}{\frac{N}{2}} \tag{1}$$

3. Analysis Phase
   The analysis phase is carried out using the results of the Function Analysis and System Technique (FAST) diagram. FAST diagrams are schematic techniques organized to systematically identify activities and describe the relationships between these activities (Pasaribu and Puspita, 2016). FAST diagrams are arranged in a hierarchy of functions, with high-level functions on the left and low-level functions on the right. FAST graphs are created with questions about how and why. Fast plotting starts with a predefined basis function, which is usually processed by the basis function (Nuruddin and Andesta, 2008).
4. Development Phase
   The development phase is carried out by creating a new packaging concept. When doing packaging development, several inputs add value to the packaging of rendang powder seasoning from Serba Guna. After obtaining alternatives, we will develop, and then conduct packaging tests for Water Vapor Transmission Rate (WVTR) and transform existing alternatives into multiple packaging concepts and prototypes of actual product packaging.
5. Recommendation Phase
   The recommendation phase is the phase where recommendations for finished prototypes are processed. Several things are done during the recommendation stage, including testing prototypes with questionnaires, determining product performance, determining the value of each concept, and determining new packaging concepts. The respondents of this study were consumers of powdered rendang spice living in the Jabodetabek district. Sampling using non-probability sampling methods and determining the number of samples to use using the Lemeshow formula as follows:

$$n = \frac{Z^2 \times p \times (1-p)}{d^2} \tag{2}$$

   After the questionnaire has been tested on respondents, the importance and relative importance of each attribute can then be calculated. The determination of importance and relative importance can be carried out using the following formula:

$$importance\ level = \frac{number\ of\ respondent\ answer\ scores\ per\ attribute}{number\ of\ respondents} \tag{3}$$

$$\%\ relative\ importance\ level = \frac{importance\ level}{total\ importance\ level} \tag{4}$$

   Product performance can be determined by adding the coefficients of the total value of the questionnaire to the weight of the quality characteristics of the product development.

Attribute weights are derived from a preliminary study related to the identification of quality attributes desired by consumers using the zero-to-one method, based on the principle of determining the proportionality of one attribute as "more important" or "less important" compared to other features. The purpose of the zero-one method is to help prioritize activities/criteria (Kurniawan et al., 2021). Performance can be determined using the following formula:

$$Performance = \sum(concept\ weight\ \times attribute\ weight) \quad (5)$$

The value calculation for each concept can be calculated by combining the performance value and price of each concept. The formula to calculate the value is:

$$Value = \frac{performance}{product\ cost} \quad (6)$$

Once the value of each package concept is found, it can be determined by assigning a new package concept by looking at the most valuable package concept.

2.2 Determination of Shelf-life

Shelf-life is determined using the Arrhenius model using the Accelerated Shelf-Life Test (ASLT) method. To achieve a correct correlation, at least 3 product storage temperatures are needed, with at least 5 observation points during storage. Commonly used test temperatures for dry food are 25, 30, 35, 40, and 45°C (Asiah et al., 2018). This study used storage temperatures of 25, 35, and 5°C and a storage time of 21 days, and data was viewed and retrieved daily. Once the data is collected, it is plotted against the old storage and decay data. Then, the linear regression equation and its ordering value (R2) appeared. In addition, the order of the reaction is determined by looking at the closest species value of 1. After that, a graph of the relationship between 1/T and ln k is constructed. Additionally, shelf-life can be determined using the following equation:

Order 0
$$t = \frac{(Q_0 - Q_s)}{k} \quad (7)$$

Order 1
$$t = \frac{ln(\frac{Q_0}{Q_s})}{k} \quad (8)$$

2.3 Proximate Analysis

A proximate analysis was performed to determine the nutritional value of the sampled food ingredients. Proximate analysis is important in this study to determine product quality consistency, production process control, efficiency optimization, and regulatory compliance. The analysis carried out includes the content of moisture, ash, fat, protein, and carbohydrates.

1. Water content

   The moisture content can be determined using the oven method by drying the sample at a temperature of 100-105 °C for 3-5 hours. The sample is then cooled in a desiccator and weighed. This is done until a constant weight is reached (the weight difference is <0.02 mg). Moisture content can be determined using the following formula:

$$Water\ Content(\%) = \frac{initial\ sample\ weight - final\ sample\ weight}{initial\ sample\ weight} \times 100\% \quad (9)$$

2. Ash content
   Ash content can be determined using a thermogravimetric method where up to 2 g of samples are placed in a porcelain crucible placed in a furnace and burned to ash. The enslavement process is then carried out in a furnace with a temperature of 600 °C. After completion, the sample is cooled in a desiccator, and is weighed. The ash content can be determined using the following formula:

$$Ash\ Content(\%) = \frac{final\ weight\ of\ sample\ (ash)}{initial\ weight\ of\ sample} \times 100\% \tag{10}$$

3. Fat content
   The Soxhlet method can generally be used to determine the fat content of a food ingredient. In this method, the sample is wrapped in paper and then extracted with a Soxhlet for several hours. Then, when the extraction is complete, the sample is placed in an oven until it reaches a constant weight and then weighed. The fat content can be determined using the following formula:

$$Fat\ Content(\%) = \frac{Initial\ weight\ (b) - \ final\ weight\ (c)}{Sample\ initial\ weight\ (a)} \times 100\% \tag{11}$$

4. Protein content
   The Kjeldahl method can be used to determine the protein content of a food ingredient. In this method, the process of determining the content of protein passes through digestion, distillation, and titration. For titration, the distillate is titrated with a standard solution of 0.02 N HCL to the endpoint of the titration (blue color to pink). Protein levels can be determined using the following formula:

$$Nitrogen\ (\%) = \frac{Vol\ Titration\ \times Normality\ \ HCL \times Nitrogen\ Atoms}{Sample\ Weight\ \ (mg)} \times 100\% \tag{12}$$

$$Protein\ Content\ (\%)\ = Nitrogen\ content\ x\ Correction\ factor\ \ (6{,}25) \tag{13}$$

5. Carbohydrates content
   Carbohydrate levels can be determined quantitatively using the Nelson-Somogyi method. The principle of the Nelson-Somogyi method is to analyze the amount of reducing sugar by looking at the ability of the saccharide to reduce to free copper ions from copper oxides, which are converted into copper oxide.

3. RESULTS AND DISCUSSION

3.1 Value Analysis

3.1.1 Information Phase

One of the most important steps in the information phase is to find out the quality characteristics of the package. The definition of the quality characteristics of the packaging is based on previous observations, starting from interviews with manufacturers, brainstorming with manufacturers, literature research, and independent observation of similar products on the market (Zulkarnain et al., 2020). A preliminary study was conducted by collecting 10 samples of powdered rendang seasoning packaging obtained from minimarkets, traditional markets to marketplaces, then grouping the packaging based on the fulfillment of the functional aspects and visual aspects of the packaging. Based on the grouping conducted, it was found that 60% of the packaging of powdered rendang seasoning products only fulfilled 50-70% of the functional aspects and visual aspects of the packaging. The average powdered rendang seasoning product is packaged using plastic only as primary packaging, making it difficult for consumers to close/store the product that has been used, in some cases, the packaging used is easily torn so that the contents of the product come out of the packaging and the incomplete packaging label such as expiration date and how to use. Using the above methods, some of the primary quality attributes of packaging were found to be packaging material, packaging shape, packaging design, ease of packaging, labeling, and packaging cost. This also applies to Anarghya et al. (2020), according to which the main characteristics of packaging are material, shape, convenience, graphic design, and labels. In addition to the primary attributes, there are also secondary attributes that are listed in Table 4.

Table 4. Packaging quality attributes

No.	Primary	Secondary
1	Material	Type of Material (plastic, aluminum foil, etc.)
2	Shape	Packaging Shape (rectangular/standing pouch) Packaging size (length and height) Transparent section shapes (rectangles, circles, etc.)
3	Ease	Ease of unpacking (there is a notch, using tools, jagged ends of the packaging) Ease of closing packaging (zip lock, additional covering tools) Ease of carrying packaging (with straps or handheld directly)
4	Graphic design	Color combination of labels and packaging Attractive and easy-to-read typeface Interesting illustrations/images
5	Label	Label making techniques (stickers, screen printing, printing) Product name Raw material information Net weight Name and address of the manufacturer Halal Production date and code Permit number (P-IRT) Expiry date, month, and year
6	Cost	Manufacturing cost per pack

On the other hand, proximate analysis testing has been carried out on the initial sample of powdered rendang seasoning. The test results are as follows: moisture content 1.80±0.035%; ash content 0.07±0.000%; fat content 0.18±0.012%; protein content 0.32±0.025%; and carbohydrate content 2.48±0.002%. The results of the testing of powdered rendang seasoning samples against SNI 01-3709-1995 found that the moisture content and ash content for the product samples used were still below the maximum percentage that had been set.

3.1.2 Creative Phase

Furthermore, in the creative phase of creating effective packaging, it is essential to fulfill three main functions of packaging: as a product protector, as a container, and as a promotional medium. If these three main functions are met, it will result in packaging that attracts consumers and functions at its best (Wahyudi & Satriyono, 2017). The prioritization of the package functions to be developed is used in the expert evaluation study to evaluate the priority of the development of the package functions made by several parties. An expert opinion is a person who qualifies in a field. In this study, 5 people, including 2 researchers and 3 people from the Department of Agriculture and Food Safety, completed the questionnaire with expert judgment. The prioritization of the package functions to be developed is used in the expert evaluation study to evaluate the priority of the development of the package functions made by several parties. After filling out the questionnaire, the Content Validity Ratio (CVR) test is continued, by which the compatibility of the content of each sentence in the questionnaire with the subject under consideration is determined, and the value of each feature is determined. According to the CVR table, with a significance level of 5%, the rating scale of the CVR test is -1 to 1. This peer-review survey has 20 statements that the panelists then rate. package development priority. The evaluation uses a scale of 1-3, where scale 3 means "important", scale 2 "useful but not important" and scale 1 is "not important". The results of developing the design of the rendang powder package selected by expert judgment are shown in Table 5.

Table 5. Priority of developing rendang powder seasoning packaging design

Statement	Code
Type of Material (Plastic, aluminum foil, etc.)	M1
Transparent section shapes (rectangles, circles, etc.)	S3
Ease of unpacking (there is a notch, using tools, jagged ends of the packaging)	E1
Ease of closing the packaging (zip lock, additional covering tools)	E2
Attractive and easy-to-read typeface	D2
Product name	L1
Raw material information	L2
Net weight	L3
Name and address of the manufacturer	L4
Halal	L5
Production date and code	L6
Permit number (P-IRT)	L7
Expiry date, month, and year	L8

3.1.3 Analysis Phase

In the analysis phase of packaging design development, the product tries to find and develop as many different alternative ideas as possible that can fulfill the main function (Friadi et al., 2022). In the analysis phase, the FAST diagram is used, which facilitates the mapping of the activities to be carried out. A FAST diagram is a technique for systematically describing product characteristics (Pasaribu & Puspita, 2016). In the FAST scheme, high-level functions are placed on the left, and low-level functions on the right. FAST is an efficient technique for finding the relationship between functions. The FAST diagram shows which functions are executed by which component if the components are presented. The FAST diagram becomes even more valuable and useful in the value measurement phase if cost and importance are allocated and posted for the functions on the diagram. The function analysis categorizes the components based on their functions; either there is a primary or a secondary function of components (Khan et al., 2018).

The results of the FAST diagram feature mapping are shown in Figure 1.

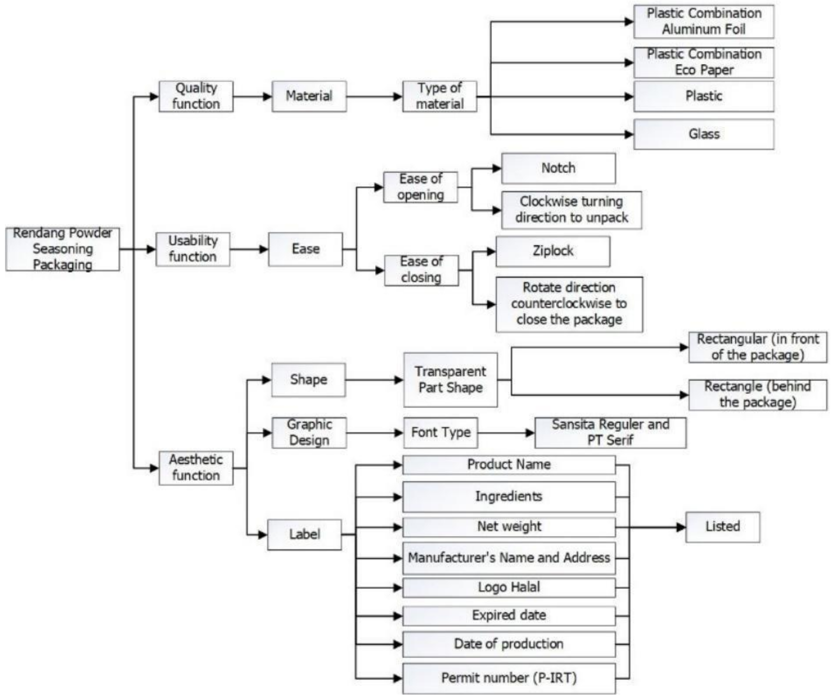

Figure 1. FAST diagram of rendang powder seasoning packaging

3.1.4 Development Phase

The development phase will be carried out by creating a new packaging concept based on the results of the packaging experts identification of packaging needs (Arif, 2017). After this, the alternative development work of Powdered Rendang Seasonings will be carried out for each package attribute, and the results are shown in Table 6.

Table 6. Alternative development of rendang seasoning packaging

No.	Packaging Quality Attributes	Development Alternatives
1	Types of Packaging Materials	Plastic combination of transparent aluminum foil Plastic combination of white aluminum foil PP Plastic Plastic combination eco paper Glass
2	Packaging form	Standing pouch Bottle Jar
3	The shape of the transparent part	Rectangle in front of the packaging Rectangle behind the packaging Entire packaging
4	Ease of opening	Notch Clockwise direction of rotation to open
5	Ease of closing	Ziplock Counterclockwise direction of rotation to close
6	Font	Sansita Regular and PT Serif
7	Packaging labels	Listed

Source: (Putri et al., 2021)

When choosing a packaging material, it is very important to consider the characteristics of the packaging and the nature of the packaging properties (Julianti, 2014). 5 different types of packaging materials are used in the development of alternative packaging material types. These include aluminum packaging combined with white plastic, aluminum packaging combined with clear plastic, eco-paper combined with plastic packaging, polypropylene packaging (PP), and glass packaging (Rokilah et al., 2018). Four The drying method is used in this test, and the five packages used are multi-layered. According to Julianti (2017), multi-layer multi-material packaging is the packaging of two or more layered materials formed into a single thin film sheet. A combination of plastic, paper, and aluminum foil is usually used. Website ukmpack.com, based on the data, the packaging combination of transparent plastic and white plastic aluminum foil has a layer of OPP / SPE-VMOPP / SPE material. Then, the PP package has OPP/CPP cover material, and the eco-paper composite plastic package has Litho/PET/CPP cover material. Packaging testing can be done using several methods, one of which is the WVTR method. The water vapor permeability (WVTR) test can be used to determine the ability of the package to withstand the entry and exit of water vapor. The advantage of the WVTR method is that it can provide information on how well the packaging material can withstand water vapor, which can affect the product's shelf-life, freshness, and safety (Wahyu et al., 2017). The WVTR value can be obtained using the dryer or water method (Lastriyanto et al., 2007). The drying method is used in this test. The drying method is used to ensure that all samples begin with uniform moisture conditions. This consistency is essential for obtaining accurate and reliable results in the packaging performance evaluation, as it eliminates variability that could arise from differing initial moisture levels in the samples. The higher the WVTR number of the package, the worse the protective properties of the package under test. The WVTR test results for the alternative packages are shown in Table 7.

Table 7. WVTR Packaging test results

Packaging	Material layer	WVTR (g/m²/day)
Plastic combination of transparent aluminum foil	OPP/SPE-VMOPP/SPE	0.1486
Plastic combination of white aluminum foil	OPP/SPE-VMOPP/SPE	0.1300
PP Plastic	OPP/CPP	0.3408
Plastic combination eco paper	Litho/PET/CPP	0.3729

Based on Table 7, it is found that the package with the lowest WVTR value is the package of aluminum foil combined with plastic, with the package material layer in the form of OPP / SPE-VMOPP / SPE. This package has a thickness of 16 and 17 μm and results in WVTR values of 0.0186 and 0.1300 g/m²/day. It is Syafira et al. (2018) that the WVTR value of 16 μm aluminum packaging is 0.1506 g/m²/day. Finally, the development phase involves prototyping the product packaging. Based on the alternative development of the packaging quality functions, several rendang powder Seasoning Packaging concepts are prepared and arranged based on the existing alternative compatibility so that the packaging function works optimally. The results of some packaging concepts for Powdered Rendang Condiment can be seen in Table 8.

Table 8. Conceptual production results for rendang powder seasoning packages

Alternative concepts	Packaging Quality Attributes					
	Types of Packaging Materials	The shape of the transparent part	Ease of opening	Ease of closing	Font	Product information
Concept 1	Plastic combination of transparent aluminum foil	Rectangle	Notch	Ziplock	Sansita Regular & PT Serif	Listed
Concept 2	Plastic combination of white aluminum foil	Rectangle	Notch	Ziplock	Sansita Regular & PT Serif	Listed
Concept 3	PP Plastic	Rectangle	Notch	Ziplock	Sansita Regular & PT Serif	Listed
Concept 4	Plastic combination eco paper	Rectangle	Notch	Ziplock	Sansita Regular & PT Serif	Listed
Concept 5	Glass	Bottom of the packaging	Clockwise direction of rotation to open	Counterclockwise direction of rotation to close	Sansita Regular & PT Serif	Listed

3.1.5 Recommendation Phase

The testing phase involves several tests. First, consumer package testing is conducted through questionnaires. Based on the results of a survey distributed to 100 respondents, the rating points for each concept are found in Table 9.

Table 9. Packaging Concept Assessment Score

Packaging Attributes	Concept				
	1	2	3	4	5
Types of Packaging Materials	272	302	301	222	349
Transparent Part Shape	318	233	344	336	334
Ease of Packaging	292	323	338	337	338
Graphic Design Packaging	325	335	326	332	340
Packaging Labelling	322	339	320	329	336

In the data collection process, 100 respondents were required to be consumers of rendang powder seasoning. Differences in how respondents evaluate the attributes may affect the result of the analysis. To manage this, appropriate statistical methods are employed to address variability in the data. Then, the importance and the reactive importance level of each package attribute is calculated. The results of the calculation of the importance level and attribution importance level are shown in the following Table 10.

Table 10. Summary of the results of the favorite questionnaire test on the packaging concept

Packaging Attributes	Concept					Sum	Importance level	Relative importance (%)
	1	2	3	4	5			
Types of Packaging Materials	272	302	301	222	349	1446	14.46	18.20
Transparent Part Shape	318	233	344	336	334	1565	15.65	19.70
Ease of Packaging	292	323	338	337	338	1628	16.28	20.50
Graphic Design Packaging	325	335	326	332	340	1658	16.58	20.87
Packaging Labelling	322	339	320	329	336	1646	16.46	20.72
	Sum					7943	79.43	100.00

In addition, the performance of each package is determined. First, the performance of each package is determined using the Zero One method, which aims to help determine the priority order of functions (criteria) (Kurniawan et al., 2021). With the zero-one method, several concepts can be compared based on each respondent's criteria and rating points. The results of the performance value calculation for each package concept are as follows in Table 11.

Table 11. Determination of performance of each packaging

	Item	Types of Packaging Materials	Transparent Part Shape	Ease of Packaging	Graphic Design Packaging	Packaging Labelling	Performance
Relative importance (%) (R)		18.20	19.70	20.50	20.87	20.72	
Concept 1	Score (S)	10	10.00	0	0	10	**586.30**
	S × R	**182.05**	**197.03**	**0**	**0**	**207.23**	
Concept 2	Score (S)	30	0.00	11.11	30.00	40	**2228.99**
	S × R	**546.14**	**0.00**	**227.73**	**626.21**	**828.91**	
Concept 3	Score (S)	0	40.00	33.33	10.00	0	**1680.05**
	S × R	**0.00**	**788.12**	**683.20**	**208.74**	**0.00**	
Concept 4	Score (S)	0	30.00	22.22	20.00	20	**1878.48**
	S × R	**0.00**	**591.09**	**455.47**	**417.47**	**414.45**	
Concept 5	Score (S)	40	20.00	33.33	40.00	30	**3262.08**
	S × R	**728.19**	**394.06**	**683.20**	**834.95**	**621.68**	

In addition, value calculations are made by dividing the performance by the package costs. The cost table for each package concept is shown in Table 12.

Table 12. Manufacturing Price per Unit Packaging

Material	Unit Price (Rp)	The cost of the concept (Rp)				
		1	2	3	4	5
Al. foil + transparent plastic and printing		1,700				
Al. foil + white plastic and printing			1,700			
Transparent PP plastic packaging and printing				1,700		
Plastic Packaging + eco paper and printing					1,700	
Glass Bottle						4,653
Sticker logo	5,000					500
Total		1,700	1,700	1,700	1,700	5,153

The results of calculating the value of each package are shown in the following Table 13.

Table 13. Value of each packaging concept

	Performance	Cost	Value
Concept 1	586.30	1,700.00	0.34
Concept 2	**2,228.99**	**1,700.00**	**1.31**
Concept 3	1,680.05	1,700.00	0.99
Concept 4	1,878.48	1,700.00	1.10
Concept 5	3,262.08	5,153.00	0.63

Based on the calculation results in Table 13 above, it can be stated that package concept 2 is the package concept with the highest value at 1.31. The selected packaging concept is shown in Figure 2.

Figure 2. Selected Packaging Concepts with Size 23x14 cm

Packaging concept 2 uses aluminum packaging material combined with white plastic on the back of the packaging, which has a transparent rectangular shape as the chosen concept. The size of the pouch is 23x14 cm. Based on a previous study by Zuniarto et al. (2021), aluminum foil is a stable package consumers prefer in instant powder packages. Packaging concept 2 is in the form of a stand-up bag, with a notch/opening point in the upper right and left corners of the package to facilitate consumer opening of the package and a zipper at the top. of the package, which makes it easier to reseal an open package. The font used in Packaging Concept 2 is Sansita Regular and PT serif, and the pack has images, namely *Rumah Gadang* and cows, as well as several spicy images. The addition of the label to packaging concept 2 complies with BPOM Regulation No. HK. 03.1.5.12.11.09955 of 2011 on the registration of processed foods, which states that the labeling of processed foods must have at least the name of the processed food, net weight, name and address of the manufacturer, list of ingredients used, registration of foods number, expired information, and production code. Given the problems identified in the introduction, the selected packaging concept can address issues of easily damaged packaging, thereby improving packaging quality. The chosen packaging concept also meets packaging labeling requirements.

3.2 Determination of Shelf-life

The shelf-life of the product is determined for 3 selected packages that have the highest value using the ASLT method of the Arrhenius model. The products were stored using the Arrhenius model ASLT method in the Bioindustry Laboratory of the Faculty of Agricultural Technology for 21 days. Three different temperatures are used to store the products, namely 25, 35, and 45°C, and product control points are made daily during storage. Product checks are carried out daily, especially for fragrances. Shelf-life calculations using formulas 7 and 8 can be seen in Table 14.

Table 14. Shelf-Life Calculation

	Arrhenius Equation		
	Packaging 2	Packaging 3	Packaging 4
	ln kt = 33,714 - 11020x(1/T)	ln kt = 27,99 – 9217.4x(1/T)	ln kt = 17,138 - 5798x(1/T)
ln kt	-3.265865772	-2.940872483	-2.318375839
kt	0.03816388	0.052819624	0.098433327
Shelf-life	131.013934	94.66178636	50.79580393
	131 days	95 days	51 days

Based on the table above, packaging 2, in which aluminum packaging material is combined with plastic, has a longer shelf-life compared to other types of packaging. The shelf-life of packaging 2 is 131 days, or equivalent to 4 months and 11 days. After that, packaging 3 with PP plastic packaging material has a shelf-life of 95 days, and finally, the package, which combines plastic packaging materials with eco-paper, has a shelf-life of 51 days.

According to the study conducted by Ijayanti et al. (2020), *wedang uwuh* powder stored at room temperature in aluminum foil, PP plastic, and a combination of aluminum foil and plastic packaging, respectively have shelf lives of 30, 44, and 45 weeks. This means that the combination packaging has the longest shelf-life compared to other packaging tested.

3.3 Proximate Analysis

Proximate analysis is performed according to the SNI 01-2891-1992 standard for testing food and beverages. The evaluation of the package exceeded the original samples, and the samples were packed in the three most valuable packages, which are package 2 (aluminum foil composite plastic), package 3 (plastic PP), and package (Plastic composite eco-paper). 3-month shelf-life, used as samples. Testing for moisture content using the thermogravimetric method by evaporating all the water in the sample. The ash content is obtained from the combustion process of the sample to determine the trace element content. The fat content is determined by the Soxhlet method, and the protein content by the Kjeldahl method. Carbohydrate content based on total sugars is determined by the Nelson-Somogyi method. The results of the close test of reference samples with package samples 2, 3, and 4 can be seen in Table 15.

Table 15. Results of general proximate analysis

Proximate Levels (%)	Packaging			
	Control	2	3	4
Moisture Content	1.80 ± 0.035	1.870 ± 0.48	1.94 ± 0.007	1.95 ± 0.016
Ash Content	0.07 ± 0.000	0.08 ± 0.004	0.09 ± 0.007	0.08 ± 0.004
Fat Content	0.18 ± 0.012	0.014 ± 0.021	0.18 ± 0.002	0.14 ± 0.009
Protein Levels	0.32 ± 0.025	0.34 ± 0.004	0.32 ± 0.007	0.33 ± 0.001
Carbohydrate Levels	2.48 ± 0.002	2.31 ± 0.005	1.80 ± 0.003	2.44 ± 0.001

The data are presented in mean ± SD, n = 2

To determine whether the data is normally distributed, a normality test was performed using the Shapiro-Wilk method since the sample data had less than 50 samples. Based on the normality test, it was concluded that the measurement data for water, ash, protein, and fat content are normally distributed. This can be seen from its significance value > 0.05. Since the data are normally distributed, the experiment can be continued with a parametric test using the independent sample t-test method. For carbohydrate levels, the significance value is based on the Shapiro-Wilk normality test, the significance value < 0.05 to conclude that the data are not normally distributed, and the test can be continued with a non-parametric test using the Mann-Whitney method. When tested by the independent sample t-test method, the p-value of each package was found in Tables 16, 17, and 18.

Table 16. Proximate Analysis comparison of control samples and Packages 2

Proximate Levels (%)	Control	Packaging 2	*P Value*
Moisture Content	1.80 ± 0.035	1.870 ± 0.480	0.238
Ash Content	0.07 ± 0.000	0.080 ± 0.004	0.095
Fat Content	0.18 ± 0.012	0.014 ± 0.021	0.130
Protein Levels	0.32 ± 0.025	0.340 ± 0.004	0.333
Carbohydrate Levels	2.48 ± 0.002	2.310 ± 0.005	0.121

Table 17. Proximate Analysis comparison of control samples and packages 3

Proximate Levels (%)	Control	Packaging 3	*P Value*
Moisture Content	1.80 ± 0.035	1.94 ± 0.007	0.036*
Ash Content	0.07 ± 0.000	0.09 ± 0.007	0.095
Fat Content	0.18 ± 0.012	0.18 ± 0.002	1.000
Protein Levels	0.32 ± 0.025	0.32 ± 0.007	1.000
Carbohydrate Levels	2.48 ± 0.002	1.80 ± 0.003	0.121

Table 18. Proximate Analysis comparison of control samples and packages 4

Proximate Levels (%)	Control	Packaging 4	*P Value*
Moisture Content	1.80 ± 0.035	1.95 ± 0.016	0.033*
Ash Content	0.07 ± 0.000	0.08 ± 0.004	0.095
Fat Content	0.18 ± 0.012	0.14 ± 0.009	0.057
Protein Levels	0.32 ± 0.025	0.33 ± 0.001	0.771
Carbohydrate Levels	2.48 ± 0,002	2.44 ± 0.001	0.121

The data are presented in mean ± SD, n = 2
The sign (*) indicates a significantly different result (P value<0.05) based on the independent sample t-test

The characteristics of packaging material greatly affect the durability of the product. The higher the packaging barrier, the better the packaging is at maintaining the packaged product to extend its shelf-life. Factors that cause changes in food products become the basis for determining the critical point of shelf-life. One of the factors that greatly affects the decline in the quality of food products is changes in product moisture content.

Packaging 2 is made of aluminum foil combined with plastic, with a thickness of 17 µm, and has a WVTR value of 0.1300 g/m2/day. Based on statistical analysis of independent sample t-test and Mann-Whitney test, it was found that after the product was stored for 3 months using packaging 2, there was no significant difference in its quality content based on proximate analysis. Then based on shelf-life testing, the shelf-life of products packaged using packaging 2 is 131 days.

Packaging 3 is made of PP plastic material with a thickness of 14 µm and has a WVTR value of 0.3408 g/m2/day. Based on the statistical analysis of the independent sample t-test and Mann-Whitney test, it was found that there were significant differences in the quality content of the products based on proximate analysis, especially in moisture content. Then based on shelf-life testing, the shelf-life of products packaged using packaging 3 is 95 days.

Packaging 4 is made of eco-paper combination plastic material with a thickness of 19.4 µm and has a WVTR value of 0.3729 g/m2/day. Based on the statistical analysis of the independent sample t-test and Mann-Whitney test, it was found that there were significant differences in product quality content based on proximate analysis, especially in moisture content. Then based on shelf-life testing, the shelf-life of products packaged using package 4 is 51 days. According to the study conducted by Ijayanti et al. (2020), *wedang uwuh* powder stored at room temperature in aluminum foil, PP plastic, and a combination of aluminum foil and plastic packaging respectively have shelf lives of 30, 44, and 45 weeks.

4. CONCLUSIONS

Packaging Concept 2 uses aluminum packaging material combined with rectangular clear white plastic has a higher value of 1.31. The packaging specifications of packaging concept 2 are the top of the package has a notch/opening and a zipper, the font used in package 2 is Sansita Regular and PT serif, and the inclusion of labels in packaging concept 2 complies with BPOM regulation number HK. 03.1.5.12.11.09955 of 2011 on the registration of processed foods. Based on shelf-life determination, out of the 3 packaging with the highest value tested, packaging concept 2 is the best in terms of shelf-life, which is 131 days. In addition, packaging concept 2 is a package in which the products can be stored without significant differences compared to the control samples.

REFERENCES

Anarghya, A. P., Kastaman, R., & Mardawati, E. 2021. Pengembangan Kemasan Nata De Coco dengan Pendekatan Value Engineering. 32, 16-26. https://doi.org/10.24198/agrikultura.v32i1.32406

Anonim. 2020. Statistika Konsumsi Pangan 2020. Jakarta: Pusat Data dan Sistem Informasi Pertanian.

Arif, M. 2017. Perancangan Tata Letak Pabrik. Deepublish, Sleman.

Asiah, N., Cempaka, L., & David, W. 2018. Panduan Praktis Pendugaan Umur Simpan Produk Pangan. Universitas Bakrie, Jakarta.

Benayoun, M. 2014. Rendang Retrieved 06 24, 2024, from 196 Flavors: https://www.196flavors.com/indonesia-rendang/

Cenadi, C. S. 2000. Peranan Desain Kemasan Dalam Dunia Pemasaran. 92-103. https://doi.org/10.9744/nirmana.2.2.

Friadi, J., Satriawan, B., Sigid Safarudin, M., Puspita Dewi, N., & Titik Windayati, D. 2022. Kewirausahaan Berbasis Produk. Samudra Biru, Yogyakarta.

Ijayanti, N., Listanti, R., & Ediati, R. 2020. Pendugaan Umur Simpan Serbuk Wedang Uwuh Menggunakan Metode ASLT (Accelerated Shelf-life Testing) dengan Pendekatan Arrhenius. 1, 46-60.

Julianti, S. 2014. The Art of Packaging. PT Gramedia Pustaka Utama, Jakarta.

Julianti, S. 2017. A Practical Guide to Flexible Packaging: PT Gramedia Pustaka Utama. Jakarta

Khan, Z. A., Siddiquee, A. N., Kumar, B., & Abidi, M. H. 2018. Principles of Engineering Economics with Applications. Cambridge University Press, United Kingdom.

Kurniawan, E., Simaremare, A. A., Prahastono, I., & Nainggolan, A. 2021. Kajian Alternatif Metode Kerja Perbaikan Trashrack (Saringan) Intake Malalo Unit PLTA Singkarak. 23, 18-27. https://doi.org/10.14710/rotasi.23.4.18-27

Lastriyanto, A., Dwi Argo, B., Sumardi, H., Komar, N., Choviya Hawa, L., & Bagos Hermanto, M. 2007. Penentuan Koefisien Permeabilitas Film Edible Terhadap Transmisi Uap Air, Gas O_2 dan Gas CO_2. 8, 182-187.

Nuruddin, M., & Andesta, D. 2008. Pemilihan Mesin Welding Otomatis Dengan Penerapan Value Engineering Dan Analitical Hierarchy Process. 11, 74-85. https://doi.org/10.18196/st.v11i1.791

Pasaribu, M. F., & Puspita, R. 2016. Tahap Informasi, Kreatif, dan Analisa Pada Rekayasa Nilai Untuk Meningkatkan Kualitas Pelayanan Hotel. 5, 46-51. https://doi.org/10.53912/iejm.v5i2.142

Putri A, A., Kastman, R., & Mardawati, E. 2021. Pengembangan Kemasan Nata De Coco dengan Pendekatan Value Engineering. 32, 16-26. https://doi.org/10.24198/agrikultura.v32i1.32406

Rokilah, Prarudiyanto, A., & Werdiningsih, W. 2018. Pengaruh Kombinasi Kemasan dan Masa Simpan Terhadap Beberapa Komponen Mutu Bumbu Plecingan Instan. 6, 60-68. https://doi.org/10.29303/jrpb.v6i1.76

Sujayanto, G. 2016. Apa Perlunya SNI dan Manfaatnya? Retrieved 06 23, 2024, from Badan Standarisasi Nasional: https://bsn.go.id/main/berita/berita_det/7147/Apa-Perlunya-SNI-dan-Apa-Manfaatnya-

Syafira, Supardianningsih, & Nugraha, M. 2018. Identification of Water Vapour Transmission Rate (WVTR) of Aluminum Foil Packaging Barrier using The Gravimetric Testing Method. 6, 49-54. https://doi.org/10.46961/jip.v6i1.80

Wahyu S, B., Nurcahya D, E., & Susanto, E. 2017. Karakteristik Edible Film Campuran Tepung Semirefined Karaginan dengan Penambahan Tepung Tapioka dan Gliserol. 6, 1-6.

Wahyudi, N., & Satriyono, S. 2017. Mantra Kemasan Juara. PT Elex Media Komputindo, Jakarta.

Zulkarnain, Machfud, Marimin, Darmawati, E., & Sugiarto. 2020. Rancangan Model Purwarupa Kemasan Kopi Speciality. 30, 1-12. https://doi.org/10.24961/j.tek.ind.pert.2020.30.1.1

Zuniarto, A. A., Mundzir, O. A., & Maulida, N. A. 2021. Uji Formulasi dan Kemasan Serbuk Instan Perasan Kulit Buah Jeruk Nipis (Citrus Aurantifiola). 6, 4845-4857. https://doi.org/10.36418/syntax-literate.v6i10.4346

Agroindustrial Journal Vol. 11 No.2 (2024) 63-71

Study of Bioactive Content in Liberica Ground Coffee *(Coffea liberica* Var*.)* and Bajakah Tampala Roots *(Spatholobus littoralis* Hassk*)* Growing in Peatland Using GC-MS

Saputera[*,1], Erni Dwi Puji Setyowati[1], Wayan Riki Mahendra[1], and Rahmad Zulkifly[1]
[1]Department of Agroindustrial Technology, Faculty of Agriculture, Universitas Palangka Raya
Email: saputeramardi@tip.upr.ac.id[*]

Received: March-13-2024; Accepted: September-26-2024; Published: December-31-2024

Abstract

Liberica coffee (Coffee liberica Var.) is known as a typical peatland coffee because of its ability to adapt to peat soils compared to other types of coffee. The bajakah tampala plant (Spatholobus littoralis Hassk) *is a plant from the genus Spatholobus. The roots of the bajakah tampala are used empirically as medicine by the Dayak community. Based on hereditary experience, boiled water from bajakah tampala root can be used as a medicine for stomach pain, diarrhea, and dysentery. This plant contains phenolics, flavonoids, tannins and saponins so bajakah tampala can be used as herbal medicine. Until now, the active compound content of the combination of Liberica coffee and bajakah tampala root is unknown. Thus, this research aims to determine the bioactive content of Liberica coffee and bajakah tampala roots. This research was conducted using two factorials, Randomized Complete Block Design (RCBD), where Factor 1, consists of Liberica coffee powder concentrations, and Factor 2 consists of bajakah tampala powder concentrations. Each factor had 3 levels. Bajakah tampala roots were sorted, washed, cut into small pieces, oven-dried at 50°C for 6 hours, ground, sieved using an 80 mesh, then weighed and ready to be used as an herbal coffee additive. Bajakah tampala was oven-dried at 50°C for 6 hours, ground, sifted, then mixed with Liberica coffee powder according to treatment groups (L1, L2, L3 and B1, B2, B3) for 9 combination treatments with 3 repetitions. Analysis of bioactive compounds in this research was determined using GC-MS. The analysis results show that 8 main components seen based on retention time, namely caffeine, hexadecanoic acid, palmitic acid, hexadecanoic acid, ethyl ester, octadec-9-enoic acid, octadecanoic acid, stearic acid, octadeca-9,12-dienoic acid methyl, 9,12-octadecadienoic acid (Z, Z)-Lino and ethyl linoleate. It is recommended that further research be carried out regarding the bioactive content of Liberica and bajakah coffee as herbal medicine.*

Keywords: *bioactive compounds; central kalimantan; GC-MS; liberica coffee; bajakah tampala root*

1. INTRODUCTION

Liberica coffee (*Coffea liberica* Var.) is a coffee plant originating from Liberia and West Africa. It can grow up to 9 meters high, which is suitable for growing on peatlands. Liberica coffee is a typical peat coffee because it can adapt to peat soil more than other types of coffee (Hulupi, 2014). The coffee has a distinctive jackfruit taste, which is called jackfruit coffee in some areas. This coffee has begun to be developed in the Central Kalimantan area.

Coffee beans contain 10 to 15% oil composed of many acid compounds, such as palmitic, linoleic, and stearic acids. Coffee also contains nicotinic acid, pyrogallic acid, trigonelline, and caffeine. It also contains minerals such as chromium and magnesium and is an important source of polyphenols, including ferulic acid, caffeic acid, coumaric acid, chlorogenic acid, and cinnamic acid (Hecimovic et al., 2011).

Based on the data from Statistics Indonesia of Central Kalimantan Province (2021), the area of coffee plantations reached 2,600 hectares, and production reached 405 tons. Liberica coffee production in Central Kalimantan is precisely grown in West Kotawaringin Regency, whose capital is Pangkalan Bun, spans in the equatorial area between 1°19'- 3° 36' South Latitude, 110° 25' to 112° 50' East Longitude. With an altitude of 900 m asl, the average rainfall is 3000 mm/year, and the air temperature ranges from 23.1°C to 24.2°C.

ISSN 2252-6137 (print), ISSN 2302-3848 (online), doi: 10.22146/aij.v11i2.94799

The quality of coffee depends on coffee varieties and proper post-harvest handling processes such as drying, roasting, brewing, and storage conditions. Proper post-harvest handling in each process can improve coffee quality (Yusdiali, 2008), identified in terms of taste, aroma, and flavor. These three factors are characteristics that influence the quality of coffee.

Consuming too much coffee will cause stomachache, so it is not good for people with stomach ulcers. In this case, it is necessary to add additional ingredients so that coffee drinkers can enjoy every day without worrying about the side effects. Bajakah tampala (*Spatholobus littoralis* Hassk) is a suitable additional ingredient because it contains antioxidants to ward off free radicals. Besides, bajakah tampala is also believed by the Dayak tribe to cure various diseases (Astuti et al., 2014).

Bajakah tampala is a plant from the genus Spatholobus, which is widespread and cultivated in many areas of Asia. The roots of the bajakah tampala are used empirically as medicine by the Dayak people of Central Kalimantan. Based on the experience passed down from generation to generation by Dayak people, boiled water from bajakah tampala roots can be used as a medicine for stomachaches, diarrhea, and dysentery. This plant root contains phenolics, flavonoids, tannins, and saponins so bajakah tampala can be used as an herbal medicine (Mochammad et al., 2019).

Bajaka tampala contains phenolic compounds that have antioxidant activity, it can ward off free radicals in the body, apart from that, antioxidants also play a role in healing degenerative diseases such as diabetes, liver damage, inflammation, cancer, and cardiovascular and nervous disorders. Although bajakah tampala is often used as herbal medicine by boiling it, its use by mixing it into food or drinks has not been used by the public. So, if bajakah tampala is used by combining it with brewed coffee, it will increase people's interest in consuming bajakah tampala without worrying about the bitter taste. Considering the importance of phenolic compounds in the realm of medicine, it is necessary to determine the total phenolic content contained in bajakah tampala so that bajakah tampala can be better utilized for its medicinal properties (Ayuchecaria et al., 2020).

While processing coffee with bajakah tampala powder, some components must be maintained. The chemical elements in bajakah tampala are susceptible to high temperatures, so during the drying process, attention must be paid to the temperature. Apart from that, the problem in making herbal coffee is that bajakah tampala can affect the taste of the coffee itself, so proper treatment and handling are required to get benefits. It can be maintained without affecting the quality of the coffee (Sianipar, 2017). Until now, the active compound content of the combination of Liberica coffee and bajakah tampala roots are not yet known, therefore research needs to be carried out on the bioactive content contained in Liberica coffee and bajakah tampala roots. This research aims to determine the bioactive components contained in the formulation of Liberia coffee and bajakah tampala, which are grown on peatlands in Central Kalimantan.

2. MATERIAL AND METHODS

2.1 Material and Tools

The ingredients used in this product were Liberia coffee, bajakah tampala powder, granulated sugar, and water. The bajakah tampala powder is originated from Mantaren Village, Pulang Pisau Regency, Central Kalimantan. Meanwhile, the materials used for analysis were chloroform, ammonia, sulfuric acid, hydrochloric acid, ethanol, H_2O_2 solution, HCl solution, NaOH, distilled water, and Na_2CO_3.

The tools used in this product were porcelain cups, glasses, thermometers, 80 mesh sieves, filters, aluminum foil, knives, trays, cutting boards, ovens, blenders, basins, scales, dropper pipettes, burettes, spoons, Erlenmeyer, volumetric flask, and GC-MS.

2.2. Research Design

This research was conducted using a factorial Randomized Complete Block Design (RCBD). Factor 1 was the concentration of Liberica coffee powder consisting of 3 levels, and factor 2 was the concentration of bajakah tampala powder consisting of 3 levels. The experiment was carried out with 9 treatment combinations with 3 repetitions so that 27 experimental samples were obtained. The following is a comparison of Liberica coffee powder and ajakah tampala coffee powder. Factor 1 concentration of Liberica coffee grounds (L) consists of several levels, namely L1 = 80%, L2 = 70%, and L3 = 60%. Factor 2, the concentration of bajakah tampala powder (B) consists of several levels, namely B1 = 0%, B2 = 6%, and B3 = 12%.

2.1.1 Sample Analysis

About 1000 grams of bajakah tampala was sorted, washed, and cut into small pieces. The pieces were then oven-dried at 50°C for 6 hours. Once dried, the bajakah tampala was ground using a blender and sieved with an 80-mesh sieve to obtain finer powder. The bajakah powder was weighed and set aside for use as an additional ingredient in herbal coffee. Additionally, 800 grams of Liberica coffee was sorted, washed, oven-dried at 50°C for 6 hours, ground, and sieved using an 80-mesh sieve. Liberica coffee powder and bajakah powder were then mixed and weighed according to the treatment groups of coffee powder (L1, L2, L3) and bajakah tampala powder (B1, B2, B3) for 9 combination treatments and 3 repetitions.

Analysis of bioactive compounds in this research can be determined using GC-MS. GC-MS is a tool that consists of two instruments, namely gas chromatography and mass spectroscopy (GC-MS). This tool detects types of compounds based on their fragmentation patterns (Cazes, 2001). Coffee samples with the addition of bajakah were then analyzed for bioactive compounds using a Shimadzu QP 2010 SE brand GC-MS with an RTX5Ms semipolar column with a length of 30m. Helium gas is used as the mobile phase with a column temperature of 80°-250° C, using a split injection ratio of 51:0. Column temperature settings start at 40° C, hold time for 5 minutes, rate 30 ml/minute, and final temperature 250° C. Analysis was carried out at a pressure of 149.6 kPa with a total flow of 147 ml/minute, column flow 2.77 ml/minute with a linear velocity of 60/sec. The results of the analysis of compounds detected in bajakah and leaves were obtained by observing the relative area of each peak in the chromatogram and detecting the compounds using a similarity index according to the retention time of each peak with the names of compounds contained in the Wiley 7.0 library on the instrument

3. RESULTS AND DISCUSSION

Bioactive Content in Coffee Treatment 85% and Bajakah 7.5%

The results of the GC-MS chromatogram screening of coffee in the K_1B_2 treatment (coffee 85% and bajakah 7.5%) can be seen in Figure 1. In the analysis of bioactive components in the K_1B_2 treatment (coffee 85% and bajakah 7.5%), 15 compounds were obtained. The results of this analysis, 9 main components were obtained based on peak and content, namely ethanol, ethyl alcohol, caffeine, hexadecanoic acid, palmitic acid, octadec-9-enoic acid, octadecanoic acid, stearic acid, octadecanoic acid, ethyl ester, octadeca- 9,12-dienoic acid methyl, 9,12-octadecadienoic acid. The concentration of volatile components from the extraction results analyzed based on GC-MS can be seen in Table 1.

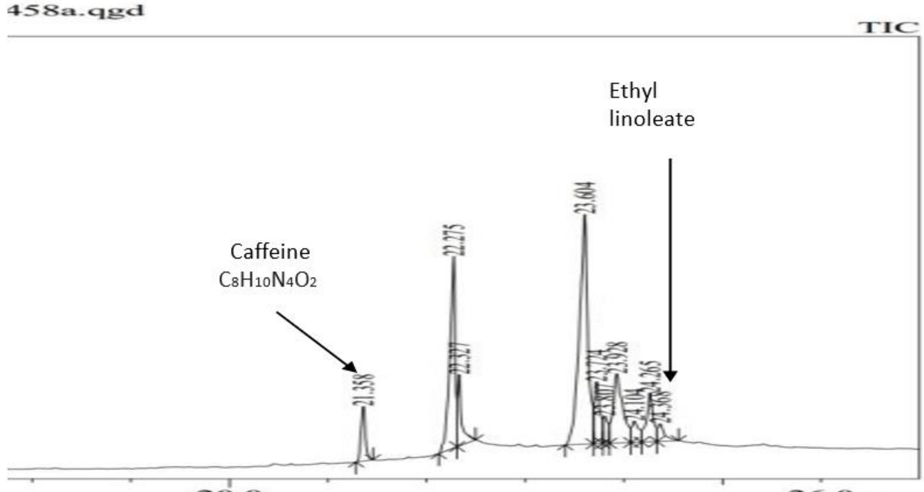

Figure 1. GC Chromatogram in K_1B_2 Treatment

Table 1. Concentration of Bioactive Compounds Result of GC-MS Analysis in Coffee Treatment 85% and Bajakah 7.5%

No	Molecular Formula	Compound	Molecular weight (g/mol)	Concentration %
1.	C_2H_6O	Ethanol ethyl alcohol	46.07	1.626
2.	$C_8H_{10}N_4O_2$	Caffeine	194.19	15.018
3.	$C_{16}H_{32}O_2$	Hexadecanoic acid	256.4	21.959
4.	$C_{18}H_{34}O_2$	Octadec-9-enoic acid	282.47	36.467
5.	$C_{18}H_{36}O_2$	Octadecanoic acidstearic acid	284.48	4.34
6.	$C_{20}H_{40}O_2$	Octadecanoic acid, ethylester ethyl	312.53	0.982
7.	$C_{19}H_{34}O_2$	Octadeca-9,12-dienoicacid methyl	294	16.395
8.	$C_{18}H_{32}O_2$	9,12-octadecadienoic acid	280.4	1.699
9.	$C_{20}H_{36}O_2$	Ethyl linoleate	308.5	1.513

Based on the results of the GCMS analysis in Table 1, it is known that the bioactive components contained in the L_1B_2 treatment (coffee 85% and bajakah 7.5%) are ethanol ethyl alcohol content of 1.626%, the caffeine content of 15.018%, hexadecenoic acid, palmitic acid levels are 21.959%, octadec-9-enoic acid levels are 36.467%, octadecanoic acid, stearic acid 4.340%, octadecanoic acid, ethyl ester levels are 0.982%, octadeca-9,12-dienoic acid methyl levels are 16.395%, 9,12-octadecadienoic acid levels are 1.699% and ethyl linoleate levels are 1.513%.

Ethanol

Ethanol is one of the main compound components in the GCMS results of coffee in the K_1B_2 treatment. The molecular formula of this compound is C_2H_6O, with a molecular weight of 46.07 g/mol and produces a concentration of 1.626%. Ethanol is currently widely used as an ingredient in making cosmetics, medicines, synthetic rubber, and as fuel. Moreover, ethanol ethyl alcohol is also used as an organic solvent (Sebayar, 2006)

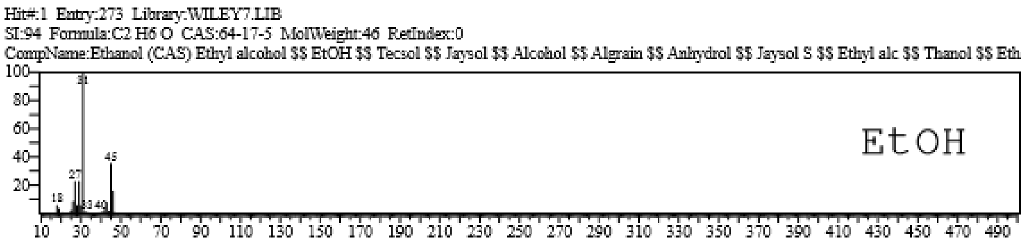

Figure 2. Results of the identification of bioactive compounds using GC-MS - Ethanol

Caffeine

Caffeine is one of the main compound components in the GCMS results of coffee in the K_1B_2 treatment. The molecular formula of this compound is $C_8H_{10}N_4O_2$, with a molecular weight of 194.19 g/mol and produces a concentration of 15.018%. The caffeine compound is one of the highest compounds in coffee, which can have a positive impact. Coffee is used to increase lung capacity in people with bronchial asthma. Caffeine has clinically beneficial pharmacological effects such as stimulating the central nervous system, muscle relaxation, and heart muscle stimulation (Rahayu et al., 2007).

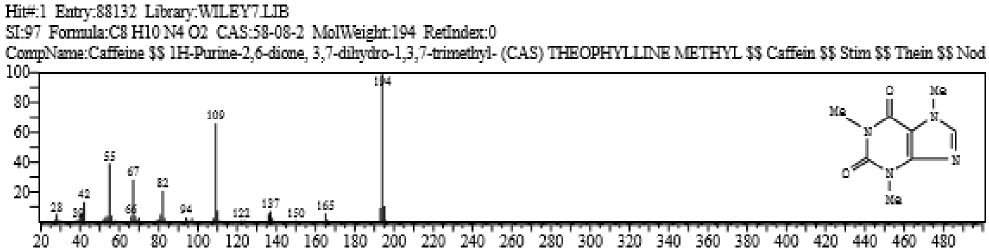

Figure 3. Results of the identification of bioactive compounds using GC-MS - Caffeine

Hexadecenoic Acid

Hexadecenoic acid is one of the main compound components in the GCMS results of coffee in the K_1B_2 treatment. The molecular formula of this compound is $C_{16}H_{32}O_2$, with a molecular weight of 256.4 g/mol and producing a concentration of 21.959%. Hexadecenoic acid or palmitic acid has important benefits for the body, namely that it can improve the blood fat profile by increasing HDL levels in the blood (Yuhana, 2019)

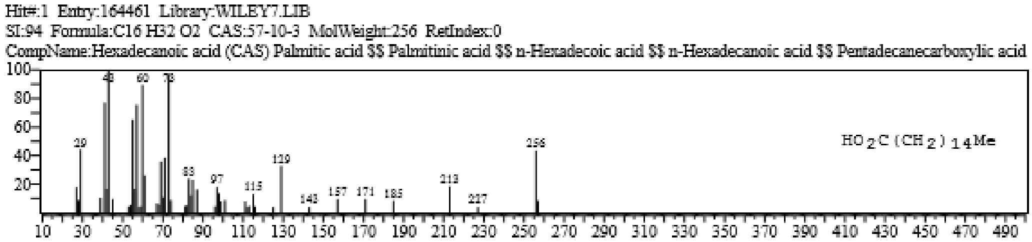

Figure 4. Results of the identification of bioactive compounds using GC-MS - Hexadecenoic Acid

Octadec-9-Enoic Acid

Octadec-9-enoic acid is one of the main compound components in the GCMS results of coffee in the K_1B_2 treatment. The molecular formula of this compound is $C_{18}H_{34}O_2$, with a molecular weight of 282.47 g/mol and produces a concentration of 36.467%. Octadec-9-enoic acid or oleic acid is an omega-9 unsaturated fatty acid and a natural component of fat that comes from either vegetable oils or animal fats. Oleic acid can soften and moisturize the skin. Because of its properties, topical treatment with oleic acid has benefits and long-term effects on skin papilloma. The use of oleic acid as an enhancer, either alone or in combination, can increase the amount of active drug substances that penetrate the skin (Lotta et al., 2004).

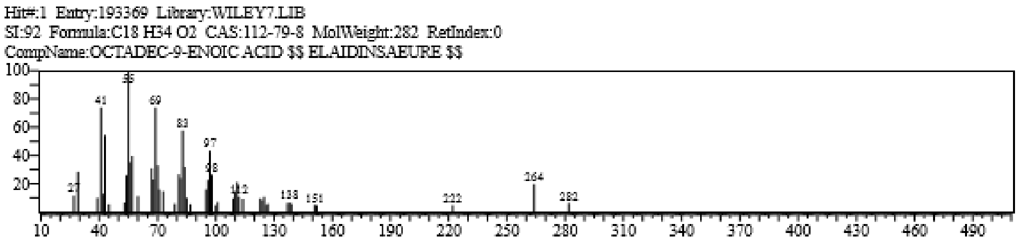

Figure 5. Results of the identification of bioactive compounds using GC-MS - Octadec-9-Enoic Acid

Octadecanoic Acid

Octadecanoic acid is one of the main compound components in the GCMS results of coffee in the K_1B_2 treatment. The molecular formula of this compound is $C_{18}H_{36}O_2$, with a molecular weight of 284.48 g/mol and produces a concentration of 4,340%. Octadecanoic acid (CAS) stearic acid functions as an ingredient in making candles, soap, plastics, and cosmetics. (Teoh et al., 2014).

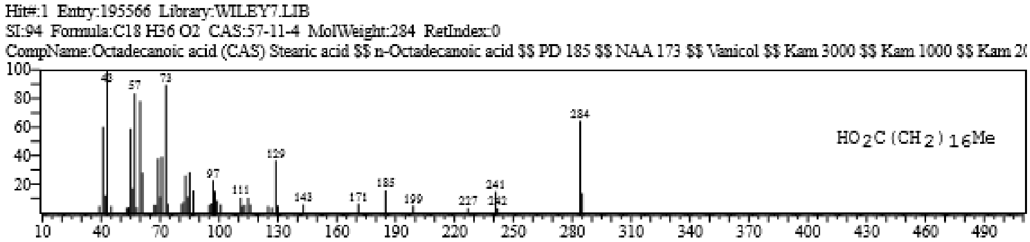

Figure 6. Results of the identification of bioactive compounds using GC-MS - Octadecanoic Acid

Octadecanoic Acid, Ethyl Ester

Octadecanoic acid and ethyl ester are among the main compound components in the GCMS results of coffee in the L_1B_2 treatment. The molecular formula of this compound is $C_{20}H_{40}O_2$, with a molecular weight of 312.53 g/mol and produces a concentration of 0.982%. Octadecanoic acid, ethyl ester (CAS) ethyl or acid arachidate is a saturated fatty acid with a 20-carbon chain. Arachidic acid itself functions as an enzyme and receptor that plays a role in the process of cell death and the stability of cell membrane fluid (Syahputra et al., 2014).

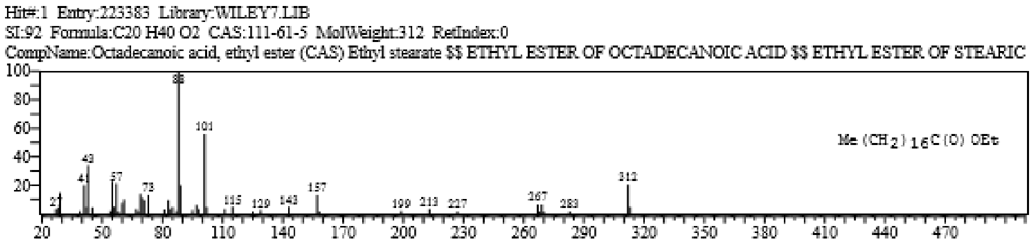

Figure 7. Results of the identification of bioactive compounds using GC-MS - Octadecanoic Acid, Ethyl

Octadeca-9,12-Dienoic Acid Methyl

Octadeca-9,12-dienoic acid methyl is one of the main compound components in the GCMS results of coffee in the L_1B_2 treatment. The molecular formula of this compound is $C_{19}H_{34}O_2$, with a molecular weight of 294 g/mol and produces a concentration of 16.395%. octadeca-9,12-dienoic acid methyl or sterculic acid is a fatty acid that also contains a cyclopropenoid group like malvalic acid. This compound also plays a role in the process of cell production, regulation of the nervous system, and strengthening of the cardiovascular system (Wahyuni et al., 2016).

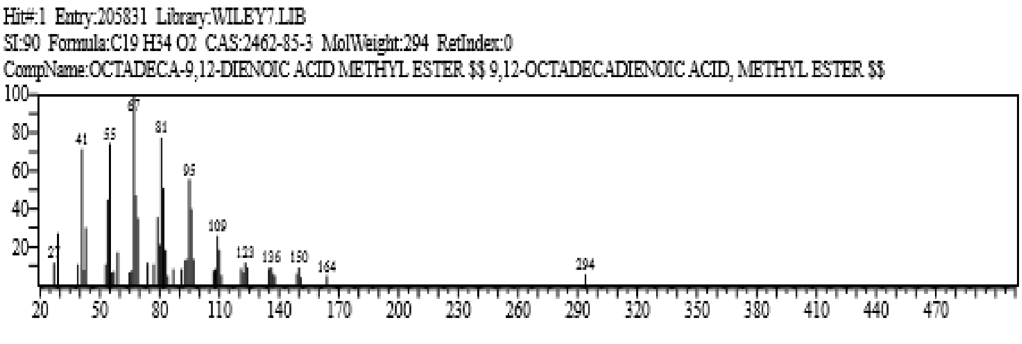

Figure 8. Results of the identification of bioactive compounds using GC-MS - Octadeca-9,12-Dienoic Acid Methyl

9,12-Octadecadienoic Acid

9,12-octadecadienoic acid is one of the main compound components in the GCMS results of coffee in the K_1B_2 treatment. The molecular formula of this compound is $C_{18}H_{32}O_2$, with a molecular weight of 294 g/mol and produces a concentration of 16.395%. 9,12-octadecadienoic acid or linoleic acid is a long-chain unsaturated fatty acid and is classified as an essential fatty acid. Linoleic acid is very important for the body because it can help cure diseases such as dermatitis, decreased reproductive ability, growth disorders, liver degeneration, and osteoporosis against infection (Isa, 2011).

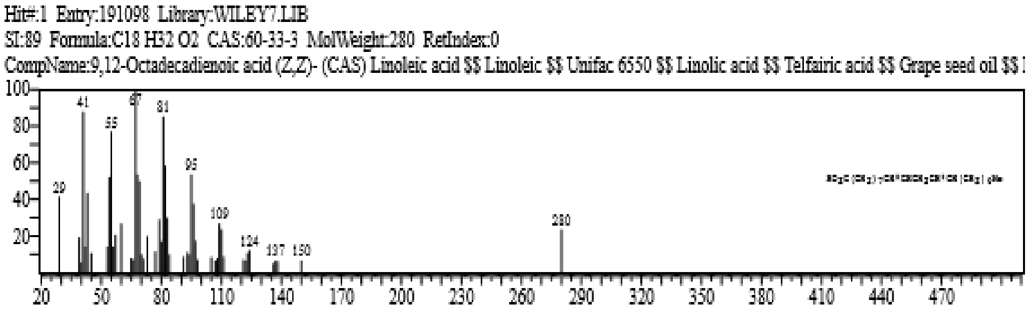

Figure 9. Results of the identification of bioactive compounds using GC-MS - 9,12-Octadecadienoic Acid

Ethyl Linoleate

Ethyl linoleate is one of the main compound components in the GCMS results of coffee in the K_1B_2 treatment. The molecular formula of this compound is $C_{20}H_{36}O_2$, with a molecular weight of 308.5 g/mol and produces a concentration of 1,513%. Ethyl linoleate functions as an antioxidant in the body by normalizing fat levels in the blood, which is used for treatment. Ethyl linoleate is an unsaturated fatty acid not synthesized by the body and is beneficial for health, especially in preventing heart disease (Sudaryatiningsih et al. 2009).

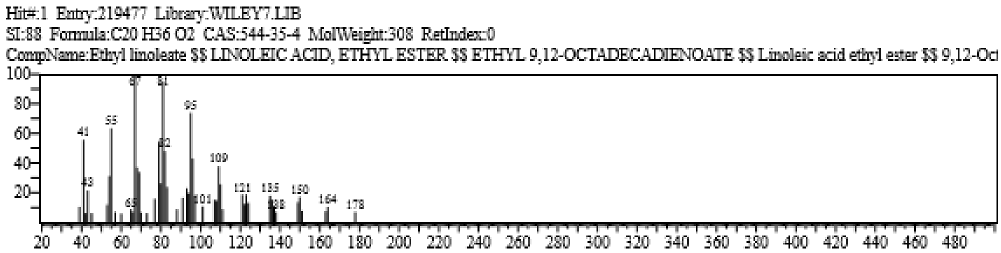

Figure 10. Ethyl Linoleate

4. CONCLUSIONS

The results of this analysis showed that 8 main components were seen based on peak, content, and biological activity, namely Ethanol with a molecular weight of 46.07 g/mol and a concentration of 1.626%, caffeine with a molecular weight of 194.19 g/mol and produces a concentration of 15.018%, Hexadecenoic acid with a molecular weight of 256.4 g/mol and produces a concentration of 21.959%, Octadecanoic acid with a molecular weight of 284.48 g/mol and produces a concentration of 4,340%, Octadecanoic acid, ethyl ester with a molecular weight of 312.53 g/mol and produces a concentration of 0.982%, Octadeca-9,12-dienoic acid methyl with a molecular weight of 294 g/mol and produces a concentration of 16.395% and Ethyl linoleate with a molecular weight of 308.5 g/mol and produces a concentration of 1,513%. It is recommended that further research be carried out regarding the bioactive content of Liberica and Bajakah coffee as herbal medicine.

ACKNOWLEDGEMENT

The authors would like to humbly express their appreciation to the Palangka Raya University PNBP Research Grant for providing research funding through 2023.

REFERENCES

AOAC. 2000. Official Method Of Analysis Of The Associations Of Analytical Chemists. Washington DC.

Aryandi, M. I., Arfi, F., & Harahap, M. R. 2020. Literature Review : Perbandingan Kadar Kafein Dalam Kopi Robusta (Coffea canephora), Kopi Arabika (Coffea arabica) dan Kopi Liberika (Coffea liberica. Var) Dengan Metode Spektrofotometri UV-Vis. Amina. 2, 64–70. https://doi.org/10.22373/amina.v2i2.700

Astuti, M. D., Maulana, A., & Kuntowati, E. M. 2014. Isolasi Steroid Dari Fraksi n-Heksana Batang Bajakah Tampala (Spatholobus littoralis. Hassk). Prosiding Seminar Nasional Kimia. https://repo-dosen.ulm.ac.id//handle/123456789/20741

Ayuchecaria, N., Alfiannor Saputera, M. M., & Niah, R. 2020. Determination of Total Phenolic Content of Bajakah Tampala Stem Extract (Spatholobus littoralis Hassk) Using Uv-Visible Spectrophotometry. 3, 132–141. https://doi.org/10.36490/journal-jps.com.v6i4.302

Badan Pusat Statistik Kalimantan Tengah. 2021. Luas Areal dan Produksi Tanaman Perkebunan Besar Negara, Perkebunan Swasta, Perkebunan Rakyat. Dinas Perkebunan Provinsi Kalimantan Tengah. Badan statistik.

Cazes. 2001. Encyclopedia of Chromatography. New York : Marcell Dakker Inc. Deliani. 2008. Effect of Fermentation Time on Protein, Fat, Fatty Acid and Phytic Acid Composition in Tempe Making. Thesis. Medan. Graduate School Chemistry Study Program. University of Northern Sumatra.

Hecimovic, I., Ana B. C., Dunja H., dan Drazenka K. 2011. Comparative Study of Polyphenols and Caffeine in Different Coffee Varieties Affected by the Degree of Roasting. Elsevier. Faculty of Food Technology and Biotechnology. University of Zagreb, Croatia.

Hulupi, R. 2014. Libtukom: Varietas Kopi Liberika Anjuran Untuk Lahan Gambut. Warta Pusat Penelitian Kopi dan Kakao. 26, 1-6. https://warta.iccri.net/wp-content/uploads/2023/06/1.-Retno-Hulupi-Libtukom-Varietas-Kopi-Liberika-Anjuran-untuk-Lahan-Gambut.pdf

Isa I., 2011, Penetapan Asam Lemak Linoleat dan Linolenat pada Minyak Kedelai secara Kromatografi Gas. Saintek. 6. 1–6. https://ejurnal.ung.ac.id/index.php/ST/article/view/416

Lotta, G, Irene L, Annika A, Ann K. M, Catharina, S. 2004. Treatment of skin papillomas with topical α-Lactalbumin-Oleic acid. New Eng. J. Med. 350: 2663-2672. https://www.nejm.org/doi/full/10.1056/NEJMoa032454

Mochammad Maulidie Alfiannor Saputera, Tio Widia Astuti Marpaung, N. A. 2019. Konsentrasi Hambat Minimum Kadar Ekstrak Etanol Batang Bajakah Tampala (Spatholobus littoralis. Hassk) Terhadap Bakteri Escherichia coli Melalui Metode Sumuran. *Jurnal Ilmiah Manuntung*. Vol. 5, 167– 173. https://doi.org/10.51352/jim.v5i2.267

Rahayu, T. dan Triastuti, R., 2007, Optimasi Fermentasi Cairan Kopi Dengan Inokulan Kultur Kombucha (Kombucha coffee). 8, 15-29. https://publikasiilmiah.ums.ac.id/handle/11617/401

Sebayang, F. 2006. Pembuatan Etanol dari Molase Secara Fermentasi Menggunakan Sel Saccharomyces cerevisiae yang Terimobilisasi pada Kalsium Alginat. 5, 75–80.

Sudaryatiningsih dan Supiyani, 2009. Linoleic and linolenic acids of soybean tofu with Rhizopus oryzae and Rhizopus oligosporus as coagulant. 1, 110–116. https://doi.org/10.13057/nusbiosci/n010302

Syahputra, G., Ambarsari L, & T, S. 2014. Simulasi docking kurkumin enol, bisdemetoksikurkumin dan analognya sebagai inhibitor enzim 12- lipoksigenase. 10, 55–67. https://core.ac.uk/download/pdf/230407112.pdf

Teoh V.P., Mat M.D. 2014. Mycelia Growth and Production of Total Flavonoids and 4H-pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-by Considering Aeration Effect and Mass Transfer Study. School of Chemical Engineering University Sains. Malaysia. http://silverstripe.fkit.hr/cabeq/assets/Uploads/Cabeq-2014-04-15.pdf

Wahyuni, S., Hambali, E., Tua, B., Marbun, H., Program. 2016. Esterifikasi Gliserol Dan Asam Lemak Jenuh Sawit Dengan Katalis Mesa. 26, 333–342. https://journal.ipb.ac.id/index.php/jurnaltin/article/view/16136

Yuhana, L. 2019. Pengaruh Lama Penyimpanan Terhadap Kadar Asam Palmitat pada Keju yang Dianalisis dengan Metode Kromatografi Gas-Spektroskopi Massa (KG-SM). Skripsi. Stikes Karya Putra Bangsa, Tulungagung.

Yusdiali, W. 2008. Pengaruh Suhu dan Lama Penyangraian terhadap Tingkat Kadar Air dan Keasaman Kopi Robusta (Coffea robusta). Skripsi. Universitas Hasanuddin, Makasar.

Analysis of Agro-Industry Supply Chain Performance on Organic Rice in Jember Regency

Thabed Tholib Baladraf*,[1]
[1]Department of Agroindustrial Engineering, Faculty of Agricultural Technology
IPB University, Jl. Raya Dramaga, Bogor, East Java, 16680, Indonesia.
Email: thabedoffice@gmail.com*

Received: August-20-2024; Accepted: December-11-2024; Published: December-31-2024

Abstract

Organic rice is one of the potential food commodity innovations, organic rice has increased interest and demand from the market but is not matched with organic rice productivity. Based on this, analyzing the supply chain to determine performance and recommend improvement strategies is necessary. The purpose of this research is to determine the current organic rice supply chain system, analyze supply chain performance, and develop strategies to improve the performance of the organic rice agroindustry supply chain in Jember Regency. The method used in this research is supply chain performance analysis using supply chain operation reference (SCOR) and strategy formulation using analytical network process and benefit opportunity cost risk (ANP-BOCR). These methods were chosen because they synergize with each other and have been widely used in previous studies to analyze similar problems. The results showed that the performance of the organic rice agroindustry supply chain in Jember Regency received a score of 66.01 or classified into the average range. Hence, there is a need for improvement in the supply chain that is carried out through strategy. The results show that the sub-criteria benefit (0.198205), opportunity (0.164375), and economic (0.109545) get the highest value. Based on the results of pairwise comparisons, it is also found that the most appropriate strategy is to improve all KPIs.

Keywords: *agroindustry; ANP-BOCR; organic rice; SCOR; supply chain*

1. INTRODUCTION

Organic food products are one of the innovations in the food sector. Organic food products are produced naturally because they are cultivated without involving chemicals, antibiotics, or genetic organism modification. (Vigar et al., 2020). In the beginning, organic food products were only consumed by physically active, highly educated, and health-focused people. However, over time consumers of organic food products have increased significantly due to the increasing awareness of the public. (Shenoy et al., 2024). In terms of health, organic food products have advantages in terms of content that is beneficial for health. According to Pawar et al. (2022), Organic food products have higher macronutrient and micronutrient content than non-organic food products. One of the organic food products that many consumers are interested in is organic rice. (Syamsiyah et al., 2023). According Sujianto et al. (2020), increased interest in organic rice is motivated by health.

The increase in demand for organic food, especially organic rice, is unfortunately not matched by the productivity of organic rice. Based on the data presented by David & Alkausar (2023), It is known that the productivity of organic rice in Indonesia is still fluctuating and tends to decrease. In 2020, organic rice production was 44,477.7 tons, while in 2021 it decreased to 35,420.1 tons and in 2022 it slightly increased to 40,376.5 tons. This is also in line with what is experienced in Jember Regency. Organic rice productivity in Jember Regency has not been able to meet consumer demand. Based on interviews conducted with the heads of organic farmer groups in Jember, it is known that organic rice farmers in Jember are only able to produce 50 tons/month, while consumer demand is 150 tons/month. This is reinforced by data from David & Alkausar (2023) Which states that organic rice is a keyword that is searched quite often on Google by the people of East Java, one of which is Jember. This shows a high interest in organic rice products. On the other hand, a survey conducted shows that 28.82% of organic rice consumers consume when the product is available. This means that organic rice products are still quite difficult to find, but have a high demand. In addition,

ISSN 225-6137 (print), ISSN 2302-3848 (online), doi: 10.22146/aij.v11i2.99299

according to Agustina (2011), the people of Jember Regency make health indicators, which shows the interest of the people of Jember Regency in organic rice. This is thought to be due to the chain structure and market structure of organic rice products that are still not well established. Supply chain structure has a significant influence on motivation and performance in a business (Sutia et al., 2020). Therefore, it is necessary to identify supply chain performance and new strategies for organic rice products in the Jember Regency.

The identification of supply chain performance needs to be done to analyze the course of the organic rice agro-industry supply chain from the beginning to the end of the process. In addition, the identification of supply chain performance can also determine the factors that affect the performance of the rice agro-industry supply chain. In the research conducted, the identification of supply chain performance is carried out using the supply chain operations reference (SCOR) method, while strategy development is carried out using the analytical network process-benefit opportunity cost ratio (ANP BOCR). SCOR is one of the methods that can assess the performance of a supply chain as well as identify processes that require improvement (Chopra et al., 2022). In several previous studies, SCOR has been used to test the performance of vegetables, corn, and horticulture (Hamdani et al., 2021; Naafilah et al., 2024; Sibuea et al., 2023). While ANP BOCR is a problem-solving method by utilizes the opinions of experts by considering the network structure of benefits, opportunities, costs, and ratios to facilitate decision-making for strategy (Sari & Suprayitno, 2020). ANP BOCR has also been used in several previous studies such as for the selection of suppliers of pharmaceutical products, the selection of waste management alternatives, to the preparation of agricultural cooperative development strategies (Astuti et al., 2011; Fatikhah et al., 2020). This research aims to identify supply chain performance and develop strategies to improve the performance of the organic rice agro-industry supply chain in Jember Regency.

2. MATERIAL AND METHODS

This research was conducted in Jember Regency from September 2021 to December 2021. This research was conducted in Jember Regency from September 2021 to December 2021. This research was conducted in Jember Regency from September 2021 to December 2021. Jember Regency was chosen as the research site because this area has organic farms managed by the people. Thus, organic rice farming in Jember Regency has experienced good development. According to the interview with the head of the organic farmer community Jember Regency, there are 82 organic farmer groups in the Jember Regency. The research stages carried out in this study are presented in Figure 1.

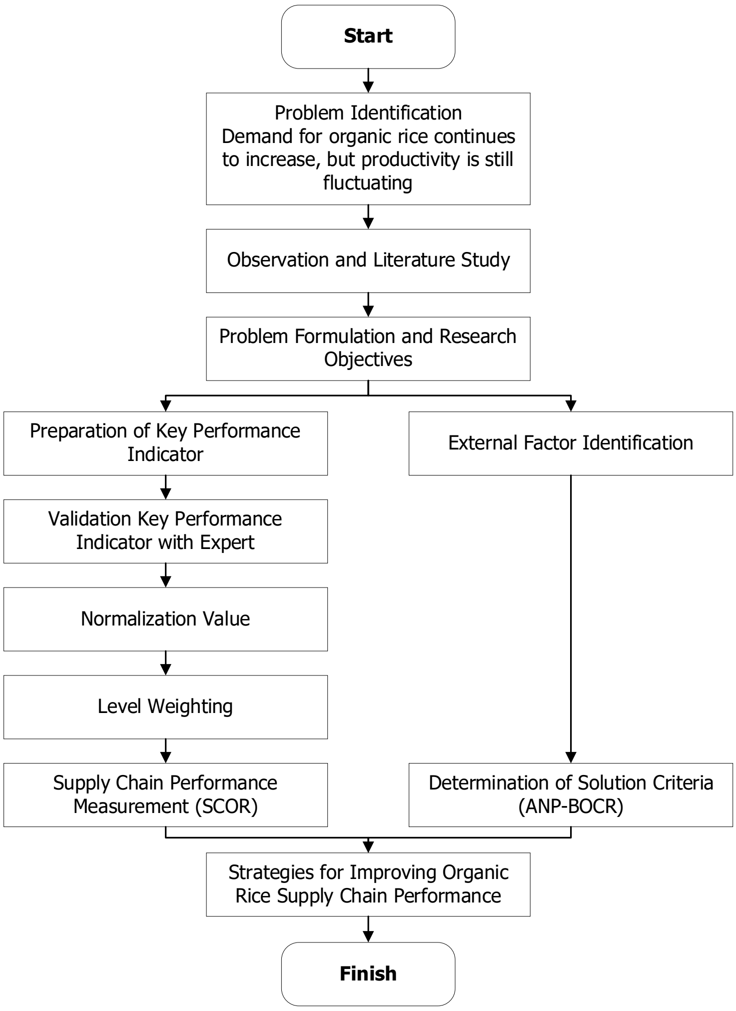

Figure 1. Research Stage

The tools used in this research are a laptop used to express research findings and analyze data obtained through the software Microsoft Excel and Super Decision. Mobile phones were used for brief note-taking and used to contact the interviewees. The camera was used for taking pictures and documenting the research conducted. Finally, the questionnaire was used to collect the primary data needed in this study. Meanwhile, the materials used in this research are primary data and secondary data.

2.1 Preparation and Validation of Key Performance Indicators

The development of key performance indicators was conducted by mapping the organic rice agroindustry process, which was divided into five processes: plan, source, make, deliver, and return. Mapping is conducted from the point of origin to the point of consumption for each supply chain actor, including farmers, grain collectors, and rice retailers. The key performance indicators were developed through structured interviews with two experts, namely an academic expert in the field of agro-industry and an expert practitioner in the domain of organic rice. The two experts were selected from the academic and practitioner communities because their diverse perspectives facilitate the generation of reliable data during fieldwork. After the consolidation of primary performance indicators, data collection will be conducted at each stage of the chain, commencing with farmers, progressing to grain collectors, and concluding with interviews within the organic rice agro-industry in the Jember Regency. Data collection was conducted through a questionnaire accompanied by researchers to ensure the accuracy and completeness of the data. Key performance indicators are presented in Table 1 to Table 3.

Table 1. Key performance indicators farmers

Main Process	Attribute	Metric	Unit
Plan	Reliability	Match of actual harvest to predicted harvest	%
	Reliability	Grain order fulfillment	%
Source	Reliability	Fertilizer needs	kg/litre
	Reliability	Subsidized fertilizer received	kg/litre
	Reliability	Pest and weed medications required	g/ml
	Flexibility	Supplier availability	People
	Cost	Total cost of farm inputs	Rp
	Asset	Serviceable support machine	Machine
Make	Reliability	Match of actual harvest to predicted harvest	%
	Reliability	Labor reliability farmer	%
	Responsiveness	Harvest cycle time	Day
	Cost	Production cost farmers	Rp

Table 2. Key performance indicators grain collectors

Main Process	Attribute	Metric	Unit
Plan	Reliability	Accuracy of grain raw material inventory	%
	Flexibility	Unexpected alternatives	%
Source	Reliability	Percentage of grain defects	%
	Reliability	Percentage of damaged packaging materials	%
	Reliability	Percentage of orders fulfilled	%
	Flexibility	Supplier availability	People
	Cost	Ordering cost to the farmer	Rp
Make	Reliability	Percentage decrease in rice yield	%
	Reliability	Labor reliability collector	%
	Responsiveness	Product process time	Day
	Cost	Production cost collector	Rp
Delivery	Reliability	Request fulfilled by collector	%

Table 3. Key performance indicators rice retailers

Main Process	Attribute	Metric	Unit
Plan	Reliability	Accuracy of raw material and grain inventory	%
Source	Reliability	Percentage of rice defects	%
	Flexibility	Supplier availability	People
	Cost	Ordering cost to the collector	Rp
Make	Reliability	Percentage of defective rice products	%
	Reliability	Packaging accuracy	%
	Cost	Production and maintenance cost	Rp
Delivery	Reliability	The request was fulfilled by the distributor	%

2.2 Weighting Key Performance Indicators

The performance indicators that have been determined and validated will then be given a weighting based on their level of importance by experts who have been determined using a pairwise comparison questionnaire. The selected experts include farmers, procurement in the grain collection industry, and organic rice retailers. Weighting is carried out using the Analytical Hierarchy Process (AHP) concept and processed using Expert Choice software.

2.3 Supply Chain Performance Measurement

Supply chain performance assessment is carried out by comparing the actual value with the target contained in each supply chain actor. The assessment begins with normalization using the Snorm de Boer formula so that there is uniformity of value. After normalizing the value, an assessment is then carried out through interviews with farmers, grain collectors, and rice retailers to get actual and expected data. The results of the next value will be multiplied by the weight that has been determined on each indicator so that the value of supply chain performance will be obtained. The details of the supply chain performance score category that refers to Saragih et al. (2021) Are presented in Table 4.

Table 4. Supply chain performance score category

Performance Score	Category
95-100	Excellent
90-94	Above Average
80-89	Average
70-79	Below Average
60-69	Poor
<60	Unacceptable

Source: Rakhman et al. (2018)

2.4 Strategy Design Using ANP & BOCR

Strategy formulation is carried out using the ANP & BOCR method in the hope of improving supply chain performance. Strategy formulation begins with determining criteria and sub-criteria based on the results of previous tests and discussions with farmers, grain collectors, and organic rice retailers. The results of determining the criteria and sub-criteria are then compiled in the form of networks and questionnaires using pairwise comparison for data collection which will be carried out on experts in this case the head of the agriculture office, supply chain academics, heads of farming businesses, and representatives of organic rice companies.

3. RESULTS AND DISCUSSION

3.1 Supply Chain Management Organic Rice Agroindustry

The supply chain of organic rice in Jember Regency involves three main actors: farmers, rice collectors, and organic rice retailers. To study the organic rice supply chain that occurs, the researchers conducted interviews with organic rice farmers and the food crops, horticulture, and plantations office. The agro-industrial supply chain of organic rice begins with the planting of organic rice seeds. During the planting period, measurements are taken of the fertilizers used (KPI 6), the subsidized fertilizers provided (KPI 7), the pesticides used (KPI 8), unexpected alternatives (KPI 5), the input costs incurred by the farmers (KPI 16), the production costs incurred (KPI 28), the reliability of the labor (KPI 22), the harvest cycle time (KPI 26), product process time (KPI 27), farmer availability (KPI 14), accuracy grain inventory (KPI 3), and the fulfillment of the collectors demand (KPI 2, 11). The results of interviews conducted with farmers indicate that the requisite quantity of organic rice seeds for one hectare of land is 7.5 kilograms, with the cultivation process requiring 100-110 days. The harvesting process yielded a wet paddy weighing 5.8 tons. In this process, the accuracy of the quantity of rice produced (KPI 1), the precision of order fulfillment, and the amount of defective grain produced will be quantified (KPI 9). Subsequently, the harvested wet paddy is transferred to the rice collector, where it undergoes a drying process to reduce the moisture content until it reaches the desired level of dry paddy. The result of the drying process is 4.5 tons of dry paddy. The subsequent phase is milling, which serves to separate the husk from the organic rice. The milling process yields a weight of 2.92 tons. At this juncture, the percentage decrease in rice yield (KPI 21), the accuracy of rice order fulfillment and prediction (KPI 20, 31), the accuracy of raw material inventory (KPI 4), the percentage of defective rice produced (KPI 12), the cost of ordering from farmers (KPI 17), the use of supporting machines (KPI 19), the reliability of collecting labor (KPI 23), the production cost of collectors (KPI 29), maintenance cost (KPI 30), collector availability (KPI 15) and the accuracy of packaging will be evaluated (KPI 10, 25). The organic rice that has been obtained is then packaged and distributed to organic rice retailers. At this retail stage, measurements related to the percentage of defective rice (KPI 24) ordering costs for collectors (KPI 18), store availability (KPI 13), and meeting needs will be conducted (KPI 32).

Based on the flow of goods, the distribution of organic rice is currently carried out with a bottom-up scheme, namely through ordering. This is due to the high demand for organic rice, but on the other hand, organic rice productivity has not been met. Another thing that causes an imbalance between demand and production is the absence of regional policies that support organic rice production in the Jember Regency. Based on the financial flow created, it is known that consumers have the choice if they want to buy organic rice products, they can go through retail or collectors. So that finances will end up in farmers by the agreed profit sharing. Meanwhile, based on the flow of information, it occurs in two directions in various lines to determine the quantity and quality of organic rice products. The supply chain management pattern that occurs in organic rice products is visually presented in Figure 2.

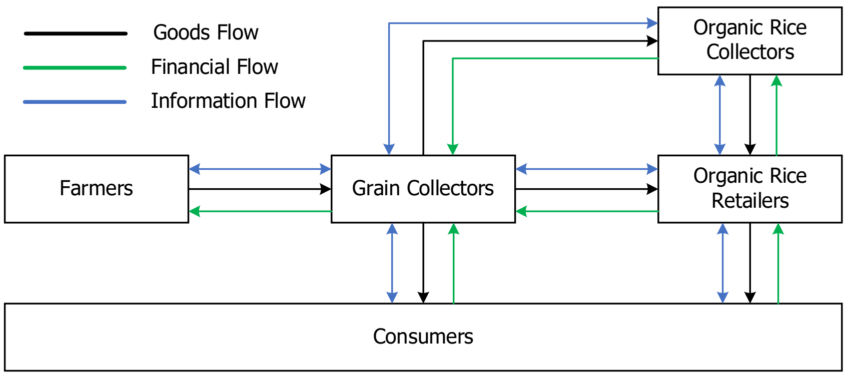

Figure 2. Supply Chain Management of Organic Rice Agroindustry

3.2 Valid Key Performance Indicator

The supply chain key performance indicators used were validated by experts and then arranged in the form of a hierarchy. Validation has a function to get the right indicators to measure supply chain performance. The description of the key performance indicators used and the hierarchical structure used is presented in Table 5 and Figure 3.

Table 5. Key performance indicators details

Process (Lv 1)	Dimensions (Lv 2)	Code	Matrix (Lv 3)	Unit
Plan	Reliability	KPI 1	Match of actual harvest to predicted harvest	%
		KPI 2	Grain order fulfillment	%
		KPI 3	Accuracy of grain raw material inventory	%
		KPI 4	Accuracy of raw material and grain inventory	%
	Flexibility	KPI 5	Unexpected alternatives	%
Source	Reliability	KPI 6	Fertilizer needs	Kg/litre
		KPI 7	Subsidized fertilizer received	Kg/litre
		KPI 8	Pest weed medications required	g/ml
		KPI 9	Percentage of grain defects	%
		KPI 10	Percentage of damaged packaging materials	%
		KPI 11	Percentage of orders fulfilled	%
		KPI 12	Percentage of rice defects	%
	Flexibility	KPI 13	Supplier store availability	People
		KPI 14	Supplier farmers availability	People
		KPI 15	Supplier collectors availability	People
	Cost	KPI 16	Total cost of farm inputs	Rp
		KPI 17	Ordering cost to farmers	Rp
		KPI 18	Ordering cost to the collector	Rp
	Asset	KPI 19	Serviceable support machine	Machine
Make	Reliability	KPI 20	Match of actual harvest to predicted harvest	%
		KPI 21	Percentage decrease in rice yield	%
		KPI 22	Labor reliability farmer	%
		KPI 23	Labor reliability collector	%
		KPI 24	Percentage of defective rice	%
		KPI 25	Packaging accuracy	%
	Responsiveness	KPI 26	Harvest cycle time	Day
		KPI 27	Product process time	Day
	Cost	KPI 28	Production cost farmer	Rp
		KPI 29	Production cost collector	Rp
		KPI 30	Production & maintenance cost	Rp
Delivery	Reliability	KPI 31	Request fulfilled by collector	%
		KPI 32	The request was fulfilled by the distributor.	%

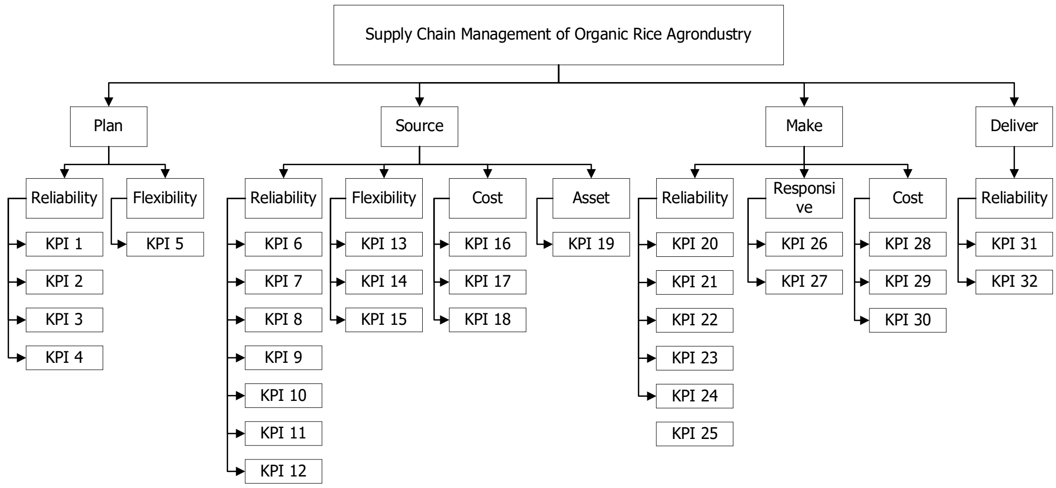

Figure 3. Hierarchical Structure of Key Performance Indicators

Based on the hierarchy presented above, several key performance indicators are key in solving the problem of the gap between demand and production. Some of the key performance indicators that are considered crucial are the percentage of fulfilled demand (KPI 11), availability of supplier farmers (KPI 14), availability of collectors (KPI 15), total input costs (KPI 16), fulfillment of collectors' requests (KPI 31), and fulfillment of distributor requests (KPI 32). These key performance indicators are considered to be the focus because they are closely related to the problems faced today, namely the inability to fulfill demand for organic rice products. One of the factors to focus on is the cost of inputs used because farmers consider the cost of organic rice cultivation inputs such as organic fertilizers and organic pesticides to be more expensive than the cost of inputs for non-organic rice cultivation. This is in line with the research of Nurhidayati et al. (2021), which states that the input costs of organic rice cultivation are more expensive than the input costs of non-organic rice cultivation. This has an impact on the availability of supplier farmers and the availability of collectors which is minimal, which has an impact on the minimum supply produced. In more detail, several KPIs that are the focus will be measured in the next section.

3.3 Calculation of Normalisation Value Key Performance Indicators

The normalization calculation is performed to uniform the performance values obtained using the Snorm de Boer formula. The Snorm de Boer formula normalizes by considering the actual value, the best performance value, and the worst performance value. These values will be filled in by the interviewed experts, namely farmers, procurement in the grain collection industry, and organic rice retailers. The results of value normalization are presented in Table 6.

Table 6. Result normalization value key performance indicators

Process (Lv 1)	Dimensions (Lv 2)	Matrix (Lv 3)	Score
Plan	Reliability	KPI 1	86.67
		KPI 2	92.00
		KPI 3	66.67
		KPI 4	66.67
	Flexibility	KPI 5	70.00
Source	Reliability	KPI 6	64.29
		KPI 7	25.00
		KPI 8	80.00
		KPI 9	75.00
		KPI 10	75.00
		KPI 11	61.90
		KPI 12	87.50
	Flexibility	KPI 13	100.00
		KPI 14	50.00
		KPI 15	50.00
	Cost	KPI 16	25.00
		KPI 17	50.00
		KPI 18	40.00
	Asset	KPI 19	71.43
Make	Reliability	KPI 20	77.78
		KPI 21	80.00
		KPI 22	92.31
		KPI 23	83.33
		KPI 24	75.00
		KPI 25	85.00
	Responsiveness	KPI 26	25.00
		KPI 27	75.00
	Cost	KPI 28	70.00
		KPI 29	76.67
		KPI 30	84.21
Delivery	Reliability	KPI 31	66.67
		KPI 32	60.00

Based on the data that has been obtained, it is known that KPI 13 gets the highest score of 100 and the lowest score is obtained by KPI 7, 16, and 26 with a score of 25. KPI 13 gets the highest score because the available rice supply can always be fulfilled. Meanwhile, KPI 7 gets the lowest score because the subsidized fertilizer received is still lacking, even though the subsidized fertilizer is considered very helpful for organic rice farmers. On the other hand, KPI 16 also received the lowest score because the cost of agricultural inputs is arguably quite high due to the uncontrolled price of raw materials. KPI 26 also received the lowest score, which is about the timing of the harvest cycle which is increasingly difficult to predict due to climate change. This is in line with Ansari et al. (2021), who stated that climate change has a significant impact on the timing of rice planting, necessitating several adjustments to be made to the climate.

3.4 Weighting Result Key Performance Indicators

The weighting of key performance indicators was carried out using an analytical hierarchy process using expert choice software through a pairwise comparison questionnaire on each of the performance labels. The weighting is carried out by experts who have been selected in this study, namely farmers, procurement in the grain collection industry, and organic rice retailers. The weighting results at each level are presented in Table 7.

Table 7. Weighting result each level

Process (Lv 1)	Weight	Dimensions (Lv 2)	Weight	Matrix (Lv 3)	Weight
Plan	0.183	Reliability	0.757	KPI 1	0.190
				KPI 2	0.414
				KPI 3	0.186
				KPI 4	0.211
		Flexibility	0.243	KPI 5	1.000
Source	0.408	Reliability	0.288	KPI 6	0.206
				KPI 7	0.067
				KPI 8	0.062
				KPI 9	0.096
				KPI 10	0.043
				KPI 11	0.371
				KPI 12	0.489
		Flexibility	0.084	KPI 13	0.403
				KPI 14	0.292
				KPI 15	0.305
		Cost	0.474	KPI 16	0.567
				KPI 17	0.216
				KPI 18	0.216
		Asset	0.155	KPI 19	1.000
Make	0.141	Reliability	0.194	KPI 20	0.276
				KPI 21	0.034
				KPI 22	0.328
				KPI 23	0.034
				KPI 24	0.245
				KPI 25	0.083
		Responsiveness	0.207	KPI 26	0.645
				KPI 27	0.355
		Cost	0.599	KPI 28	0.471
				KPI 29	0.275
				KPI 30	0.254
Delivery	0.268	Reliability	1.000	KPI 31	0.558
				KPI 32	0.442

Based on the results obtained, it can be seen that the source process is the process with the greatest weight. This means that the sourcing process, namely raw materials, is a top priority for organic rice agro-industry actors. This is because quality organic rice raw materials will produce quality organic rice. (Purwandoko et al., 2019). The next priority lies in the delivery, planning, and making processes.

3.5 Supply Chain Performance Measurement

The calculation of the performance of the organic rice agro-industry supply chain is done by multiplying the score by the weight that has been determined at each level starting from level 3 to level 1. The supply chain performance at level 3 is presented in Table 8.

Table 8. Supply chain performance level 3

Process (Lv 1)	Dimensions (Lv 2)	Matrix (Lv 3)	Score	Weight	Final	Total
Plan	Reliability	KPI 1	86.67	0.190	16.47	81.02
		KPI 2	92.00	0.414	38.09	
		KPI 3	66.67	0.186	12.40	
		KPI 4	66.67	0.211	14.07	
	Flexibility	KPI 5	70.00	1.000	70.00	70.00
Source	Reliability	KPI 6	64.29	0.206	13.24	96.06
		KPI 7	25.00	0.067	1.68	
		KPI 8	80.00	0.062	4.96	
		KPI 9	75.00	0.096	7.20	
		KPI 10	75.00	0.043	3.23	
		KPI 11	61.90	0.371	22.96	
		KPI 12	87.50	0.489	42.79	
	Flexibility	KPI 13	100.00	0.403	40.30	70.15
		KPI 14	50.00	0.292	14.60	
		KPI 15	50.00	0.305	15.25	
	Cost	KPI 16	25.00	0.567	14.18	33.62
		KPI 17	50.00	0.216	10.80	
		KPI 18	40.00	0.216	8.64	
	Asset	KPI 19	71.43	1.000	71.43	71.43
Make	Reliability	KPI 20	77.78	0.276	21.47	82.73
		KPI 21	80.00	0.034	2.72	
		KPI 22	92.31	0.328	30.28	
		KPI 23	83.33	0.034	2.83	
		KPI 24	75.00	0.245	18.38	
		KPI 25	85.00	0.083	7.06	
	Responsiveness	KPI 26	25.00	0.645	16.13	42.75
		KPI 27	75.00	0.355	26.63	
	Cost	KPI 28	70.00	0.471	32.97	75.44
		KPI 29	76.67	0.275	21.08	
		KPI 30	84.21	0.254	21.39	
Delivery	Reliability	KPI 31	66.67	0.558	37.20	63.72
		KPI 32	60.00	0.442	26.52	

Based on the results that have been obtained, it is known that the source process in the reliability dimension has the highest value compared to other dimensions with a value of 96.06. This is in line with the previous explanation that the quality and resilience of organic rice raw materials are the main focus for organic rice agro-industry actors. Quality and resilient raw materials will make quality product results in terms of nutritional content. The lowest value is obtained by the source process in the cost dimension with a value of 33.62. This is because the input costs generated are fluctuating and uncontrollable, which affects the price of the final product. Mardalisa et al. (2023) Stated that price fluctuations are a major risk faced by farmers, especially in organic rice products. Furthermore, the supply chain performance at level 2 is presented in Table 9.

Table 9. Supply chain performance level 2

Process (Lv 1)	Dimensions (Lv 2)	Score	Weight	Final	Total
Plan	Reliability	81.02	0.757	61.33	78.34
	Flexibility	70.00	0.243	17.01	
Source	Reliability	96.06	0.288	27.67	60.57
	Flexibility	70.15	0.084	5.89	
	Cost	33.62	0.474	15.94	
	Asset	71.43	0.155	11.07	
Make	Reliability	82.73	0.194	16.05	70.09
	Responsiveness	42.75	0.207	8.85	
	Cost	75.44	0.599	45.19	
Delivery	Reliability	63.72	1.000	63.72	63.72

Based on the results above, it can be seen that the planning process at this level has the highest value compared to other core processes with a value of 78.34. This is because the planning process includes the fulfillment of grain orders, which is a crucial process that is the focus of organic rice agro-industry business actors. The source core process at this level has the lowest value compared to other core processes with a value of 60.57. This shows that there needs to be improvements in the core source process, especially in the cost dimension. Furthermore, the supply chain performance at level 1 is presented in Table 10.

Table 10. Supply chain performance level 1

Process (Lv 1)	Score	Weight	Total
Plan	78.34	0.183	14.34
Source	60.57	0.408	24.71
Make	70.09	0.141	9.88
Delivery	63.72	0.268	17.08
Total			66.01

Based on the test of supply chain performance at the final level, the highest to lowest value is obtained, namely the core process of source with 24.71, the core process of deliver with a value of 17.08, the core process of plan with a value of 14.34, and the core process of make with a value of 9.88. In total, the score is 66.01 or classified as average because it is in the range of 50-70. This shows that there is a need for improvement in the organic rice agro-industry supply chain in Jember.

3.6 Strategy Design Using ANP & BOCR

The development of strategies to improve the supply chain of organic rice agro-industry was carried out using analytical network processes and benefit opportunity cost risk. The application of the analytical network process is carried out using three main steps, namely extracting problems through interviews with experts, developing an analytical network process, and determining alternative solutions and policy strategies. This analytical network process will be combined with benefit opportunity cost risk consisting of internal factors (economic, social, environmental, legal and political, transport), benefit opportunity cost risk, and alternative strategies. The detailed data of criteria, sub-criteria, and alternative strategies are presented in Table 11, and the relationship diagram is presented in Figure 4.

Table 11. Criteria, sub-criteria, and alternative strategies

Code	Criteria	No	Sub-Criteria
A	Internal Factor	1	Economy
		2	Social
		3	Ecology
		4	Politic and Law
		5	Transportation
B	BOCR	6	Benefit
		7	Opportunities
		8	Cost
		9	Risk
C	Alternative	10	Improve all KPI
		11	Improve some KPI
		12	No improvement

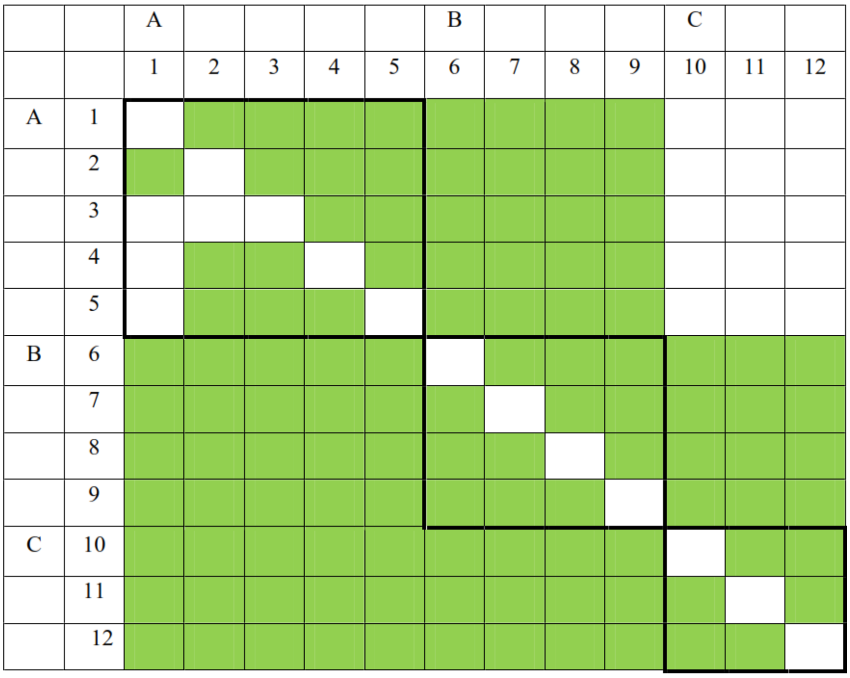

Figure 4. Relationship Diagram

The graph above illustrates the interrelationship in research by showing the correlation between one set of elements with another set of elements either in the same cluster called inner dependence or showing the relationship between one set of elements with another set of elements but in a different cluster called outer dependence. In its application, several things need to be considered related to the clusters used in this study, including internal factors, BOCR, and alternatives. Internal clusters are factors that come from factors that can be controlled and come from within the industry, while BOCR is a cluster that explains the desired things in the form of benefits, and unwanted things in the form of costs, and can also be things that have the potential to occur in the future, which are presented in the form of opportunities and risks. The last cluster is an alternative strategy that is implemented, in this case, the alternative strategy is divided into three things, namely the need for improvement on all KPIs, the need for improvement on some KPIs, or there is no need for improvement on KPIs. The ANP BOCR structure is presented in Figure 5.

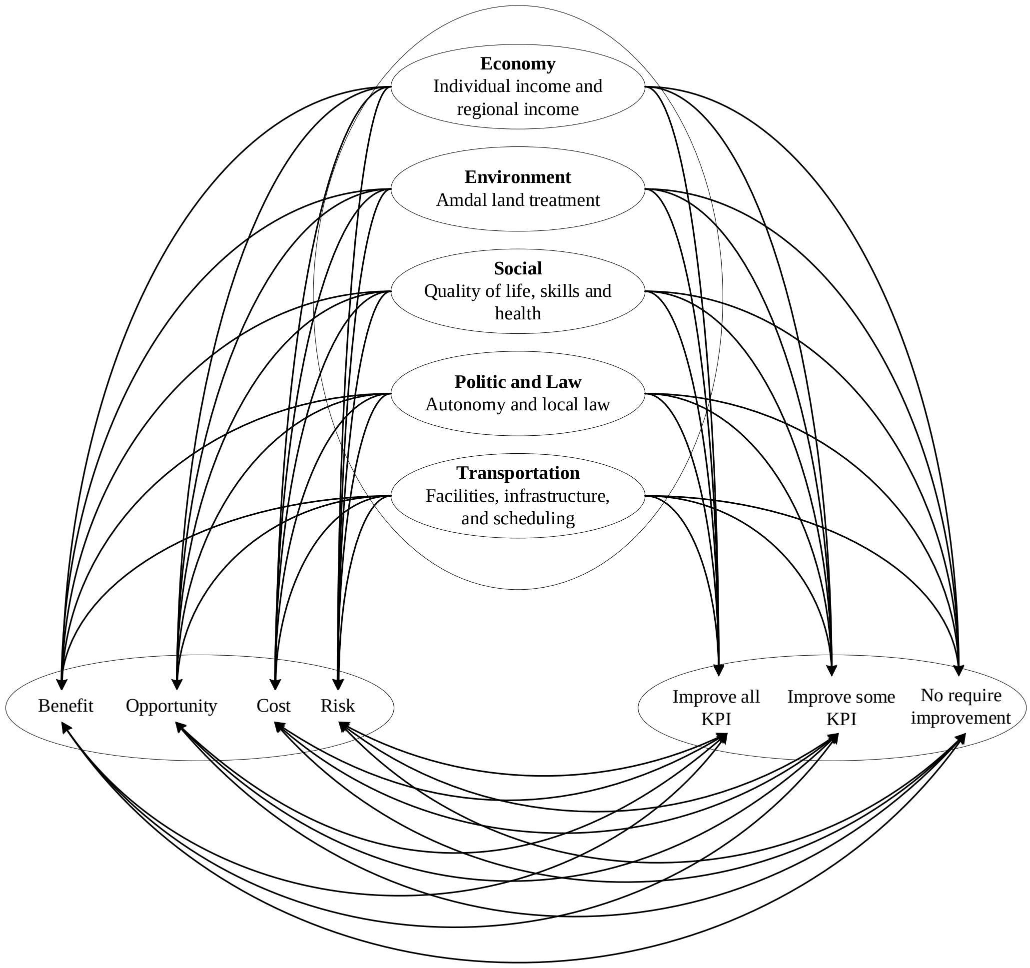

Figure 5. Hierarchy Structure ANP BOCR

The process of determining alternative strategies for developing organic rice agro-industry is carried out by reviewing alternatives based on benefits, costs, opportunities, and risks to predetermined aspects, namely economic, social, environmental, legal & political, and transportation. Later conclusions will be drawn in the form of three alternatives, namely improving all KPIs, improving some KPIs, or making no improvements. The elements used in detail are presented in Table 12.

Table 12. Elements ANP BOCR

Cluster	Criteria	Benefit	Opportunity	Cost	Risk
Economy	Individual Income Regional Income	Contribution to economic improvement at the community level	Economic opportunities created by the increase in the selling value of organic rice	Costs incurred due to repairs	The risk of economic instability will trigger input, land, and technology prices.
Social	Quality of Life Skill Possesd Public Health	Improving community welfare	Opportunities for job creation	Social costs arising from squatter settlements	Risk of social divide from those who favor conventional agriculture
Environment	Amdal Treat	Creation of integrated and environmentally friendly neighborhoods	An organic management system creates good environmental sanitation	Cost of managing impacts due to changes in conventional agriculture	Soil changes due to change from conventional to organic
Politic and Law	Autonomy Local Law	Improved security and absence of conflict	Increased legal and political awareness of the community	Costs incurred due to permit processing	Politics mass mobilization due to the system change
Transportation	Facilities, Infrastructure, & Scheduling	Creating accessible transport access	Better transport links created	Technology investment cost/technology failure	Maintenance of transport facilities

Priority analysis and synthesis are carried out through interviews with experts to get priority weights. The sub-criteria priority weights are presented in Table 13.

Table 13. Weight priority sub criteria

Code	Sub criteria	Normalized by Cluster	Limiting
A	1. Economy	0.39414	0.109545
	2. Social	0.23524	0.065381
	3. Ecology	0.14451	0.040165
	4. Politics and Law	0.15428	0.042879
	5. Transportation	0.07182	0.019961
B	6. Benefit	0.35889	0.198205
	7. Opportunities	0.29764	0.164375
	8. Cost	0.19247	0.106294
	9. Risk	0.15100	0.083395
C	10. Improve all KPI	0.42088	0.071465
	11. Improve some KPI	0.41239	0.070023
	12. No improvement	0.16674	0.028312

Based on the results of the calculations that have been carried out, it is found that the benefit sub criteria is the sub criteria that gets the highest weight with 0.198205, followed by the opportunity sub criteria with 0.164375, and the economic sub criteria with 0.109545. The highest weight value indicates a priority that supports the successful implementation of alternative organic rice agro-industry business development strategies. The results of the data processing obtained will be useful in decision-making so that it can be better. Furthermore, prioritization of the three alternatives obtained and the largest value states the best choice. The ranking of alternative strategies for developing organic rice agro-industry is presented in Table 14.

Table 14. Ranking of alternative strategies for organic rice agroindustry development

Alternative	Raw	Normal	Ideal	Ranking
Improve all KPI	0.071465	0.42088	1.000	1
Improve some KPI	0.070023	0.41239	0.979	2
No improvement	0.028312	0.16674	0.396	3

Based on the data processing results using the super decision software, the highest result is the improvement of all KPIs with a value of 0.42088, followed by the improvement of some KPIs with a value of 0.41239, and no need for improvement with a value of 0.16674. From the obtained results, it can be concluded that there is a need for improvement in the specified KPIs to enhance the performance of the organic rice agro-industrial supply chain. Some practical steps that can be taken to improve the performance of the supply chain include providing in-depth education to farmers on how to properly practice organic farming to produce high-quality and marketable organic rice products. Providing an understanding of the various long-term benefits of organic farming also needs to be disseminated to farmers so that a positive multiplier effect can be created. In addition, providing incentives or subsidies to farmers interested in organic farming, especially rice, can indirectly increase organic rice production and meet the demand.

4. CONCLUSIONS

Based on the research that has been conducted the rice agro-industry supply chain has several actors including farmers, kiosks, rice milling manufacturers, distributors, and consumers. The results of testing the performance of the rice agro-industry supply chain in Jember Regency obtained results that were classified as average with a value of 66.01. This shows that there is a need for improvement in the supply chain that has been carried out so that it can be better. Providing intensive education to farmers on how to farm organically properly and correctly to produce high-quality and marketable organic rice, as well as imparting an understanding of the various long-term benefits of organic farming, should also be disseminated to farmers to create a positive multiplier effect. On the other hand, offering incentives or subsidies to farmers interested in organic farming, particularly organic rice, can also be a solution to increase organic rice production and meet demand. The preparation of strategies for improving the organic rice agro-industry was carried out through ANP BOCR. The results show that the sub-criteria benefit (0.198205), opportunity (0.164375), and economic (0.109545) get the highest value. Based on the results of pairwise comparisons, it is also found that the most appropriate strategy is to improve all KPIs.

ACKNOWLEDGEMENT

The researcher would like to thank you for the Agroindustrial Engineering study program, at IPB University for facilitating researchers to learn about supply chain science in depth.

REFERENCES

Ansari, A., Lin, Y. P., & Lur, H. S. 2021. Evaluating and adapting climate change impacts on rice production in Indonesia: A case study of the Keduang subwatershed, Central Java. 8, https://doi.org/10.3390/environments8110117

Astuti, P., Amran, T. G., & Herdono. 2011. Pemilihan Alternatif Pengelolaan Sampah Dengan Metode ANP dan BOCR di Dinas Kebersihan Propinsi DKI Jakarta. 6, 87–94.

https://doi.org/10.12777/jati.6.2.87-94
Chopra, A., Golwala, D., & Chopra, A. R. 2022. SCOR (Supply Chain Operations Reference) Model in Textile Industry. 57, 368–378. https://doi.org/10.35741/issn.0258-2724.57.1.33
David, W., & Alkausar, S. 2023. Statistik Pertanian Organik Indonesia. Universitas Bakrie, Jakarta.
Fatikhah, F., Kosim, A. M., & Devi, A. 2020. Strategi Pembangunan Koperasi Pertanian Alpukat Berbasis Syariah Pendekatan ANP-BOCR. 1, 117. http://dx.doi.org/10.31000/almaal.v1i2.1837
Hamdani, H., Wahyudin, W., & Nugraha, B. 2021. Supply Chain Operation Reference Analysis of Local Vegetable E-Commerce. 18, 10–18. http://dx.doi.org/10.17358/jma.18.1.10
Mardalisa, J., Kilat Adhi, A., & Suwarsinah, H. K. 2023. Analisis Pemasaran Beras Organik di Provinsi Sumatera Barat. Jurnal Agribisnis Indonesia, 11(2), 262–276.
Naafilah, M., Mubarokah, & Tondang, I. S. 2024. Performance Analysis Of Horticulture Supply Chain Management at CV. Miracle Kurnia Farm Kabupaten Sidoarjo. 3, 427–438. https://doi.org/10.54443/ijset.v3i2.372
Pawar, J., Choudhari, V., Choudhari, G., Wagh, P., More, G., & Ramanathan, V. 2022. Organic Food: The Importance from Public Health Perspective. 34, 28–37. https://doi.org/10.9734/jpri/2022/v34i29B36055
Purwandoko, P. B., Seminar, K. B., Sutrisno, S., & Sugiyanta, S. 2019. Analisis Rantai Pasok Beras Organik Di Provinsi Jawa Barat. Jurnal Pangan, 27, 187–194. https://doi.org/10.33964/jp.v27i3.390
Saragih, S., Pujianto, T., & Ardiansah, I. 2021. Pengukuran Kinerja Rantai Pasok pada PT. Saudagar Buah Indonesia dengan Menggunakan Metode Supply Chain Operation Reference (SCOR). 5, 520–532. https://doi.org/10.21776/ub.jepa.2021.005.02.20
Sari, A. F., & Suprayitno, G. 2020. Perancangan Model Pengambilan Keputusan Pemilihan Pemasok di Perusahaan Manufaktur Produk Farmasi dengan Pendekatan ANP BOCR. 14, 127. https://doi.org/10.22441/pasti.2020.v14i2.003
Shenoy, K. R., Ranjith, V. K., Nayak, S., & Anirvinna, C. 2024. Conceptualizing organic food consumption: a consumer motive perspective. Cogent Social Sciences, 10(1). http://dx.doi.org/10.1080/23311886.2024.2338864
Sibuea, F., Sibuea, M., Rahman, A., & Hartanto, A. 2023. Supply Chain Performance Analysis of Corn Processed Animal Feed. Habitat, 34(2), 203–212. http://dx.doi.org/10.21776/ub.habitat.2023.034.2.18
Sujianto, S., Gunawan, E., & Datta, A. 2020. Development Status and Challenges of Organic Rice Farming in Indonesia. Proceedings of the 13th International Interdisciplinary Studies Seminar
Sutia, S., Riadi, R., & Fahlevi, M. 2020. The influence of supply chain performance and motivation on employee performance. 9, 86–92. https://doi.org/10.59160/ijscm.v9i2.3269
Syamsiyah, J., Ariyanto, D. P., Herawati, A., Komariah, K., Hartati, S., & Nurbaiti, F. 2023. Rice Quality and Yield at Various Application Times of Organic Rice Management System. 28, 9. http://dx.doi.org/10.5400/jts.2023.v28i1.9-15
Vigar, V., Myers, S., Oliver, C., Arellano, J., Robinson, S., & Leifert, C. (2020). A Systematic Review of Organic Versus Conventional. Nutrients, 12(7), PMC7019963. https://doi.org/10.3390/nu12010007

Agroindustrial Journal Vol. 11 No. 2 (2024) 89-95

Bioassay of Functional Drink - KoTeJa (Coffee, Sea Cucumber, Ginger) Using Male Mice (*Mus musculus l.*)

Kurnia Harlina Dewi[1,*], Helmiyetti[2] and Ruca Ruci[2]
[1]Department of Agricultural Industrial Technology, Faculty of Agricultural Technology, Andalas University, Padang, Indonesia
[2]Department of Biology, Faculty of Math and Natural Science, University of Bengkulu, Indonesia
E-mail: kurniaharlinadewi@ae.unand.ac.id*

Received: October-24-2024; Accepted: December-27-2024; Published: December-31-2024

Abstract

This study aimed to examine the effect of sea cucumber ginger coffee on the behaviors and libido of the Swiss Webster male mice (mus musculus L.), which has given a functional drink product of sea cucumber ginger coffee (KoTeJa). This study consists of five treatments and each treatment was repeated 5 times repetition. These treatments in this study consisted of a negative control (P0); a positive control (P1) using methyl testosterone; a 2nd treatment (P2) using sea cucumber flour; (P3) for KoTeJa + sugar + creamer; and (P4) ginseng coffee. Observations of the libido were performed on days 0 to 5; on days 7 to 9 for locomotor activity; and on day 12 for the spermatozoa quality performed. The results showed that KoTeJa (P3) provides the best effect on the behavior of libido, with an average of 25 times introduction (on the 3rd day) and 39.25 times (on the 5th day), 6 times of average climbing (on the 3rd day), and 2 times of average coitus (on day 3), at an average of 86 times loops of locomotor activity (day 7), 108.66 loops (day to 8) and 124 loops (day 9), and an indicators of the quality of spermatozoa normality of 60.6%.

Keywords: *aphrodisiac; bioassay; KoTeJa; sea cucumber*

1. INTRODUCTION

Indonesia is one of the countries with quite a lot of people who consume coffee. The coffee beverage is becoming well-liked because of its distinctive aroma which arouses the appetite of consumers. Coffee can cause dependence due to its caffeine content. Caffeine is one type of alkaloid that is widely found in coffee beans, tea leaves, and cocoa (Maramis et al., 2013).

The addition of ginger and sea cucumbers in coffee allegedly could improve body vitality. The content of secondary metabolites contained in ginger plant extracts is a class of flavonoids, phenols, terpenoids, and essential oils. Phenol derivatives such as gingerol and shogaol are the main constituent compounds of ginger oleoresin (Witantri et al., 2013). Another material believed to increase vitality is sea cucumber. The study results prove that sea cucumber contains testosterone [(Maramis et al., 2013), (Witantri et al., 2013), (Nurjanah, 2008)]. Flour of sea cucumber is reported to contain steroids, saponins, fat, protein, carbohydrates, essential amino acids, and minerals that are known to be useful for increasing libido in males (Nurjanah, 2008). Phytochemical investigations of a body wall sub-fraction of black sea cucumber (H. atra) resulted in two isolated compounds: one previously reported triterpene glycoside, desholothurin B, and one triterpene glycoside isolated for the first time, 12-epi-desholothurin B (Puspita, 2023). The extract was standardized with specific parameters, including organoleptic, water and ethanol soluble content, phytochemical screening, and protein content, and non-specific parameters, including drying shrinkage, water content, ash content, and acid insoluble ash content (Evascuasiany & Puradisastra, 2010).

Libido or sexual desire is the conscious feeling of the sex drive of the desire to have sex (Puspita, 2023). In the male high libido condition will affect locomotor activity. The higher the libido the higher the locomotor activity. Libido in males is very closely related to testosterone. Testosterone is a steroid hormone that is responsible for the establishment and development of sex organs and libido and can be used as an active ingredient aphrodisiac in humans (male). In the human body, the steroid hormone is produced by the Leydig cells within the testes. Leydig cells play a role in the biosynthesis of testosterone, thus allowing the process of spermatogenesis in the testes (Nurjanah, 2008). Spermatogenesis is the process of formation of spermatozoa from spermatogonium, through

ISSN 225-6137 (print), ISSN 2302-3848 (online), doi: 10.22146/aij.v11i2.90104

the development of complex and orderly. Spermatogenesis in the seminiferous tubules occurs in the testes, through several processes, namely proliferation, differentiation, and transformation (Rusmini et al., 2023). Based on the above publication alleged that sea cucumber and ginger coffee (KoTeJa) will affect libido and the spermatogenesis process. So far, there have not been found publications on the effect of the combination of KoTeJa on the behavior of mice libido and sperm quality. Based on the description above, this study was conducted by observing the behavior of Swiss Webster male mice.

2. MATERIAL AND METHODS

A fiber cage measuring 22x16x14 cm and CCTV cameras were prepared for the observation of mice behavior. Materials used in this study are a 1001 brand coffee powder, sugar, creamer, sea cucumber powder, ginger powder, methyl testosterone, distilled water, feed mice, tissue, physiological solution (NaCl 0.9%), infusion solution, eosin of 2 %, and 0.5%.

2.1 Preparation of sea cucumber flour.

Sea cucumbers are cleaned from the entrails, then cut into small pieces, and then dried by using an oven at 160°C for ± 2 hours. The dried material in the form of sheets was blended and then sieved with a sieve of ± 60 mesh (Nurjanah, 2008).

2.2 Preparation of ginger flour.

The selected ginger was cleaned under running water, and then thinly sliced. Then the ginger slices dried using an oven at a temperature of 45°C for 30-40 hours. Once dry, then blended until finer and filtered with a sieve size of 60 mesh (Nurjanah, 2008).

2.3 Preparation of mice test animals.

Adult mice used in the range of 2.5-3 months of age. For the purposes of the study, a sample of 60 mice was taken randomly (by simple random). The number of male mice required is 30 and 30 female mice. Mice were acclimatized for one week.

2.4 Provision of functional drink.

Intake of KoTeJa product was conducted to obtain mice in conditions of high testosterone, by looking at the behavior shown by the high activity of libido. Methyl testosterone was given for the positive control. Intake of products and methyl testosterone was conducted at 02:00 pm as prescribed treatment using *gavage*.

This study uses a completely randomized design (CRD), with 5 treatments and 5 replications. The treatment consists of:

1. Treatment 0 (P0) as a negative control: mice without treatment KoTeJa, were only given food and drink ad libitum.
2. Treatment 1 (P1) as a positive control: mice were given methyl testosterone, at a dose of 0.0042 gr/bw in 1 ml of water.
3. Treatment 2 (P2), mice were given sea cucumbers powdered, at a dose of 0.0004 g/bw in 5 ml of water.
4. Treatment 3 (P3), mice were given KoTeJa + sugar + creamer, at the combination of all doses of 0.0074 gr/bw in 1 ml of water.
5. Treatment 4 (P4), mice were given ginseng coffee products, at a dose of 0.0108 g/bw in 1 ml of water.1.

The products are given once a day for 12 days orally using a *gavage*. Observations of libido performed on days 0, 1, 2, 3, 4, and 5 and its locomotor activity on days 7, 8, and 9. The observation was continued on the 12th day to see the quality of sperm of male mice.

3 RESULTS AND DISCUSSION

3.1 Change in locomotor activity behavior using a jogging ball.

Mice were put into the jogging ball. Observations were calculated based on wheel rotation within 15 minutes at intervals of 5 minutes. The time recorded since the mice were placed on a wheel (Evascuasiany & Puradisastra, 2010).

3.2 Observation of behavior change of Libido (Introduction).

Measurement of libido conduct by observing the behavior of male mice after 1 hour of treatment. One male mouse and two female mice were put in a fiber cage size of 22 x 16 x 14 cm. Cages lined for the bulkhead between male mice with females. Mice were adapted for 10 minutes, then the seal opened and observed their sexual behavior to see the introduction during the first 15 minutes, then male mice were issued to be rested. After 15 minutes made a second observation. Observations were conducted for six days, i.e. days 0, 1, 2, 3, 4, and 5. The behavior of libido was observed using CCTV cameras.

3.3 Observation of behavior change of Climbing.

Climbing libido measurement was conducted by observing the behavior of male mice after 1 hour of treatment. One male mouse and two female mice were put in a fiber cage. Mice were adapted for 10 minutes, then the seal opened and observed their sexual behavior during the first 15 minutes. The observation was conducted on the stages that occur when male mice ride (climbing) female mice, and then male mice were issued to be rested. After 15 minutes made a second observation. Observations were conducted for six days, i.e. days 0, 1, 2, 3, 4, and 5. The behavior of libido was observed using CCTV cameras.

3.4 Observation of behavior change of Coitus.

Intercourse libido measurement (coitus) was also conducted by observing the behavior of male mice after 1 hour of treatment. One male mouse and two female mice were put in a fiber cage. Mice were adapted for 10 minutes, then the seal opened and observed their sexual behavior during the first 15 minutes. Observation was conducted on the stages that occur during intercourse, then male mice were issued to be rested. After 15 minutes made a second observation. Observations were conducted for six days, i.e. days 0, 1, 2, 3, 4, and 5. The behavior of libido was observed using CCTV cameras.

3.5 Observation of behavior change of locomotor activity.

Locomotor activity is an activity of motion as a result of changes in the electrical activity caused by changes in the postsynaptic membrane permeability and by the release of the transmitter by the presynaptic neurons in the central nervous system (Evascuasiany & Puradisastra, 2010). Figure 1 shows the results of the frequency of locomotor activity of mice. This graph shows that treatment with the provision of the product showed the presence of effects on locomotor activity of mice with higher average locomotor activity at each treatment compared to the control for 15 minutes. A given product affects locomotor activity in mice, and KoTeJa products given in treatment P3 give a better effect of all treatments since the average value of locomotor activity with the difference in numbers rise was not too large. It concluded that KoTeJa provided the most excellent effects on the locomotor activity of mice.

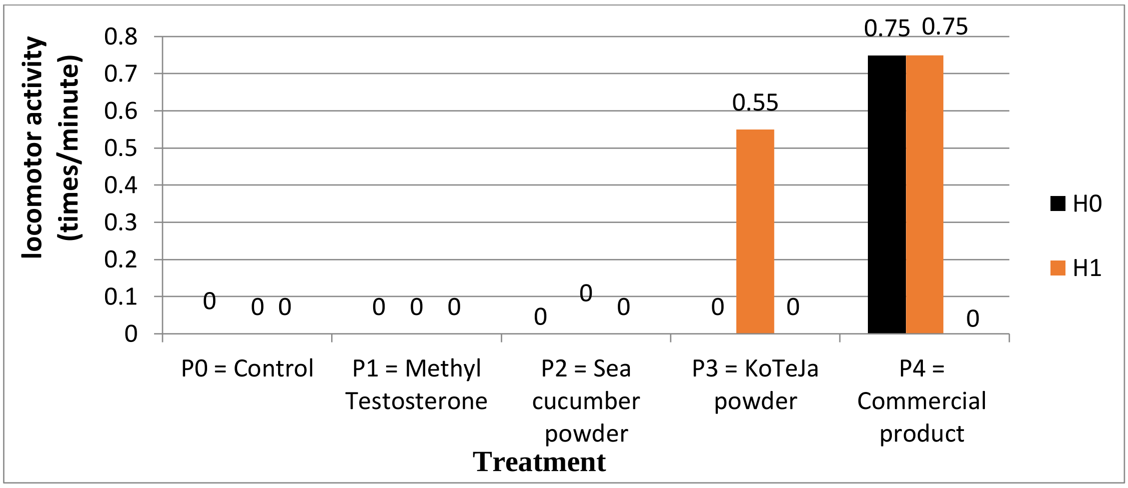

Figure 1. The average behavior of locomotor activity on 1 and 2nd day for 15 min of observation.

P0= negative control (food and drink), P1= positive control, P2: sea cucumbers flour (0.0004 g/kg bw in 5 ml of water), P3= KoTeJa (0.0074 gr/mm in 1 ml of water), and P4= ginseng coffee 0.0108 g/kg bw in 15 ml of water), P3= KoTeJa (0.0074 gr/mm in 1 ml of water), and P4= ginseng coffee (0.0108 g/kg bw in 1 ml of water).

3.6 Observation of behavior change of Libido (Introduction).

It's a stage that occurs when the male mice approached the female mice in the form of kissing mouth and kissing vagina. Figure 2 shows the behavior of frequency (introduction). Based on the frequency of introduction in Fig 2, the sea cucumber ginger coffee (KoTeJa) provides the best effect on the introduction behavior of male mice against the female mice. This influence is suspected because of the active compounds effect in the KoTeJa product. The results are consistent with the results of research conducted by references Widotama (2008) that the provision of flour trepang increases the frequency of sexual behavior (kissing vagina and mounting) in male mice. Sea cucumber flour contains steroids, saponins, fat, protein, carbohydrates, essential amino acids, and minerals that are very useful for increasing libido in male mice (Nurjanah, 2008).

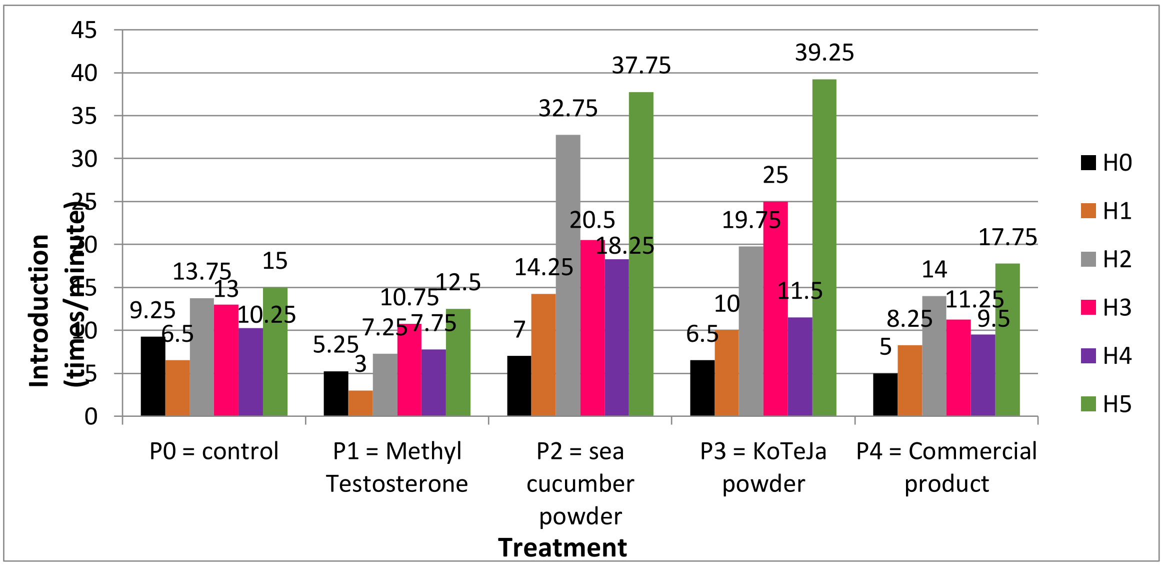

Figure 2. The average behavior of introduction on 0 - 5th day for 30 min of observation.

H0= 1st day, observation without treatment, H2= 2nd day, H3= 3rd day, H4= 4th day, H5= 5th day, P0= negative control (food and drink), P1= positive control, P2: sea cucumbers flour (0.0004 g/kg bw in 5 ml of water), P3= KoTeJa (0.0074 gr/mm in 1 ml of water), and P4= ginseng coffee (0.0108 g/kg bw in 1 ml of water).

3.7 Observation of behavior change of Climbing.

It's a stage that occurs when the male mice ride (climbing) female mice. Figure 3 shows the behavior change of climbing. The treatment P4 shows the behavior of climbing with an average higher than P2 and P3. However, the treatment of P2 and P3 respectively shows the influence of product on the behavior of climbing, despite the low average daily. This happens because the mice have more activity introduction (recognition), so the mice become exhausted and do little climbing. From Figure 3, it can be seen that the products supplied to each treatment showed different effects depending on the active compound contained in the product.

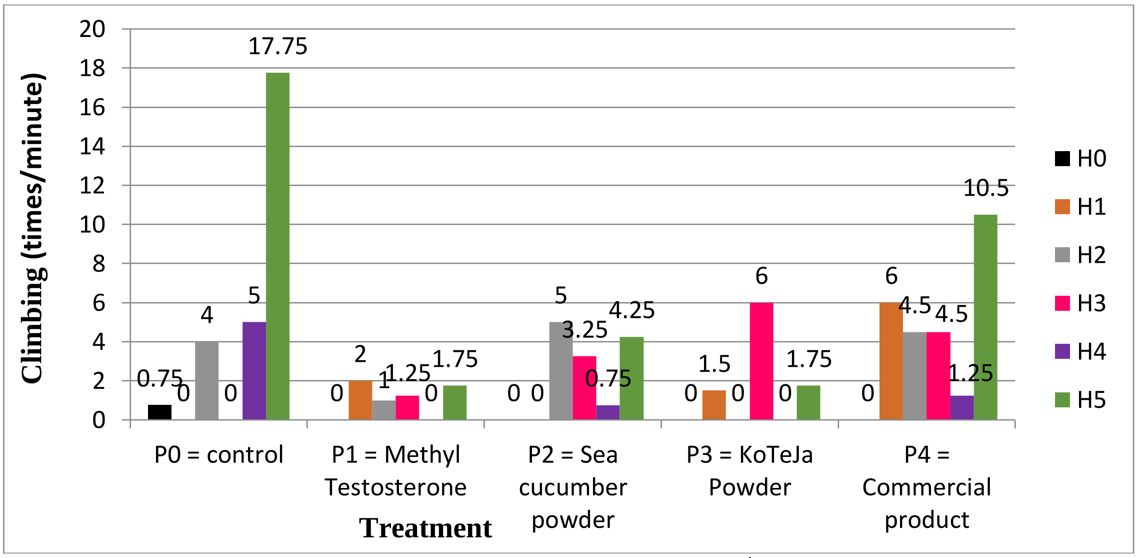

Figure 3. The average behavior changes of climbing on 0 - 5th day for 30 min of observation.

H0= 1st day, observation without treatment, H2= 2nd day, H3= 3rd day, H4= 4th day, H5= 5th day, P0= negative control (food and drink), P1= positive control, P2: sea cucumbers flour (0.0004 g/kg bw in 5 ml of water), P3= KoTeJa (0.0074 gr/mm in 1 ml of water), and P4= ginseng coffee (0.0108 g/kg bw in 1 ml of water)

3.8 Observation of behavior change of Coitus.

It's the state when the male rides the female mice that lasts for 4-7 seconds to perform coitus (mating). Figure 4 shows the behavior of frequency of intercourse

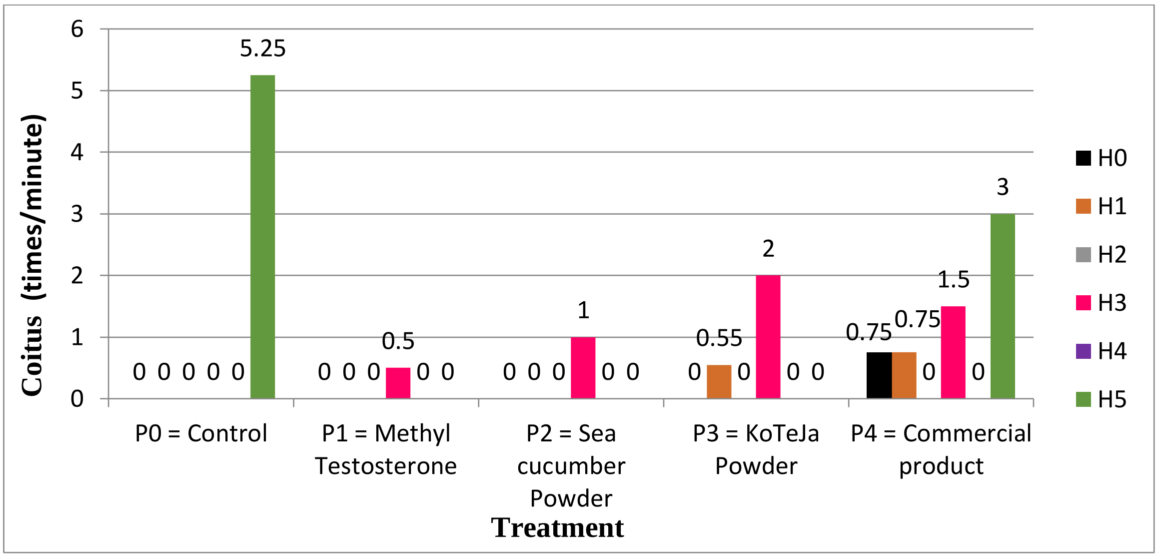

Figure 4. The average behavior changes of climbing on 0 - 5th day for 30 min of observation.

H0= 1st day, observation without treatment, H2= 2nd day, H3= 3rd day, H4= 4th day, H5= 5th day, P0= negative control (food and drink), P1= positive control, P2: sea cucumbers flour (0.0004 g/kg bw in 5 ml of water), P3= KoTeJa (0.0074 gr/mm in 1 ml of water), and P4= ginseng coffee (0.0108 g/kg bw in 1 ml of water).

After the introduction and climbing activity, usually mice will engage in sexual intercourse (coitus). Fig 4 shows that the average response to the behavior of the highest intercourse (coitus) on day five is indicated by P0 and P4. The mating/intercourse is preceded by climbing. The high percentage of intercourse behavior occurs because of a high riding percentage as well. Because at the time of going to engage in sexual intercourse, male mice will ride female mice first, and then just continue with mating that occurred in a few seconds. From these observations, it is stated that the mice had intercourse/mating when male mice rode the female mice for ± 4-7 seconds and then down and mice immediately licked their genitals to clean the genitals.

In the treatment of P1 and P2, intercourse occurred only on day 3 with a low frequency. While on treatment of P3, intercourse behavior has been seen on the 2nd day and 3rd day, with an average higher than P1 and P2. Meanwhile, P4 treatment showed the best effect on the behavior of intercourse with a high average and intercourse took place almost daily. In the treatment of P1, P2, P3, and P4, the average difference in male mice performed coitus, is thought to occur because of the effect of any product that contains an active ingredient which is also different.

4. CONCLUSIONS

Based on the results of the study influence of sea cucumber ginger coffee (KoTeJa) to behavioral change of Swiss webster male mice libido (Mus musculus L.), it can be concluded that sea cucumber ginger coffee (KoTeJa) at a dose of 0.0074 gr/bw provides the best effect to changes in libido behaviors of mice, namely: Changes on behavior of libido introduction is the highest on day 5 (39.25 times). Change in the behavior of climbing is the highest on day 3 (6 times). Changes in the behavior of intercourse (coitus) are the highest on day 3 (2 times). Further study on the mechanism of KoTeJa as a natural aphrodisiac with several dose levels is necessary, so it can be seen the influence of KoTeJa based on the dose of provision to test animals. Further studies regarding KoTeJa as an aphrodisiac in mice on the process of spermatogenesis in histopathology.

REFERENCES

Dewi H K, Helmiyetti, Nusril, Y Rosalina., and R A Siahan., 2014. Kajian Penerimaan Konsumen Terhadap Produk "KOTEJA" Kopi Dengan Tambahan Bahan Berkhasiat. 6, 25-30. https://doi.org/10.17969/jtipi.v6i2.2067

Dewi H K, R Yessi, Nusril., and Helmiyetti., 2013. Analisis Tingkat Kepuasan Produk Kopi Teripang Jahe Dalam Kemasan Di Kota Bengkulu. Proc Seminar Nasional. Persatuan Ahli Teknologi Pertanian Indonesia

Evascuasiany E and S Puradisastra., 2010. Ekstrak Biji Pala (Myristica fragans Houtt) dan Cabe Jawa (Piper retrofractum Vahl) sebagai Afrodisiak pada Tikus dan Mencit. Farmakologi Fakultas Kedokteran Universitas Kristen Maranata.

Maramis, K R G Citraningtyas and F Wehantou., 2013. Analisis Kafein Dalam Kopi Bubuk Di Kota Manado Menggunakan Spektrofotometri UV-VIS. 2. https://doi.org/10.35799/pha.2.2013.3100

Nurjanah S 2008 Identifikasi Steroid Teripang dan Pemanfaatan Sebagai Sumber Aprodisiaka Alami. Ph.D thesis. Sekolah Pascasarjana, Institut Pertanian Bogor, Bogor.

Nurjanah S, E Gumbira-Said, K Syamsu, Suprihati and E Riani., 2007. Pengaruh pemberian Teripang Pasir (Holothura scabra) Terhadap perilaku Seksual dan Kadar Testosteron Darah Mencit (Mus musculus).

Puspita, Yunita Eka., 2023. Phytochemical and Antidiabetic Investigations on Marine Products from Indonesia. https://hdl.handle.net/10067/2079460151162165141

Rusmini, Wintari Taurina and Mohamad Andrie., 2023. Standardization of Golden Sea Cucumber (Stichopus hermanii) Extracts from Pelapis Island, Kayong Regency, West Kalimantan. Biology, Medicine, & Natural Product Chemistry. 12, 539-545 https://doi.org/10.14421/biomedich.2023.122.539-545

Widotama G., 2008. Pengaruh Isolat Herba Vernonia cinerea terhadap Spermatogenesis Tikus Putih Jurnal Kimia 2, 117-124.

Witantri W, E Suprijatna and W Sarengat., 2013. Pengaruh Penambahan Tepung Jahe Merah (Zingiber officinale var Rubrum) Dalam Ransum Terhadap Kualitas Telur Ayam Kampung Periode Layer. Animal Agriculture Journal. 2. https://ejournal3.undip.ac.id/index.php/aaj/article/view/2464/2472

Identifying and Reducing Waste in the Chicken Carcass Production Process at PT Ciomas Adisatwa

Ulfah Izdihar*[,1], Novita Erma Kristanti[2], Nurbaiti[1], Indira Hapsarini[1], Ayu Saraswati[1]
[1]Department of Agriculture Industrial Technology, Faculty of Industrial Technology
Sumatera Institut of Technology, Jl. Terusan Ryacudu, Way Huwi, Kec. Jati Agung, Kabupaten Lampung Selatan, Lampung 35365, Indonesia.
[2]Department of Agroindustrial Technology, Faculty of Agricultural Technology
Universitas Gadjah Mada, Jl. Flora No.1 Bulaksumur 55281, Indonesia.
Email: Ulfah.izdihar@tip.itera.ac.id*

Received: October-23-2024; Accepted: January-13-2025 Published: January-14-2025

Abstract
PT. Ciomas Adisatwa unit Berbah is one of the Poultry Slaughterhouses (PSh) in Yogyakarta, producing 2,000 chickens/hour. However, some production steps do not increase the value of the finished product. Because of that, wasteful and non-value-added production processes must be eliminated to reduce the risk of contamination in PSh products and make the production process more efficient. Therefore, this study aims to identify the causes of waste and find an appropriate system to reduce the waste process. The methods used in this study include the Value Stream Analysis Tools (VALSAT) technique and future state mapping. Lean manufacturing is a concept used to reduce or eliminate waste in a production process. The wastes identified in the PT Ciomas Adisatwa production process include waiting activity, inappropriate processing, and unnecessary motion. The material weighing process identified the waiting activity because it was waiting for the Delivery Order (DO). Inappropriate processing occurs in hair removal rework in a clean area. The third waste is unnecessary motion, movement that is not needed occurs in cutting operators and dirty processes. The proposed improvements to address these wastes include enhancing the integration of information flow systems using a computer network, adding a plucker machine, and clarifying the division of tasks for each workstation to avoid unnecessary motion.
Keywords: *Chicken carcass; lean manufacturing; value stream mapping; waste*

1. INTRODUCTION

Chicken is one type of poultry where the Indonesian public favors almost every part of its body, such as meat, eggs, and innards. Chicken meat is widely consumed due to its high nutritional value and affordability (Fauzi and Wijaya, 2021). According to the Central Bureau of Statistics (2024), the production of broiler chickens in Indonesia amounted to 3.1 million tons in 2021 and increased to 3.9 million tons in 2023. This indicates a growing demand for chicken meat each year. Generally, the produced chicken meat is sold directly or used as raw material in the production of frozen food (Lenap et al., 2023). Chicken producers must increase their production to meet demand, which needs more costs. Producers must try to reduce production costs to keep profitability by improving production efficiency. By increasing efficiency, producers can produce more chicken meat in less time. Efficiency not only impacts the quantity but also the quality of chicken meat. A hygienic and fast slaughtering process will result in better-quality meat.

PT Ciomas Adisatwa is one of the Poultry Slaughterhouses (PSh) in Yogyakarta, operating in the commercial farming and slaughterhouse sectors under the umbrella of PT Japfa Comfeed Indonesia. Its production capacity reaches 2,000 chickens per hour or 20,000 chickens per day. In its production process, activities that do not add value or create waste have been identified like waiting, inappropriate processing, and unnecessary motion, this causes the production process to be inefficient. The PSh serves as a strategic link in the supply chain of SHIH (safe, healthy, intact, and hygienic) chicken carcasses, and the products it produces are categorized as high-risk. According to Dewi et al. (2016), meat is a perishable product that is at high risk of being contaminated by microbes. If the product has been contaminated with microbes, the product has been damaged which is not suitable for consumption because it will cause disease, so it requires a fast and hygienic production process. Therefore, it is necessary to eliminate waste activities using the lean manufacturing concept. Lean manufacturing is an approach that can be used to address waste in a company, thereby reducing production lead time (Setiawan and Rahman, 2021). The advantages of the lean manufacturing concept are that it can design effective and efficient production processes with small inventories, cheaper, and faster production processes with minimal space (Firdaus and Wahyudin, 2023). To reduce the identified waste, it is necessary to use Value Stream Mapping (VSM) which is a tool in the lean concept, which is a tool used to describe or map the production flow of a product from small components to finished products.

The application of lean manufacturing is expected to identify waste, the causes of waste, and ways to reduce or eliminate it. According to Lestari and Susandi (2019), waste refers to activities that do not add value to the product and must be eliminated. Lean manufacturing, as a value-driven production philosophy, has proven to be the foundation for improved efficiency and productivity (Kumar et al., 2022). Through the elimination of waste, this concept enables organizations to achieve a competitive edge. With the advancement of technology, the implementation of lean manufacturing is further enriched by the integration of digital solutions. As researched by ergeeva et al., (2024) the utilization of advanced technologies in industrial settings not only supports loss reduction efforts but also unlocks new opportunities for innovation and process optimization. This research aims to identify waste within the production process and propose improvements to reduce it.

2. MATERIAL AND METHODS

The research was conducted at PT. Ciomas Adisatwa, Berbah unit, located within the Agrotechnology Innovation Center (PIAT) of Universitas Gadjah Mada in Madurejo Village, Tanjung Tirto Street, Kalitirto, Berbah, Sleman Regency, Special Region of Yogyakarta. This study is descriptive research that describes the activities, characteristics, and relationships within a chicken carcass production system. The analysis of issues in the production process was conducted through a Focus Group Discussion (FGD) with several division heads at PT. Ciomas Adisatwa, Berbah Unit They are The HRD manager, the head of the inventory division, the head of the QA division, and the head of the production division of PT. Ciomas Adisatwa, this was done twice each approximately 2 hours.

The stages of the research implementation are as follows: 1) Preliminary survey, 2) Problem formulation and goal setting, 3) Literature review and field study, 4) Creation of value stream mapping, 5) Identification of the value stream, 6) Identification of key issues using a Pareto diagram, 7) Waste workshop, 8) Waste identification using VALSAT, 9) Identification of waste causes using fault tree analysis, and 10) Creating a future state map.

3. RESULTS AND DISCUSSION

Current State Map

The selection of products that will be mapped in this research is based on the number of products that are mostly produced at PT Ciomas Adisatwa. From FGD the product chosen to be analyzed and identified in this research is the CU-9 the chicken carcass specification is 1.3 Kg for 8.000 birds per day or 40% of the total birds. Current State Map or Value Stream Mapping (VSM) This is a diagram that illustrates a simplified production flow, allowing for the identification of its value stream (Setiawan et al., 2021). According to Ma'ruf and Dahdah (2021), the data generated from mapping through Value Stream Mapping (VSM) includes systematic physical flows throughout all production activities, operational times (lead time and cycle time), as well as the distances between each area. The information contained in the VSM can be used to see the existence of waste activities in the production process and used as the basis for eliminating or reducing these activities to obtain the ideal time for each stage of the activity process. The value stream of the chicken carcass production process at PT. Ciomas Adisatwa can be seen in the following Figure 1.

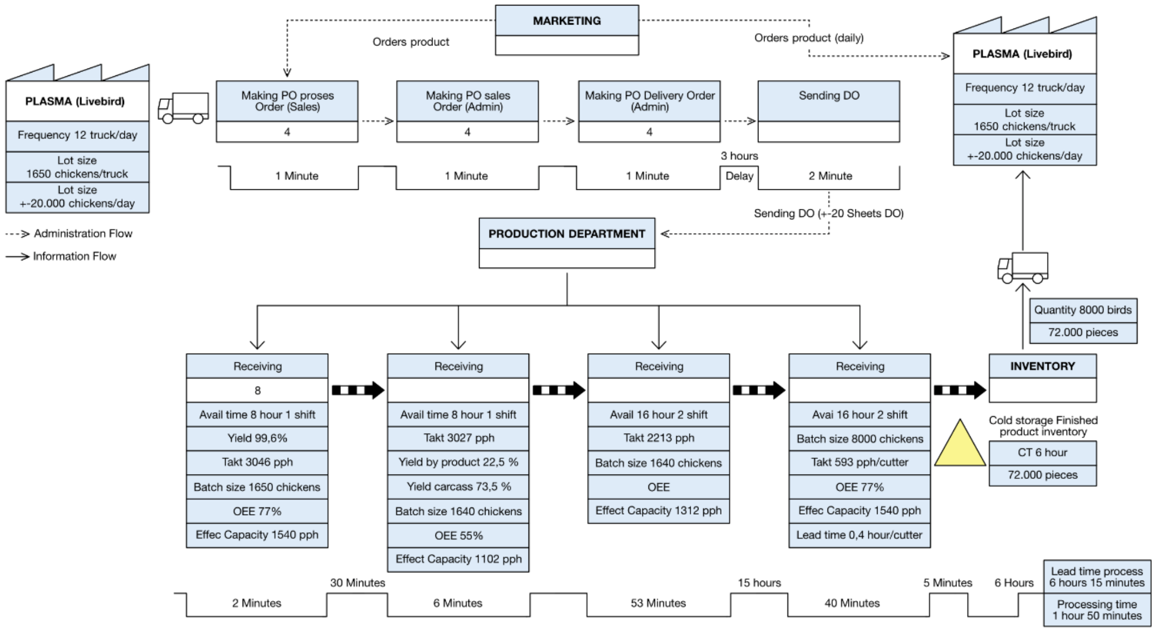

Figure 1. Current State Mapping of PT Ciomas Adisatwa

Based on Figure 1, Physical and administrative flow activities at the PT Ciomas Adisatwa, Berbah unit are fully explained below.

Material Flow

The physical or material flow begins with the raw materials (living chicken) which are provided daily by farmers (plasma or non-plasma), where the physical or material flow starts. Plasma farms are farms that follow a partnership pattern with livestock companies or other companies, while non-plasma farms do not follow this partnership pattern. The delivery of chickens amounts to over 20,000 birds every day or 12 trucks. Figure 2 below shows the physical flow of producing chicken carcasses.

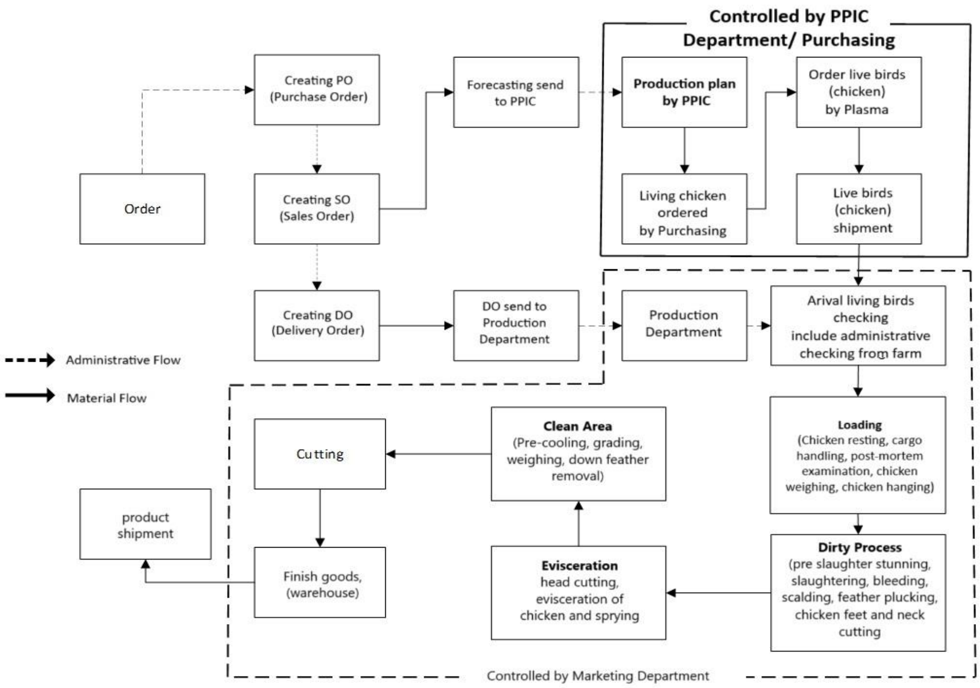

Figure 2. Material Flow of PT Ciomas Adisatwa

The chicken carcass production process begins in the receiving area and continues in the dirty area, which includes the processes of resting the chickens, receiving the chickens, performing antemortem inspections, weighing the chickens, hanging, stunning, Slaughtering, bleeding, scalding, defeathering, neck cutting, foot cutting, head removal, eviscerating or removing the internal organs, and finally spraying. The process then moves into the clean area, which includes pre-cooling, grading, weighing ingredients, cutting, marinating, and blast freezing. Based on Figure 2 the physical flow of the chicken carcass making process starting from the DO given from marketing to production and SO forecasting from marketing given to PPIC. The forecasting made by marketing is a prediction of the products that will be ordered the day after tomorrow. This forecast is made based on SO data from the previous period

Administrative Flow

The administrative flow begins with the sales department's receipt of customer orders, which is then processed through the input of purchase orders (PO). The administrative document then creates Sales Orders (SO) and Delivery Orders (DO). This data is subsequently handed over to the production department for processing. This information helps develop value stream mapping and understanding of document movement or administrative flow. This information is used to identify waste or waste contained in the administration flow of a system. The following Figure 3 illustrates the administrative flow of chicken carcass production at PT. Ciomas Adisatwa.

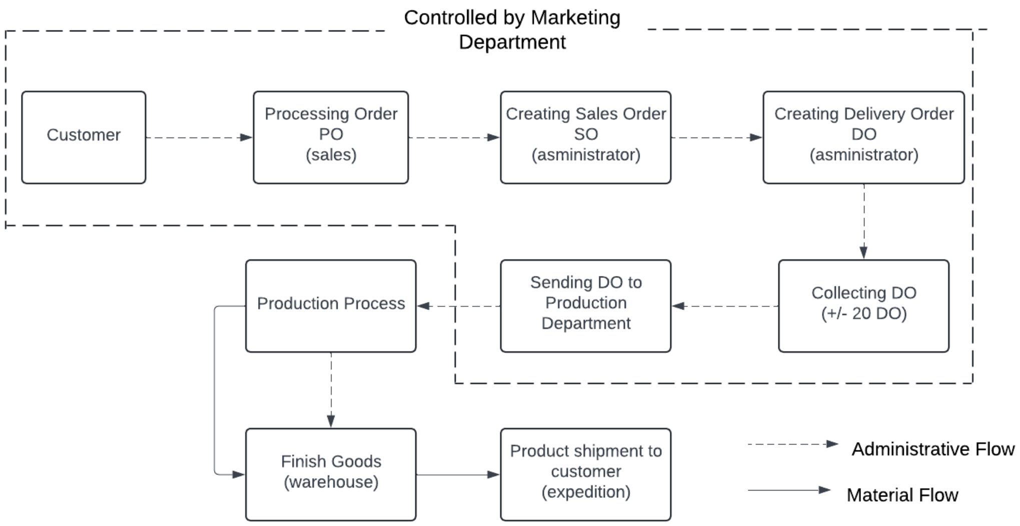

Figure 3. Administrative Flow of PT.Ciomas Adisatwa

Key Issues Identification

The HRD manager, the head of the inventory division, the head of the QA division, and the head of the production division of PT. Ciomas Adisatwa, Berbah Unit participated in a Focus Group Discussion (FGD) to identify the difficulties. Late arrival of chickens, rework in feather removal, delays at the chicken weighing station (TTA) because of waiting for the creation of the delivery order (DO), hot conditions in the production area (dirty area), limited water and ice supply, and machine downtime are some of the issues discussed in the production process. A Pareto diagram study then identified the main problems.

Rosyidi (2022) explains that a Pareto diagram is created to identify the key causes or issues in problem-solving based on the frequency of occurrences and cumulative percentage. The left X-axis lists the contributing factors, the right Y-axis shows cumulative percentage data, and the Y-axis represents the frequency of each cause. Figure 4 displays the findings of the Pareto diagram used to identify the main issues in the manufacturing of chicken carcasses at PT. Ciomas Adisatwa, Berbah unit.

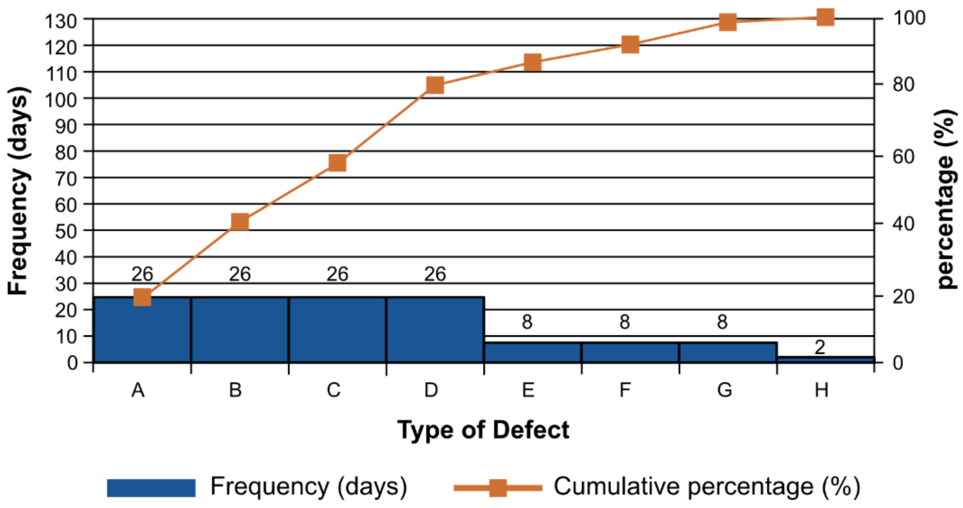

Figure 4. Main Issues at the Production Process

Description:
A: rework on feather plucking
B: high production room temperature at dirty area
C: delayed processed at a chicken weighing station (TTA) due to prolonged DO process
D: workers low performance at cutting section
E: late arrival of chicken
F: limited ice supply
G: limited water supply
H: machine downtime

The results from the Pareto diagram show that the issues falling within the 80% cumulative percentage include rework in feather removal, high working environment temperature in the dirty area, delays in the process at the chicken weighing station (TTA), and low performance of the cutting workforce.

Waste workshop

The waste workshop, using the seven wastes approach, was conducted to gather information on waste activities within the value stream of the production process. According to Hibatullah et al. (2021), the seven wastes approach classifies waste activities into seven categories: overproduction, unnecessary motion, unnecessary inventory, inappropriate processing, excessive transportation, waiting, and defects. Data collection was carried out through discussions and interviews with representatives from the QA department, the Production department, the Warehouse department, as well as the branch manager. The final data consisted of scores for each type of waste, provided by each division and recorded in the provided questionnaire. The scoring used a scale from 1 to 5, with the following details: 1 = no waste, 2 = occasional waste, 3 = some waste, 4 = significant waste, and 5 = very significant waste. The results of the seven-waste scoring at PT. Ciomas Adisatwa, Berbah unit, can be seen in Table 1.

Table 1. Results of Waste Scoring Questionnaire

No	Type of Waste	Score				Total Score	Average Value	Rank
		QA Dept	Production Dept	Warehouse Dept	Branch Manager			
1	Overproduction	3	3	2	5	13	3,25	6
2	Unnecessary motion	3	4	4	4	15	3,75	3
3	Unnecessary Inventory	3	3	3	5	14	3,5	4
4	Inappropriate processing	3	4	5	4	16	4	2
5	Transportation	2	4	4	2	10	2,5	7
6	Waiting	3	4	5	5	17	4,25	1
7	Defects	4	3	3	4	14	3,5	5

Based on the scoring results, the three highest-ranked wastes are waiting, inappropriate processing, and unnecessary motion. The waste classified under the waiting category was identified at the chicken weighing station (TTA). Delays in the process due to the waiting time for the creation of the delivery order (DO) result in live birds remaining on the production floor for an extended period. The high temperatures in this waiting area make live birds susceptible to heat shock. According to Mangan and Siwek (2024), poultry is more prone to heat shock due to its inability to regulate temperature through sweating. High temperatures, as reported by Goo et al. (2019) and Hirakawa et al. (2020), can lead to weight loss and decreased immunity in poultry. Generally, heat shock in poultry can increase the likelihood of disease occurrence, potentially leading to poultry mortality (Oluwagbenga and Fraley, 2023).

The second type of waste is inappropriate processing. This improper process occurs during the rework activity of feather removal in the clean area. Feathers are a part of the chicken's body that is contaminated and thus serve as a source of contaminants. Feathers, which have a high potential for contamination, should not enter the clean area. The third type of waste is unnecessary motion, referring to movements that are not required. This waste was identified in the cutting operators and the workforce involved in the dirty process. When the chicken carcasses to be cut are depleted, the cutting operator will retrieve the carcasses from the previous workstation (feather removal), causing the cutting process to halt during the retrieval activity.

Value Stream Analysis Tools (VALSAT)

To identify the locations of waste and facilitate understanding of the wastes identified within the value stream, a detailed mapping selection was conducted using VALSAT. The selection of the tool was carried out by multiplying the scores obtained for each type of waste by the VALSAT matrix. The 7 waste assessment score data obtained from distributing the questionnaire is data waste weighting which will then be multiplied by the multiplier factor in the method tools table VALSAT. There are 7 tools recognized in VALSAT, namely Process Activity Mapping (PAM) is a tool for mapping the production process in detail that is used to determine the proportion of activities grouped in value added (VA), necessary non-value added (NNVA), and non-value added (NVA), Supply Chain Response Matrix (SCRM) is a graph that connects between cumulative inventory with cumulative lead time on the distribution channel used to determine the increase or decrease inventory levels and lead time lengths at the time of distribution of each supply chain area, Production Variety Funnel (PVF) is a visual mapping technique where in a sequence of processes there is an increase in product variation, Quality Filter Mapping (QFM) is a tool used to map where quality problems arise in an existing supply chain, Demand Amplification Mapping (DAM) a tool used to map patterns or demand changes in each supply chain, Decision Point Analysis (DPA) is the point where there is a change in the trigger of production activities that initially based on the forecast to be based on orders and

Physical Structure (PS) is a tool that used to understand the condition of the supply chain on the production floor. The results of the calculation between waste and tools in VALSAT aim to obtain a selection ranking on tools, namely the highest ranking used to analyze waste.

Table 2. Scoring Result of Value Stream Analysis Tools

No	Waste	Total	PAM	SCRM	PVF	QFM	DAM	DPA	PS
1	Overproduction	13	13	39		13	39	39	
2	Waiting	17	153	153	17		51	51	
3	Transportation	10	90						10
4	Inappropriate processing	16	144		48	16		16	
5	Unnecessary motion	14	42	126	42		42	42	14
6	Excess inventory	15	135	15					
7	Defects	15	15			135			
	Total		592	333	107	132	132	148	24

Based on the analysis in Table 2, the selected detailed mapping tools are Process Activity Mapping (PAM), which ranks first, and Supply Chain Response Matrix (SCRM), which ranks second.

Process Activity Mapping (PAM)

Process Activity Mapping is defined by Zulfikar and Rachman (2020) as a tool that serves to identify and evaluate activities within the production process that provide value (value-added), those that do not provide value (non-value-added), and those that are necessary but do not add value (necessary but non-value-added).

Based on the observations made and the measurement of the cycle time for each process, there are four types of activities within the physical flow of the production process: operation, inspection, transportation, and storage. These activities are subsequently classified of value-added (VA), non-value-added (NVA), and necessary but non-value-added (NNVA). The data on the time and percentage of each activity performed in the chicken carcass production process is presented in Table 3.

Table 3. Activities in Material Flow

Activities Category	Total Activity	Time (minutes)	Percentage
Value added (VA)	14	75	16 %
Non-Value-added time (NVA)	6	2	3 %
Necessary but Non-Value Added (NNVA)	5	362	81 %

Table 3 shows that activities classified as necessary but non-value-added account for 81% of the total time. The activity that consumes the most time in the production process is waiting for the delivery of the finished chicken carcasses, the longest activity during the process of waiting for delivery of ready-to-ship is 5 hours. Based on the results of interviews and discussions, this does not disrupt the production flow, as a designated area is provided for the finished carcasses to await the delivery process.

Process Activity Mapping is also utilized to analyze the administrative flow. Based on the Process Activity Mapping (PAM), there are activities classified into value-added, non-value-added, and necessary but non-value-added categories within the administrative flow of the chicken carcass production process. The activities present in the administrative flow include the creation of Purchase Orders (PO), Sales Orders (SO), Delivery Orders (DO), collection of DOs, and delivery of DOs to the production department by the marketing admin. The percentage of activity types in the physical flow at PT. Ciomas Adisatwa Unit Berbah can be seen in Table 4.

Table 4. Activities in Administrative Flow

Activity Categories	Total Activity	Time (minute)	Percentage
Value added time (VA)	3	3	8,5 %
Non-Value-added time (NVA)	1	180	85 %
Necessary but Non-Value-Added Time (NNVA)	1	2	5,5 %

The category of activities with the highest percentage in the administrative flow is Non-Value Added (NVA), which accounts for 85%. This waste occurs during the stacking or collection process of Delivery Orders (DO). Once the DOs are printed by the marketing admin, they are not sent immediately; instead, they are stacked or held until a total of 20 sheets are collected. Once there are enough DOs, the marketing admin will deliver them to the production department. This practice causes delays in the weighing process in the TTA area, as it has to wait for the completion of the DOs. Delayed orderscan disrupt production schedules, leading to imbalances in production flow. This can result in idle resources, increased downtime and decreased overall productivity (Yasin, 2023).

Supply Chain Response Matrix (SCRM)

The Supply Chain Response Matrix (SCRM) is a graph that illustrates the relationship between inventory and lead time, enabling the identification of increases or decreases in inventory levels during distribution across each area of the supply chain (Marie et al., 2017).

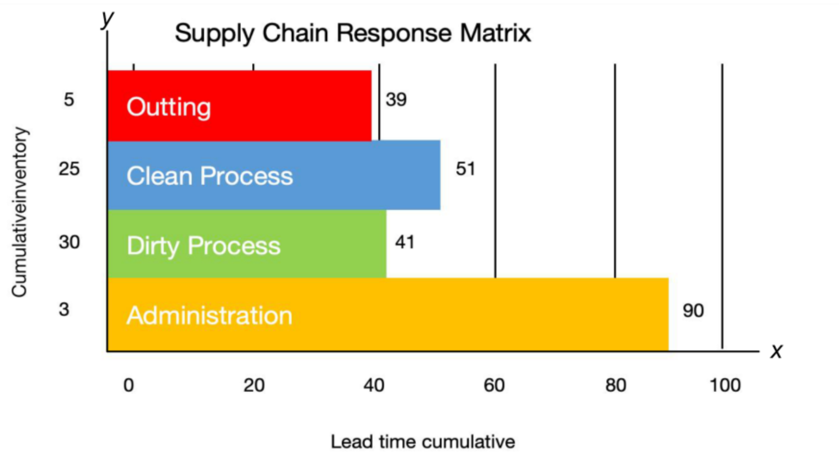

Figure 5. Supply Chain Response Matrix

Figure 5 illustrates the results of the supply chain response matrix mapping at PT. Ciomas Adisatwa Unit Berbah. The total cumulative lead time is 5.2 hours, with the longest cumulative lead time identified in the administrative process, which takes 90 minutes. The physical stock days were identified as 6.5 hours. Physical stock days are defined by Restuningtias et al. (2020) as the average daily duration that inventory remains in the order fulfillment system. The higher the physical stock days, the longer the accumulation of inventory throughout the system chain. The prolonged waiting time results in an extended lead time required in the production process.

Fault tree analysis (FTA)

According to Mangngenre et al. (2019), Fault Tree Analysis is a quality control method in the form of a tree diagram used to systematically trace defects by analyzing system errors from a collection of interacting objects. The identified wastes are waiting inappropriate processes, and unnecessary motion. The following is a fault tree analysis of the reasons for each waste:

a. Waiting Activity

The material weighing area is where the waiting activity takes place. The reason for this waiting is the delayed Delivery Order (DO). The distribution procedure of the DO from the marketing department to the production department isn't functioning properly, which is the reason why the DO is waiting at the chicken weighing station (TTA), according to the Fault Tree Analysis diagram. The following are the causes, shown in Figure 6:

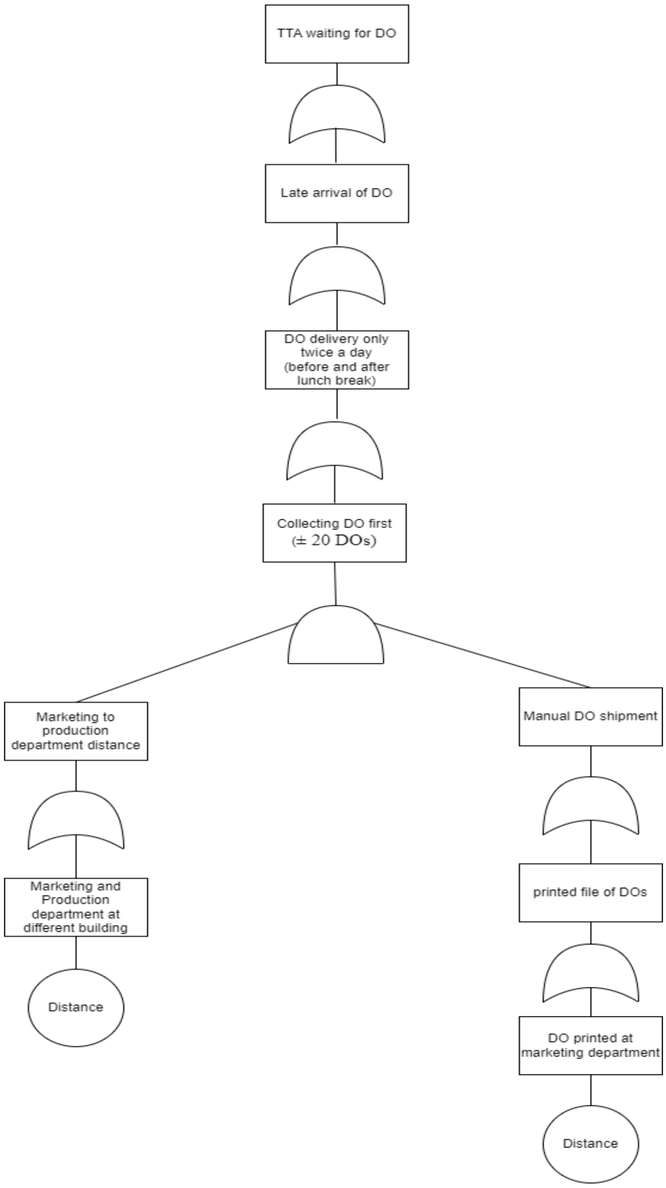

Figure 6. Fault Tree Analysis of Waiting Process at TTA

1) Manual delivery of DO

The Delivery Order (DO) is a document containing customer orders issued by the marketing department as official proof of product creation. Workers (admin) consider the technique of accumulating DOs before sending them more effective than sending each DO individually, as they are responsible for delivering the DOs themselves.

2) Delivery scope distance

The manual delivery of DOs overwhelms the marketing department when they have to deliver each DO individually to the production department, as the production area is located in a separate building from marketing.

b. Inappropriate processing

The reason for the feather plucking rework is that the output carcass from the plucker machine is not perfectly clean. This cause is shown in Figure 7:

1) Conveyor Speed

The high conveyor speed shortens the chicken scalding process, leading to incomplete feather plucking. This speed is used to meet the company's slaughter target. The high slaughter target is due to increased product demand, and to achieve the production goal, the conveyor speed then needs to be increased.

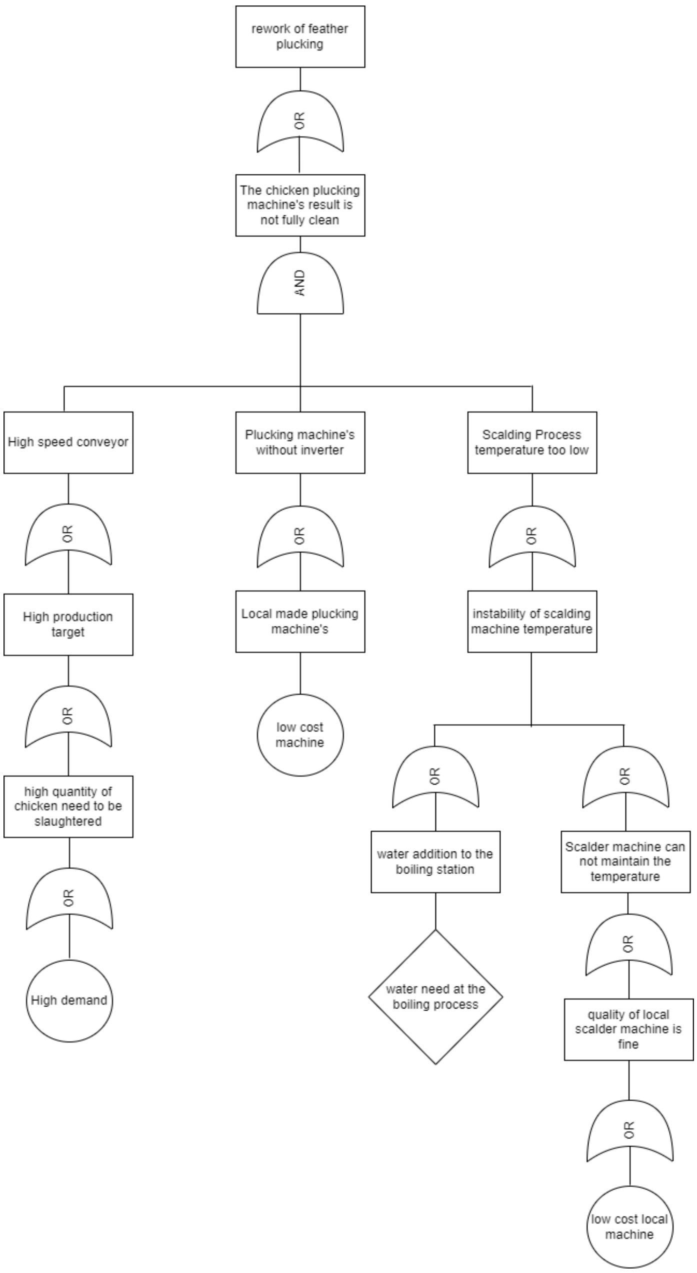

Figure 7. Fault tree analysis rework of feather plucking

2) Instability of scalder machine temperature

The instability of the scalding using hot water with a temperature of approximately 68℃ for 1.5-2 minutes is caused by the water addition activity performed by the scalder operator.

c. Unnecessary Motion

This unnecessary movement has been identified by the cutting operator and the workforce present in the dirty area (where the scalder/scalding machine is located). The causes of this issue are shown in Figures 8 and 9:

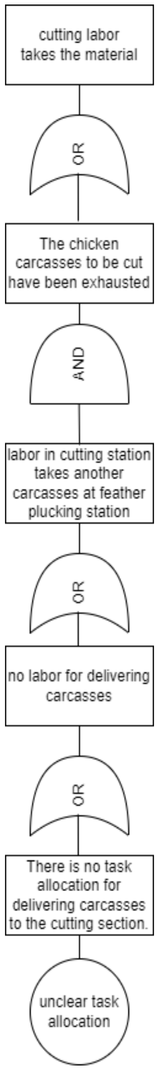

Figure 8. Fault tree analysis of unnecessary motion operator in the cutting process

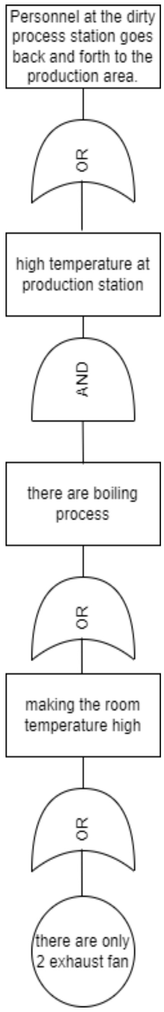

Figure 9. Fault tree analysis of unnecessary motion in dirty process

1) Unnecessary Motion by cutting operator

The cutting operator makes movements to retrieve the carcasses for cutting because there is no worker assigned to distribute the carcasses after the feather plucking (sorting) process to the cutting area. Therefore, as soon as the carcasses run out, the cutting operator has to retrieve them by themselves. During the retrieval of carcasses, the cutting process comes to a halt, and this happens repeatedly. When the carcasses being cut are exhausted, the cutting operator will go back to retrieve more. This issue is caused by unclear task allocation.

2) Unnecessary Motion in a dirty area

Workers in the dirty area, where the scalding process occurs, frequently enter and exit or rotate positions (rolling) with other workers after processing two trucks. This happens because the high temperature in the room makes the workers uncomfortable and often leads to fatigue. The processes that occurred in that area include neck and head cutting, which require concentration during the cutting operation. The high room temperature and fatigue can lead to injuries among workers. The removal of hot air is not functioning effectively because there are only two exhaust fans.

Proposed Improvement

The suggested recommendation is to simplify the process steps, particularly in the administrative process, to reduce the lead time. The proposed solutions are expected to have a positive impact on the overall system. Based on the identified issues, the proposed improvements are:

a. Waiting

The suggestion for improvement to facilitate the flow of Delivery Orders (DO) for prompt acceptance by production is to enhance the integration of information systems using a computer network. The use of a computerized system can shorten and reduce lead time in the production process. Shilamaya and Sisdianto (2024) reported that better application of information and technology in an industrial manufacturer resulted in higher operational efficiency and increased productivity.

b. Inappropriate processing

The proposed recommendation to eliminate the feather plucking rework in the clean area is to add additional plucker machines to ensure a cleaner feather removal process, thereby preventing the need for rework. Quantity is one of the important factors to be considered in poultry defeathering mechanization to ensure production effectiveness (Adetola et al., 2023).

c. Unnecessary motion

The proposed recommendation to address unnecessary motion among the cutting operators is to clarify the responsibilities within the organizational structure and enhance the supervision of work methods. Providing clear guidance to employees through SOPs helps minimize confusion, therefore speeding up workflow, increasing productivity, maintaining consistent product quality, and ensuring compliance with production standards (Rahmawati and Suryana, 2024) Additionally, establishing monitoring and communication systems will increase awareness among workers. For improvements in the dirty area, it is suggested to add more exhaust fans, as the current two exhaust fans are insufficient. Poultry processing in closed space exposes the workers to airborne dust, allergens, endotoxins, microorganisms, chemical pollutants, and organic gases which can cause skin allergies, acute respiratory symptoms such as wheezing and sneezing, oversensitive lung disorders, asthma, and other respiratory disorders (Islam et al., 2023).

Future State Map

Based on the results of the future state map, it is evident that the lead time of the process has decreased. Mapping of future state maps based on the identification of waste and proposed suggestions for improvement based on company conditions. These improvement suggestions will be able to reduce waste and activities that do not add value to the product. There is some waste in several parts of the production system, as explained in the analysis of the causes of waste. Mapping the current conditions depicted in the current state map shows that there is waste activity during the DO waiting time in the marketing department, this causes the process of weighing materials to be hampered. Therefore, it is necessary to implement a computer system that makes DO immediately sent to the production department and makes the process lead time shorter. This shorter production process can reduce the potential for contamination of the product and prevent weight loss in the carcass. A plucker machine that has an inverter is expected to produce carcasses that are clean from feather removal in the clean area and in the clean area and the labor, and rework process can be transferred to other processes. The lead time process before is 6 hours 50 minutes and the processing time is 2 hours 8 minutes after. In the future state map lead time process is 6 hours and 15 minutes and the processing time is 1 hour and 50 minutes because there is no DO Collection, rework (inappropriate processing), and unnecessary motion in the dirty area. Therefore, there will be no more feather removal rework, which can make the process lead time shorter. This Future State Map can be seen in Figure 10

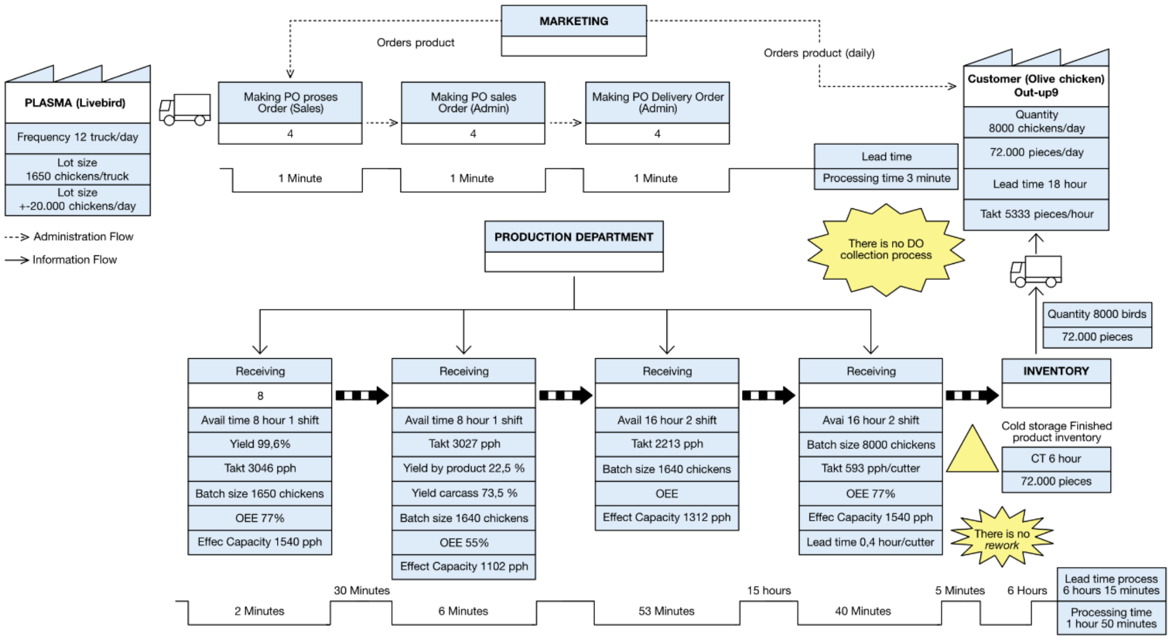

Figure 10. Future State Map

4. CONCLUSIONS

This study aims to identify the causes of waste and find an appropriate system to reduce it. The identified wastes in the chicken carcass production process at PT. Ciomas Adisatwa is waiting for inappropriate processing and unnecessary motion. The proposed improvements include simplifying the process by implementing a computerized system. With the use of a computer network, the lead time is expected to be reduced. Additionally, to address inappropriate processing, adding plucker machines to ensure cleaner feather removal is recommended. Furthermore, clarifying task allocations for each workstation will help eliminate unnecessary motion.

ACKNOWLEDGMENT

The author would like to express sincere gratitude to all those who have contributed to completing this research. The author extends his deepest appreciation to the supervisors who have patiently provided guidance and direction throughout the process of writing this journal. The author would also like to thank the management of PT. Ciomas Adisatwa for granting permission and facilities for conducting research at the Berbah unit. Lastly, the author wishes to express his gratitude to his family and friends who have always provided moral support and motivation throughout this research journey.

REFERENCES

Adetola, O. A, Oluwajana, A. S. and Akpan, V. D. 2023. Modification and Testing of a Poultry Bird Defeathering Machine. Proceedings of the 2023 School of Engineering and EngineeringTechnology (SEET) Annual Conference, p86-91.

Badan Pusat Statistik. (2024). Produksi Daging Ayam Ras Pedaging menurut Provinsi (Ton), 2021-2023. https://www.bps.go.id/id/statistics-table/2/NDg4IzI=/produksi-daging-ayam-ras-pedaging-menurut-provinsi.html

Dewi, E. S., Latifa, E. I., Fawwarahly, and Kautsar, R. 2016. Kualitas Mikrobiologis Daging Unggas di RPA dan yang Beredar di Pasaran. 4(3), 379-385. http://dx.doi.org/10.29244/jipthp.4.3.379-385

Fauzi, N. A. and Wijaya. 2021. Faktor-Faktor yang Mempengaruhi Perilaku Konsumen dalam Pembelian Daging Ayam Broiler di Pasar Celancang. 34(1), 69-72.

Firdaus, R.Z. and Wahyudin, W. (2023) 'Penerapan Konsep Lean Manufacturing untuk Meminimasi Waste pada PT Anugerah Damai Mandiri (ADM). 6(1), pp. 21–31. Available at:

https://doi.org/10.28932/jis.v6i1.5632.
Goo, D., Kim, J. H., Park, G. H., Delos Reyes, J. B., and Kil, D. Y. 2019. Effect of heat stress and stocking density on growth performance, breast meat quality, and intestinal barrier function in broiler chickens. 9(3), 107. http://dx.doi.org/10.3390/ani9030107
Hibatullah, N. D., Guritno, A. D., and Nugrahini, A. D. 2021. The analysis of lean manufacturing in waste reduction during rosin ester production at PT XYZ. 8(1), 501-507. https://doi.org/10.22146/aij.v8i1.73540
Hirakawa, R., Nurjanah, S., Furukawa, K., Murai, A., Kikusato, M., Nochi, T., and Toyomizu, M. 2020. Heat stress causes immune abnormalities via massive damage to effect proliferation and differentiation of lymphocytes in broiler chickens. Frontiers in veterinary science, 7, 46. https://doi.org/10.3389/fvets.2020.00046
Islam, M.N., Toha, M., Sikder, S., Khan, A.S. and Rahman, M.M. 2023. Explore the linkage of occupational respiratory symptoms on the demographics and lifestyle of poultry workers in local chicken retail markets in Dhaka, Bangladesh. Case Studies in Chemical and Environmental Engineering, 8, p.100544. http://dx.doi.org/10.1016/j.cscee.2023.100544
Lenap, I. P., Karim, N. K. and Sasanti, E. E. 2023. Pengembangan Potensi Wirausaha Melalui Produk Frozen Food dari Olahan Daging Ayam di Lingkungan Karang Panas Kecamatan Ampenan Kota Mataram. Sangkabira, 3 (2), 344-350.
Lestari, K. and Susandi, D. 2019. Penerapan Lean Manufacturing untuk mengidentifikasi waste pada proses produksi kain knitting di lantai produksi PT. XYZ. 567-575. https://doi.org/10.35313/IRWNS.V10I1.1519
Ma'ruf, F., and Dahdah, S. S. 2021. Analisis Pemetaan Aliran Nilai Menggunakan Waste Failure Mode and Effect Analysis (W-FMEA) dan Lean Manufacturing. 11(2), 140-149.
Mangan, M., and Siwek, M. 2024. Strategies to combat heat stress in poultry production—A review. 108(3), 576-595.
Mangngenre, Mulyadi, Pratama, A., Dahlan, M., Rauf, N., Saleh, A. 2019. Implementasi Metode Fault Tree Analysis Untuk Analisis Kecacatan Produk. 4(1), 50-56.
Marie, I. A., Sugiarto, D., and Mustika, D. (2017). Lean Supply Chain untuk Meningkatkan Efisiensi Sistem Manufaktur pada PT. XYZ. 7(2), 119–131. http://dx.doi.org/10.25105/jti.v7i2.2215
Oluwagbenga, E. M., and Fraley, G. S. 2023. Heat stress and poultry production: a comprehensive review. Poultry Science, 103141. https://doi.org/10.1016/j.psj.2023.103141
Rahmawati, F., & Suryana, N. N. 2024. Pentingnya Standar Operasional Prosedur (SOP) Dalam Meningkatkan Efisiensi Dan Konsistensi Operasional Pada Perusahaan Manufaktur. 1(3) 01-15. https://doi.org/10.61132/jumbidter.v1i3.112
Restuningtias, G., Sudri, N. M., and Widianty, Y. 2020. Peningkatan Efisiensi Proses Produksi Benang dengan Pendekatan Lean Manufacturing Menggunakan Metode WAM dan VALSAT di PT. XYZ. 4(1), 27-32. https://doi.org/10.31543/jii.v4i1.158
Rosyidi, M. R. 2022. Buku Ajar Pengendalian dan Penjaminan Mutu. Ahlimedia Press. Malang.
Setiawan, I. and Rahman, A. 2021. Penerapan Lean Manufacturing Untuk Meminimalkan Waste Dengan Menggunakan Metode VSM Dan WAM Pada PT XYZ. Pp. 1-10.
Setiawan, I., Tumanggor, O. S. P., and Purba, H. H. 2021. Value Stream Mapping: Literature review and implications for service industry. 23(2), 155-166. https://doi.org/10.32734/jsti.v23i2.6038
Shilamaya, P. and Sisdianto, E., 2024. Analisis Pengaruh Penerapan Teknologi Informasi Terhadap Efisiensi Operasional Dan Kinerja Keuangan Pada Pt. Pertamina. 2(4).
Yasin Tadayon and Alassane Balle Ndiaye. 2023. A New Key Performance Indicator Model for Demand Forecasting in Inventory Management considering supply Chain Reliability and Seasonality. Supply Chain Analytics. 3:1-15. https://doi.org/10.1016/j.sca.2023.100026
Zulfikar, A. M., and Rachman, T. 2020. Penerapan Value Stream Mapping Dan Process Activity Mapping Untuk Identifikasi Dan Minimasi 7 Waste Pada Proses Produksi Sepatu X di PT. PAI. 16(1), 13-24.