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Optimization of Skipjack Tuna *(Katsuwonus Pelamis)* Quality Factors in Chilled Box Storage Using Taguchi Method

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Abstract

Skipjack tuna (Katsuwonus pelamis) is one of tuna fish species in Indonesia,which is perishable and must be kept its freshness by chilling. Aim of this research were to optimize influenced quality factors and to find the best method for reduce deterioration process. The research was conducted by using Taguchi Method, which was used quality robustness concept and multi-performance characteristics to achieve optimal combination of factors. Controlled factors during chilled storage were; weight ratio of ice and fish (A), box size (B), time replacing ice (C), ice form (D), concentration of added salt (E), fish form (F) and number of fishes per kg (G). Quality responses for assessing the freshness were; peroxide value (POV), water content (WC), pH value, texture and Total Plate Count (TPC). The result showed, increase of peroxide value was affected by A of 26.52% and C of 26.52%. Increase of water content was influenced by F of 37.25%. Fluctuation of pH was affected by G of 59.58%. Decrease of texture was influenced by A of 40.47%. Increase of TPC was influenced by A of 31.20%. Priority Scale of factors during storage were A, E, D, G, F, B, and C. Result of analysis muli-performance characteristics gave a conclusion that factors A1, B1, C1, D2, E2, F2 and G2 are the best chilling storage methods.

Keywords*: Multi-performance Characteristics, Skipjack Tuna, Taguchi Methode*

1. INTRODUCTION

Indonesia is an archipelago country which has long coastal line and large potential sea. This condition leads to high potency of fishery products that could be as protein sources of human life. The fishery products became one of main Indonesian export commodities. Based on data from the Central Statistics Agency (BPS) for the January-July 2021 period, Indonesia has exported 1.2 million tonnes of yellowfin tuna with a total export value of USD 4.8 million worldwide with the main markets being Japan (95.09%), the United States (1.85%), Vietnam (1.55%), Australia (0.47%), and Singapore (0.44%) (Kementerian Perdagangan, 2021).

Skipjack tuna (*Katsuwanus pelamis*) or *cakalang* fish is one most consumed fish in Yogyakarta area at southern coast of Java island, and normally it was supplied by fishermen from northern part. Main problem of these fishes in Yogyakarta was decrease of its quality especially its freshness when it arrived at end consumers. Distance from northern to southern part of Java island was approximately 125 km and it took 3-4 hours.

Fish belonged to most perishable products, because it contained high protein which was potential to be degraded by microbial activities. When the fish was captured and died, it was weaker and easier to be attacked by microbes which led to deterioration process. Some external factors could accelerate the deterioration process such as temperature, physical impacts, bad post-fishing handling etc. (Chakma et al., 2020)

One of the characteristics of fish products are perishable, or easily damaged. The causes of this is due to the quality and microbial enzymatic activities are still going after the fish dies. If the activity increases, the decline in the quality of the fish was quick. The length of the fish supply chain, will lead to enzymatic and microbial activity lasts longer, so the fish products that the consumer is in a bad state. Enzymatic and microbial activity that occurs in the body of the fish can be minimized by storage at cold temperatures (Chakma et al., 2020).

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Storage that has been done by the business of cold storage is to use ice but not optimal keeping fish remain fresh. Therefore this study conducted optimization factors that affect the quality of tuna during storage. Further factors determining priorities for maintaining product quality remains good tuna, as well as determining the best storage method tuna.

2. MATERIALS AND METHODS

The research was conducted by using Taguchi Method, which was used quality robustness concept and multi-performance characteristics to achieve optimal combination of factors to maintain the freshness. It was based on experimental design for achieving efficient characteristics of product or production process, then combined with statistical analysis for every deviation or appeared variants (Monika Kussetya Ciptani, 1999). Taguchi introduced an integrated design which is divided into three steps; a) system design, in which quality characteristics and influenced factors were determined and classified into: smaller the better, nominal the best, larger the better; b) parameter (measure) design, the parameters were focused on product or process become robust from environmental influences, c) tolerance design. Three main tools of Taguchi were Orthogonal Array, ANOVA and SN Ration (S/N) (Khosla, 2006).

The controlled factors during chilled storage were; weight ratio of ice and fish (A), box size (B), time replacing ice (C), ice form (D), concentration of added salt (E), fish form (F) and number of fishes per kg (G). The quality responses for assessing the freshness were; peroxide value (POV), water content (WC), pH value, texture and Total Plate Count (TPC).

The fresh fishes were purchased at marketing point of fishermen at Jalan Bantul in Yogyakarta. They sold the fishes normally at 02.00 – 03.00 am, because they would be distributed to markets in Yogyakarta city. For every treatment 3-5 kg fresh fishes were provided. The number of fishes in every 1 kg weight was 4 to 5 pieces. The storage boxes for experiments (Styrofoam) were provided from the store and they were usually used by fish-seller in the market and had 2 dimensions 45 x 29 x 14 cm^3 and 35 x 21 x 14 cm^3. The household salt (NaCl) and block-ice were provided from market at Jalan Kaliurang, Sleman, Yogyakarta. The controlled factors and their levels were described in table 1. The implementation of controlled factors and their levels were systematically arranged by using Orthogonal Array in table 2 and the experiments were conduted based on the mentioned table.

Table 1. Controlled factors and levels.

Factors	Level	
	1	2
Percentage weight of ice and fish (A)	1 : 1	1.5 : 1
Experiment size (B)	45 x 29 x 14 cm^3	35 x 21 x 14 cm^3
Time for ice replacing (C)	12 hours	24 hours
Ice Form (D)	crushed ice	Cube ice
Added salt concentration (E)	5%	10%
Fish form (F)	Drawn fish	Dressed fish
Number of fishes /kg (G)	4 fishes	5 fishes

Table 2. Orthogonal Array for Conducting Research

Experiment	Factors						
	A	B	C	D	E	F	G
1	1	1	1	1	1	1	1
2	1	1	1	2	2	2	2
3	1	2	2	1	1	2	2
4	1	2	2	2	2	1	1
5	2	1	2	1	2	1	2
6	2	1	2	2	1	2	1
7	2	2	1	1	2	2	1
8	2	2	1	2	1	1	2

For example experiment IV was conducted by factors as follow: A (1:1), B (35 x 21 x 14 cm^3), C (24 hours), D (cube ice), E (10%), F (drawn fish), G (4 fishes).

3. RESULTS AND DISCUSSION

3.1 Measurements of the parameters

The decline of the quality of the resulting changes to the content of the fish. In this research, the test parameters to determine fish freshness. The parameters are the peroxide value, water content, pH, texture, and total plate count. Quality parameters are done every day for 5 days with 3 repetitions. According to the results of testing that has been done during the storage experiment VI dismissal must be made on the fourth day of storage. The combinations of experiment VI level are 1.5:1, size box (45x29x14) cm^3, 24 hour replacement time ice, ice cube, concentration of salt 5%, the shape of fish dressed fish, and 4 fish of 1 kg. Condition of VI box on the fourth day showed that a bad odor, rotten, meat texture is soft, slimy, and if done with a finger pressure feels sticky. Therefore do dismissal storage.

3.1.1. Peroxide value (POV)

Peroxide value response rate during 5 days of storage are shown in Figure 1.

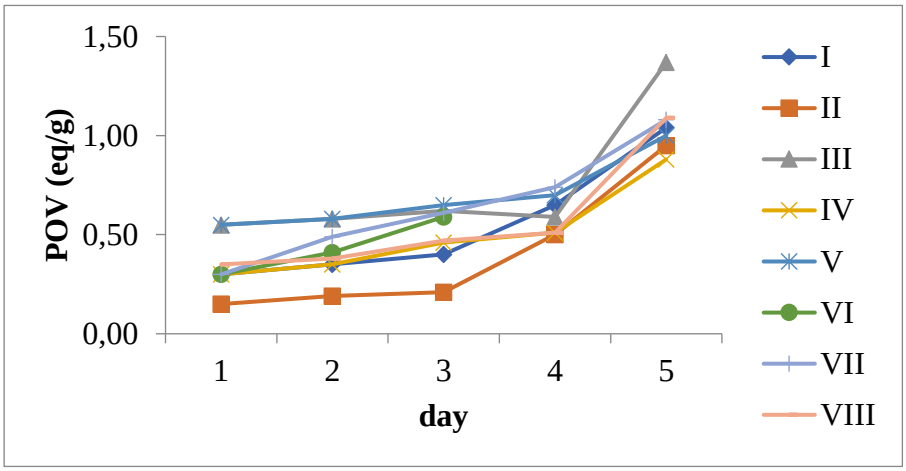

Figure 1. The peroxide response rate

In figure 1 shows that the peroxide response rate increased every day. On the fifth highest number of peroxide was 1.37 eq / g in box III. The smallest peroxide value is in box IV of 0.88 eq/g. The increasing peroxide value is supported by previous research that suggested by Sanger (2010). In the study explain that the longer the storage, the peroxide levels will increase. This is due to peroxide formed in the propagation stages with new free radicals, as well as uncontrolled temperature rise. The increasing of POV describes damage fish quality. POV is the result of fat oxidation that occurs in fish meat that is usually characterized by a rancid smell. POV are affected by fat content, temperature, oxygen, and moisture. The fat content of fish meat can affect how much POV formed.

3.1.2. Water Content

Water is an important component in food products, as well as fish products. Water content of the response values shown in figure 2.

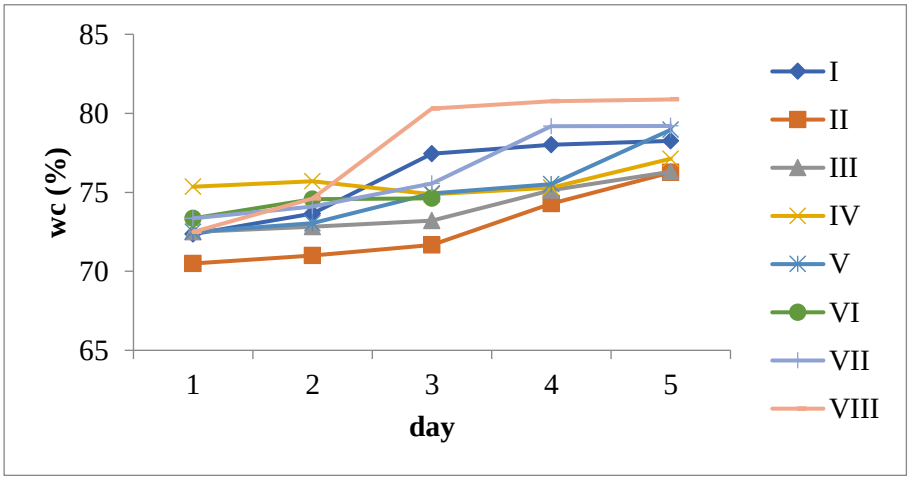

Figure 2. The water content (*%*)

In figure 2 showed that the water content increased from the second day to the fifth day on all box or experiment. On the first day, the lowest water content at the box II is 70.50% and the highest is box IV of 75.35%. After storage for 5 days, the highest water levels are box VIII which amounted to 80.88%. While the lowest water content at the box II by 76.26%

The increase of water content describes the deterioration in the quality of skipjack tuna. On the ice storage, the ability of the muscles to hold the water in the tissue fish gradually decreases, so water are easily dislodged in the tissue. This causes softening of fish meat. Water ice melt can enter the tissue of fish meat that has been damaged. So, the water content in fish has increased each day. According to Sayekti (2011), an increasing water content can be affected by environmental humidity. Low humidity will accelerate the decline of water content that due to evaporation of water (dehydration). While high humidity slows evaporation rate, but when followed by high temperatures will encourage the growth of bacteria and fungi. Therefore, high humidity and low temperatures are ideal conditions for the storage of skipjack tuna.

3.1.3. pH

The next fish quality parameters are pH, or acidity. PH numbers range is 0-14. If pH indicate 7, then the solution is called to be neutral. However, if the pH showed less than 7, it is acid. If the pH is more than 7, said base. pH neutral is safe for food, or between 6.5 to 7.5. PH value response can be shown in Figure 3.

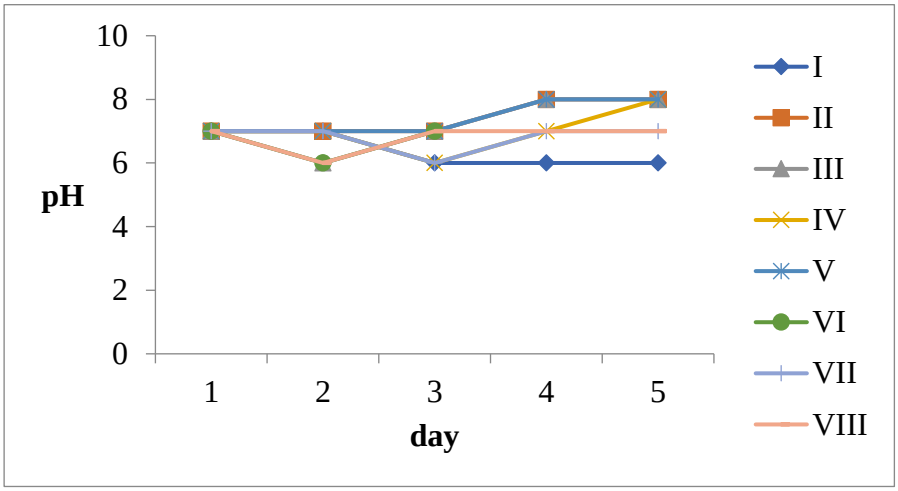

Figure 3. pH graph

Figure 3 shows the fluctuating pH response value. This statement is supported by research by Zakaria (2008) which states that the pH response value of fish which was originally neutral, will eventually become acidic due to the formation of lactic acid from the glycolysis process. Changes in pH response values in fish depend on various factors such as the type of fish, how to catch, feed, and other conditions. This decrease in pH value occurs from the pre-rigor phase to the initial post rigor phase. After that, the pH response value of fish meat will increase to alkaline, due to the formation of alkaline compounds that occur due to protein breakdown, such as NH_3 (ammonia). This compound is what causes the unpleasant odour in fish. This increase in pH response value occurs at the end of the rigor mortis phase.

3.1.4. Texture

Texture is the quality parameters that are influenced by the level of fluid in the body of fish. Determination of texture in this study used a Universal Testing Machine (UTM). The working principle of this machine is the emphasis on body samples. Emphasis will be calculated force (N) that required to push the fish to some extent. If the force (N) indicated greater, so describes texture of fish harder. Value of texture responses skipjack tuna can be shown in figure 4.

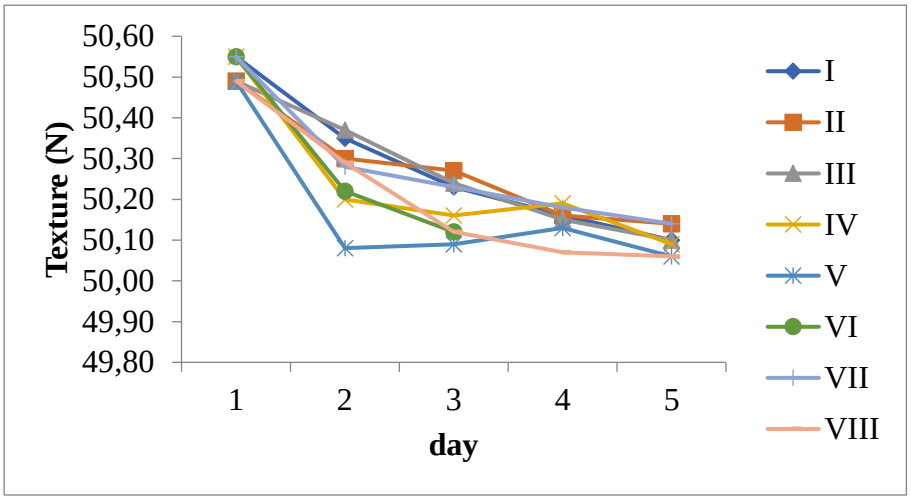

Figure 4. The texture responses (N)

In figure 4 shows the value of texture decreases every day. At the beginning, texture responses are soft. On the fifth day the softest texture of fish is box V and VII of 50.06 N. The statement was supported by research Sayekti (2011) mentions during storage, the texture of fish will be softer over time. Tenderness or loss of elasticity of meat is due to the actomyosin as a result of interaction between actin and myosin proteins. Damaging components of meat causes the release of water bonds so that the meat will lose its ability to hold water. Water will come out of the cells in the form of tiny droplets, causing a watery fish meat. It can be shown also by the results of the water content is increasing every day.

3.1.5. *Total Plate Count* (TPC)

Measuring the level of freshness of fish can be seen from the number of bacteria that thrive on fish. TPC response values can be shown in Figure 5.

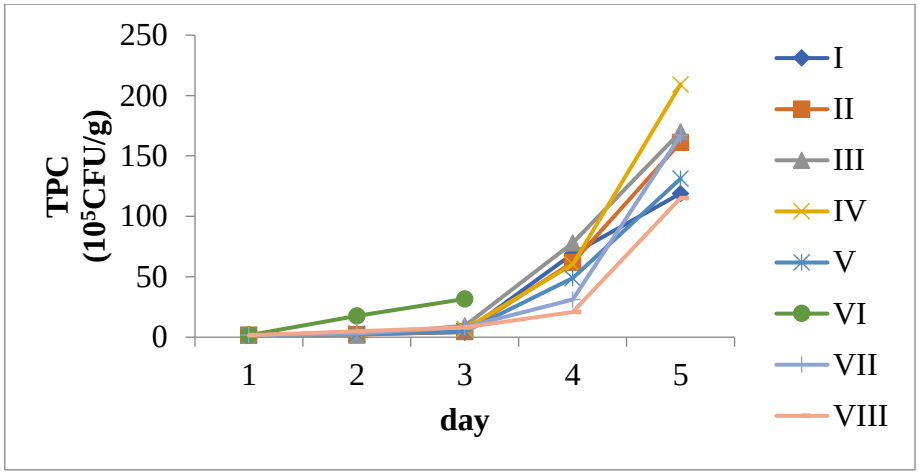

Figure 5. TPC responses

In figure 5 shows the TPC value has increased each day. The highest of TPC value is in the experiment IV with a 209x10^5 box CFU/g. Meanwhile, the lowest of TPC value is box VIII with 115x10^5 CFU/g. increasing TPC values indicates that damages fish increased. Accroding to Connel (1990) a high water content in the fish meat is a media for supports the growth of spoilage microbes. It is shown in the test results of water levels every day increasing. In addition to the research conducted by Zakaria (2008) fish meat is sterile because it has an immune system that prevent bacteria from growing in the flesh of fish. After dead, the immune system is not working anymore and bacteria can multiply freely. The process of deterioration caused by bacterial activity would not take place before the end of rigor mortis. At the end of the rigor phase, when decomposition increasingly, bacterial activity began to increase.

3.2 Mean Analysis of Skipjack tuna Quality Response

Mean analysis is an analysis that is used to determine the average value of the product. While the signal to noise is a signal analysis to determine the effect of noise products. In the calculation of S/N ratio, there are some characteristics. Characteristics of peroxide, water content, and total plate count are called smaller the better characteristic, for pH response are a nominal the best characteristics, and for textures is included larger the better characteristics.

The data used for SNR and mean analysis is the third day of data. Because, the third day is the longest storage for all experiments. On the fourth day, box VI should dismissal because the condition of fish had rotten. Table 3 is the result of the calculation of mean values and table 4 is the calculation of S/N Ratio.

Tabel 3. The Calculation of Mean

Experiment	POV (eq/g)	Water Content (%)	pH	Texture (N)	TPC (10^5CFU)
I	0.40	77.45	6.00	50.23	23.50
II	0.21	72.00	7.00	50.27	24.50
III	0.62	73.21	7.00	50.24	24.50
IV	0.46	74.88	6.00	50.16	21.50
V	0.65	74.93	7.00	50.09	23.00
VI	0.59	74.65	7.00	50.12	227.00
VII	0.61	75.56	6.00	50.23	92.50
VIII	0.47	80.31	7.00	50.12	105.50

Tabel 4. The Calculation of S/N Ratio

Experiment	POV	Water Content	pH	Texture	TPC
I	8-96	-36.53	-1.76	34.02	-24.41
II	1.93	-35.90	0.00	34.03	-24.77
III	5.56	-36.04	0.00	34.02	-24.77
IV	7.26	-36.25	-1.76	34.01	-23.64
V	5.34	-36.20	0.00	33.99	-24.23
VI	5.87	-36.17	0.00	34.00	-43.81
VII	5.65	-36.32	-1.76	34.02	-36.32
VIII	7.33	-36.91	0.00	34.00	-37.19

3.3 Comparison of the results Mean and Signal to Noise Ratio Analysis for Skipjack tuna of quality Response

Comparison of the results mean and S/N ratio analysis is intended to determine which factors are able to hold the quality of tuna products during storage. The result of mean and S/N ratio analysis shows that the ranking and factor are same. It can be shown in table 5.

Table 5. Rank of each responses

Rank.	POV		Water content		pH		Texture		TPC	
	Mean	*SNR*	*Mean*	*SNR*	*Mean*	*SNR*	*Mean*	*SNR*	*Mean*	*SNR*
1	C1	C1	F2	F2	G2	G2	A1	A1	A1	A1
2	A1	A1	C2	C2	B1	B1	F2	F2	E2	E2
3	D2	D2	E2	E2	C2	C2	C1	C1	F1	F1
4	B1	B1	A1	A1	D2	D2	D1	D1	D1	D1
5	E2	E2	B1	B1	E1	E1	B2	B2	G2	G2
6	G2	G2	G2	G2	F2	F2	E2	E2	C2	C2
7	F1	F2	D1	D1	A2	A2	G1	G1	B1	B1

Analysis of the mean and S / N ratio can produce a combination of the best level of quality on every response. The optimum combination of levels on each quality response can be shown in Table 6.

Table 6. The Optimum Factors and level

Factors	Level				
	POV	WC	pH	Texture	TPC
A	1	1	2	2	1
B	1	1	1	1	1
C	1	2	2	2	2
D	2	1	2	2	1
E	2	2	1	1	2
F	2	2	2	1	1
G	2	2	2	2	2

3.4 *Analysis of Variance* (Anova) of Skipjack Quality Response

Testing experimental data in this study used ANOVA. ANOVA is a statistical tool in base decisions to detect differences on the average results of the object being tested. In this study, Two-Way ANOVA was used to analyze the variation in the data. Two-Way ANOVA is used for experiments that have two or more factors as well as having two levels or more. ANOVA analysis is done by

comparing the value of F table and F calculate. If F calculate < F table, so it can be concluded that these factors are less significant influence on the experiment response. In this study, using 95% confidence level and (F.05; 16; 1), so we get F table 4.49. Below is a calculation of the percent contribution of ANOVA on each tuna products quality response that have been tested are shown in Table 7.

Table 7. The Contribution of ANOVA on each quality response

Faktor	Contribution factor (%)				
	POV	WC	pH	Texture	TPC
A	26,52	15,38	6,25	40,47	31,20
B	13,18	-	-	-	5,46
C	26,52	14,29	6,25	22,98	-
D	19,55	-	6,25	5,27	17,35
E	-	16,75	6,25	-	17,88
F	-	37,25	6,25	26,89	9,25
G	-	-	59,58	-	13,81
error	14,22	16,33	9,17	4,38	4,75

In the table shows different the percentage contribution of responses. In peroxide response, the most significant factors is factor A of 26.52% and C of 26.52%. In water content response is effected by F factor with 37.25%, pH response is factor G with 59.58%, texture response is factor A with 40.47% and TPC response is factor A of 31.20%.

3.5 *Multi-Performance Characteristics*

Quality Response to determine the freshness of fish in this study was peroxide value, water content, pH, texture, and total plate count. This suggests that the study is called a multi-response Taguchi. Multi-response Taguchi is a case that illustrates the quality response are more than one. If only one parameter or response, it is called a single response Taguchi.

The analysis used a multi-performance characteristics with a multi-S/N ratio. Steps in the multiple response analysis is initially calculated loss function of each response in each experiment. Further normalization of the data. The next step is to be weighted to calculate the total loss function. After that, the calculation of multi S/N ratio in each experiment and conducted by making the effect of factors to determine the best level combination. The results of the calculation of multi-performance characteristics shown in figure 6.

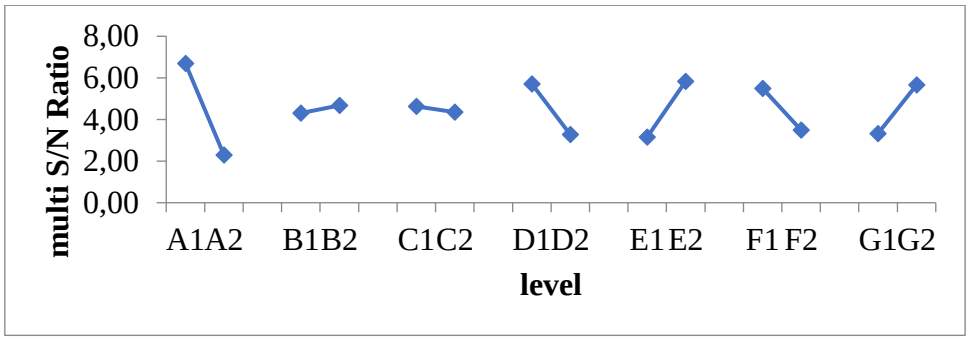

Figure 6. Factor effect of multy S/N ratio

In Figure 6 shows that the difference value factor A has the greatest. Then factor A has a major influence on the quality response of tuna products. Priorities quality factor freshness of the fish in cold storage can use the results of rank value difference. Priorities to consider the storage of fish are A, E, D, G, F, B, and finally C factor.

The most important factor to maintain the freshness is A factor, the weight ratio of ice to fish on the storage box. This factor contributes to reducing the temperature received by the fish. Ice is used

to reduce the temperature of the fish. Decrease the temperature the fish is intended to decreasing metabolites activity. Fish are relatively high temperatures, and ice are low-temperature, if they interact, there will be transfer of heat energy at a time until temperature equilibrium will occur. This supported by Rahmawan (2001) which states that if the ice is used more and more, the decreasing temperature fish faster. However, if the ice is used too much, there will be a chilling injury or damage due to tuna product quality, caused the temperature is too cold. Thus, the factor weight ratio of fish and ice is an important factor to maintain the quality of fish products during storage.

The second priority is factor E, the concentration of salt used. In this study salt tha researcher used is NaCl. Salt have function for decreasing freezing point, because the freezing point of salt solution is lower than the freezing point of water. It is also stated by Hadiwoyoto (1993) that the reaction between the salt and ice cause a decreasing temperature.

The third factor is factor D, the form of ice. Forms of ice that researcher used are smooth and cube. Form of ice is related to the ability of ice to cover the body of fish. The larger surface area ice, then the fish can be completely ice covered. This will lead to a drop in temperature could be global fish on the fish, so that deterioration can be slower. It also supported by Masyamsir (2011) that there are various forms of ice have a cooling vary speeds.

The fourth priority is factor G, the number of fish per kilogram. This is related to the surface area of fish. Fish is a food product that shapes and sizes vary even within a single species. At the market level, the number of 1 kilogram of fish is different. Fish size greatly affects the cooling surface area. If the surface area large, the cooling is rapid. Therefore, this study used a variety of fish size per kilogram consist of 4 and 5 fish.

The fifth priority is factor F, the shape of fish. Damaging fish during storage is caused by metabolic activity occurs in the body of fish. According to Junianto (2003) this activity occurred in the digestive, fins, tail and head. Therefore, fishs are weeding before being stored in the cool box.

The sixth priority is to factor B, the size of the box. In this study, fish boxes used to store the fish is made from the styrofoam. Styrofoam is a material made from a developed or expanded polysteryne having very light weight about 13 kg/m^3 to 16 kg/m^3 (Anonymous, 2012). Styrofoam box has a light weight, durable and practical, easy for storage, as well as widely used for fragile goods and fishery products, plantations, ranches and farms. Size box greatly affect the quality of fish products. This relates to the transfer heat energy in and out on the cooling system box.

The last priority is C, a replacement ice. Ice received heat energy from fish or from environment (out of the box system). Temperature of melting ice will change to reach equilibrium temperature to the temperature of fish, which would result in less than the maximum cooling. Therefore, there should be a new replacement ice storage box. Older ice melt from one experiment to another experiment differently, so that the replacement time in each experiment was different. This is supported by Hadiwiyoto (1993) that the replacement of ice time is one good way of cooling to maintain the freshness of the fish.

Priority factors which made it intends to measure the importance of these factors on fish storage in order to keep a good quality product. So that businesses can determine which factors they need to consider the fish cooling using ice during storage.

In figure 6, the best combination according to the calculation of multi S/N ratio is A1, B2, C1, D1, E2, F1, and G2. The Best level is the level which has been a higher SNR. Level the best combination is absent in orthogonal table aray. However, the combination of level approach by considering the priority factor, demonstrated by experiment II. Experiments or box II has a combination of A1, B1, C1, D2, E2, F2 and G2 with 1:1 level, (45x29x14) cm^3, 12 hours, ice cube, 10%, dressed fish, and 5 fishes.

4. CONCLUSIONS

Based on the research results, then there are several conclusions that can be drawn, which is as follows.

a. Priorities to consider the storage of fish in is weight ratio of ice and fish (A), concentration of added salt (E), ice form (D), number of fishes per kg (G), fish form (F), box size (B), and time replacing ice (C).
b. The increase of peroxide value response contributed by factor A with 26.52% and factor C of 26.52%. Decline in the water content response contributed by factor F with 37.25%. Fluctuation in the pH response by the factor G of 59.58%. The increase in the texture responses contributed by factor A of 40.47%. The increase in TPC response contributed by factor A of 31.20%.
c. The best combination level is weight ratio of ice and fish 1:1, box size (45x29x14) cm^3, time replacing ice 12 hours, ice cube, concentration of added salt 10%, fish form: dressed fish, and number of fishes per kg: 5 fishes.

Parameter quality tuna products that have been made still less to determine fish freshness. So that the necessary testing of the other quality parameters.

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Development of Sago Analog Rice with The Addition of Glucomannan Flour Using Value Engineering Method

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Abstract

Analog rice is an imitation of rice made with non-rice ingredients such as tubers and cereals as an alternative healthy food. However, the existence of analog rice has not been fully known and accepted by the public due to a lack of knowledge. The physical characteristics of analog rice do not resemble paddy rice and still have several attributes that interfere with consumer acceptance. Adding glucomannan to make analog rice is expected to improve product attributes. This study aims to determine the priority of product development attributes and produce analog rice with the best concept through high value. The method used in this product development is value engineering, which has five steps: information, creativity, analysis, development, and recommendation steps. The best concept for analogs is rice made from sago with an additional composition of 0.07 gram glucomannan flour and 7 ml pandan essence oil. Sago analog rice with 0.07 grams of glucomannan and 7 ml pandan essence oil has 83.74% carbohydrate, 3.02% fat, 4.53% protein, 8.15% water content, and 0.55% ash content.

Keywords: *glucomannan, product development, rice analog, value engineering*

1. INTRODUCTION

Indonesia is the third country in the world's most significant domestic rice consumption in 2016 – 2020, after China and India. The data support that 90% of Indonesians consume paddy rice as a staple food, with a percentage of 7.48% of the total world rice domestic market (Pusat Data dan Sistem Informasi Pertanian, 2021). The behaviour of the Indonesian people to make rice the leading staple food is feared to affect food security in the future. Therefore, there is a need for food alternatives to rice that still provide satiety and high nutrition in order to anticipate the crisis, provide alternative local food, and reduce people's dependence on paddy rice (Handajani et al., 2020).

Analog rice is an imitation of rice made from 50-98% ingredients containing starch or its derivatives, 2-45% ingredients that can enrich analog rice, and 0.1-10% hydrocolloids (Damat et al., 2020). Analog rice has a carbohydrate content that is not different from paddy rice, a lower glycemic index (GI) and provides a more prolonged feeling of satiety. Consumption of local food substitutes for paddy rice has indeed begun to develop. However, there are still obstacles, such as a lack of nutritional knowledge of the community, a lack of psychological readiness to replace staple foods, and the limited availability of food that meets people's tastes (Novrini, 2020). You can make analog rice using either granulation or extrusion. The essential difference between these two methods is in the gelatinization stage of the ingredients and the moulding stage, which will affect the product's final shape (Pudjihastuti et al., 2019). The extrusion method has advantages over the granulation method: it can produce with a larger capacity, and the process of flowing, mixing, kneading, heating, and forming occurs at the same time so that the rice produced has similar characteristics to paddy rice (Budi et al., 2013).

The selection of raw materials in making analog rice can affect the characteristics of the rice produced. For consumers, physical appearance is the first thing to be assessed in food products (Novitasari et al., 2017). Analog rice still has several attributes that interfere with consumer acceptance. Choosing the right ingredients can overcome these problems. One of the main ingredients for making analog rice is sago, a food commodity with a high starch content and complex carbohydrates that cause satiety longer (Hariyanto et al., 2017). Adding ingredients like pandan essence oil and glucomannan flour is one of the new alternatives to improve attributes considered disturbing by consumers, especially the aroma and taste attributes.

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Previous research on analog rice development has been carried out using sweet potato and taro flour (Srihari et al., 2016), breadfruit sorghum flour (Rasyid et al., 2016), mocaf and cornstarch (Yuwono and Zulfiah, 2015), white corn (Noviasari, 2013), white coconut yam (Adicandra and Estiasih, 2016), and sago flour (Septiani, 2021). However, these studies were only limited to variations in constituent ingredients, not including identification of consumer acceptance before and after product development. Based on the existing problems, it is necessary to develop analog rice by identifying the community's needs before producing the best concept. Product development uses the value engineering method, which is a method that is able to measure the value of a product with regard to quality, performance, and reliability at an acceptable price and is able to eliminate aspects that have no value (Iswahyuni, 2020). The company chose this method to develop a specific new product that the market has not yet fully recognized.

2. MATERIAL AND METHODS

2.1 Materials

The ingredients used are sago flour (65%), mocaf flour (7%), Glycerol Monostearate (1.5%), Carboxy Methyl Cellulose (1%), salt (0.1%), cooking palm oil (1.8%), water (22%), pandan essence oil (1.5%), and glucomannan flour (0-0.1%).

2.2 Tools

Tools for producing analog rice include a digital balance, stand mixer, basin, stove, steaming pot, white cloth, trays, spatula, extruder, and cabinet dryer.

2.3 Research stage

This research uses the value engineering method with several combinations of tests at each stage. This method consists of 5 stages: information, creative, analysis, development, and recommendation.

2.3.1 Information stage

At this stage, we conducted initial observations and identified analog rice quality attributes. We made these observations to gather information about analog rice through the Internet or market surveys. In addition, we observed the making of analog rice through trial and error. We will use the results of these observations as a reference and consideration in production.

After enlisting the expertise of five academic professionals, we assessed the Content Validity Ratio (CVR) to gauge the questionnaire's content validity prior to its distribution among participants. We integrated attributes that successfully cleared the CVR evaluation into an initial questionnaire to assess their perceived significance. This questionnaire employed a Likert scale that ranged from 1 (indicating very unimportant) to 5 (signifying very important). The individuals chosen to respond to the questionnaire encompassed the general public aged between 18 and 65 years, all of whom had prior experience with analog rice consumption. Upon gathering responses from 30 participants, the attributes of the questionnaire underwent rigorous testing for validity and reliability by utilizing IBM SPSS Statistics 26 software. If we confirm that all attributes possess validity and reliability, we will distribute the questionnaire to a larger cohort of no fewer than 100 respondents. This expanded distribution will occur with a high level of confidence at 95% and a significance level set at 5%. This statistical approach adheres to the established minimum sample size requirement of 97, as stipulated by Sugiyono in 2019.

After identifying five academic experts, we conducted a Content Validity Ratio (CVR) test to measure the content validity of the questionnaire before distributing it to respondents. After passing the CVR test, we will place the attributes into a preliminary questionnaire about the importance level. This questionnaire will utilize a Likert scale ranging from 1 (very unimportant) to 5 (very important). The questionnaire respondents were the general public aged 18 - 65 years who had consumed analog rice. After getting 30 respondents, the questionnaire attributes were tested for validity and reliability using IBM SPSS Statistic 26 software. Upon confirming the validity and reliability of all attributes, we distributed the questionnaire to a minimum of 100 respondents with a confidence level of 95% and a significance level of 5%, effectively fulfilling the minimum sample requirement of 97 (Sugiyono, 2019).

2.3.2 Creative stage

At this stage, we will determine the level of importance of the product by utilizing the formula for assessing importance and assigning weights to prioritize the development of product attributes.

$$Level\ of\ importance\ attributes = \frac{Score\ level\ per\ attribute}{Number\ of\ respondents} \quad (1)$$

$$Weighted\ importance\ level = \frac{Level\ of\ importance\ per\ attribute}{Total\ importance\ level} \quad (2)$$

2.3.3 Analysis stage

We generated Function Analysis and System Technique (FAST) diagrams for raw and cooked rice during this stage. A FAST diagram represents the technical functions of the product through graphical means, structured by a hierarchy of primary and secondary functions. The primary function elucidates the fundamental technical attributes of the product, whereas secondary functions expound upon the collection of advanced attributes inherent to the product (Julien and Barradas, 2017).

2.3.4 Development stage

We determined alternative product concepts by formulating a zero-level concept using the attributes identified earlier. We then conducted prototyping of analog rice products, introducing variations in the formulation of additional ingredients while keeping the production process unchanged.

2.3.5 Recommendation stage

This stage begins with product testing using the organoleptic test, specifically the hedonic test (level of preference), with 33 untrained panellists. The number of panellists follows SNI 01-2346-2006 related to the organoleptic test, which uses a minimum of 30 untrained panellists in one test (Badan Standardisasi Nasional, 2006). This test uses a questionnaire form with a scale of liking levels of 1 (immensely dislike) to 7 (very like). In this study, we will test the parameters of liking for the colour, texture, aroma, and shape of raw analog rice and the taste, colour, texture, and aroma of cooked analog rice.

We calculated each product concept's performance, cost, and value upon testing. The higher the performance value for each concept, the more the concept is favoured by the panellists.

$$Performance = \sum(total\ score\ x\ attribute\ weight) \quad (3)$$

We can calculate the attribute weights for each factor using the formula.

$$Attribute\ weight = \frac{Score\ of\ each\ factor}{Total\ score\ for\ each\ factor} \quad (4)$$

The next step is to determine production costs, especially raw material costs. This research does not consider the cost of equipment, rent, and labour because all concepts are considered the same. The primary step is calculating the best concept based on the highest value.

$$Value = \frac{Performance}{Cost} \quad (5)$$

Performance and cost values did not have the same units. Therefore, before determining the value of each concept, it is necessary to convert the performance needs into rupiah units to calculate the value of each alternative. We obtain the average alternative by averaging the performance of multiple alternatives and the average cost of several alternative costs. You can calculate the IDR value of each alternative performance using the following equation (Hidayat et al., 2021).

$$Pn' = \frac{Pn\ x\ Co}{Po} \quad (6)$$

Pn' is converting alternative performance to rupiah, Pn is alternative performance n, Co is the alternative average cost, Po is alternative average performance.

After obtaining the value for each concept, you can determine the best product concept by selecting the one with the highest value.

3. RESULTS AND DISCUSSION

3.1 Information stage

We identified attributes for raw rice and cooked analog rice by conducting a literature study of previous research, performing a Content Validity Ratio (CVR) test, and assessing validity and reliability. The resulting attributes, presented in Table 1, will be utilized in preparing the level of importance questionnaire.

Table 1. Identification of Product Attributes

Primary attributes	Secondary attributes	Reference
Raw analog rice		
Shape	Slender and oval; uniform size	(Mardiah et al., 2016) & (Nafiah et al., 2015)
Texture	Strong and not easily broken	(Novitasari et al., 2017)
Colour	Pure white; evenly coloured	(Novitasari et al., 2017)
Aroma	Unscented (neutral)	(Nurjaya and Maulida, 2018)
Cooked analog rice		
Taste	Neutral flavor	(Mardiah et al., 2016)
Texture	Soft and fluffy	(Novitasari et al., 2017)
Colour	Bright white, evenly coloured	(Hasan et al., 2022)
Aroma	Unscented (neutral)	(Rizkiabdillah, 2017)

Previous research according to the reference list in the table is only limited to identifying attributes based on consumer voices. However, there is no advanced stage to realize these attributes in product development. So that in this study, information related to relevant attributes is needed in order to develop products in the form of prototypes according to consumer desires. Research (Septiani, 2021) also uses the value engineering method in developing analog rice but is only limited to cooked rice, while this research is reviewed from 2 sides of raw and cooked rice.

3.2 Creative stage

We utilized the predetermined primary attributes to craft a level-importance questionnaire. Each attribute has a percentage weight level of importance. The importance weight value is obtained from the calculation of formula (2) by dividing the level of importance per attribute by the total importance level. This score is obtained from a recap of the questionnaire respondent's assessment which will be calculated by the researcher. The importance weight value is employed to prioritize the attributes for development. Table 2 presents the attribute weight percentages.

Table 2. Weighted Importance Level Raw Rice and Cooked Rice

Primary attributes	Weighted importance level
Raw analog rice	
Texture	26.99%
Aroma	25.87%
Colour	24.13%
Shape	23.01%
Cooked analog rice	
Taste	26.84%
Texture	25.85%
Aroma	24.87%
Colour	22.44%

Not all attributes desired by consumers into consideration in product development because there are cost constraints, it will only be prioritized on the top 2 attributes. Based on Table 2, development priorities focused on texture and aroma for uncooked rice and flavor and texture for cooked rice. These results are quite in accordance with (Novitasari et al., 2017) which states that the attributes that consumers consider in development of rice analog are fluffy texture, fragrant aroma, good taste, and economical price. In the study (Nurjaya and Maulida, 2018) also mentioned that the

attribute that most determines the level of consumer preference for rice is the aroma variable. Aroma is considered important as a distinctive point of rice and increases consumer interest in buying. In research (Pratiwi and Rosyid, 2022) states that the strategy for developing rice attributes is to focus on the attributes of fullness, color, cleanliness, durability, price, and ease of obtaining products. This shows that the results of this study are not much different from previous studies regarding what rice attributes are considered important by consumers.

In raw rice, the texture attribute is expected to have firm grains, not sticking together, and not crumbling easily, so a binder additive is needed, namely Carboxy Methyl Cellulose (CMC) (Hidayat et al., 2013). In cooked rice, the expected texture attributes are soft and fluffy, so it uses a sago starch base material that contains high amylopectin (73%) and low amylose (27%) (Rahmawati et al., 2019). Texture is enhanced using additional ingredients, namely mocaf flour and glucomannan. Glucomannan has the ability to expand, gel, thicken, absorb, and bind water so that the texture and rheological properties of food products can be improved (Amrozi, 2018). Furthermore, the taste and aroma attributes that consumers want are neutral. Basically, analog rice made from sago flour and mocaf has a taste and aroma that is quite disturbing due to the influence of the ingredients themselves. The musty smell and taste comes from flour and processed products from tubers (Cahyani, 2018) Therefore, additional ingredients are needed in making analog rice that can cover the annoying taste and aroma. The material chosen is flavor in the form of pandan essence oil. According to (Habullah et al., 2019), it turns out that aromatic rice and fragrant rice flavor are more in demand by consumers. Flavors with aromas such as pandan leaves are ingredients that are often added in making rice by Indonesians so it is hoped that these aromas can be well received by consumers.

3.3 Analysis stage

At this stage, we create Function Analysis and System Technique (FAST) diagrams for raw and cooked rice attributes. We had previously categorized the primary attributes into essential functions. The FAST diagram of raw analog rice is presented in Figure 1 and FAST diagram of cooked analog rice is presented in Figure 2.

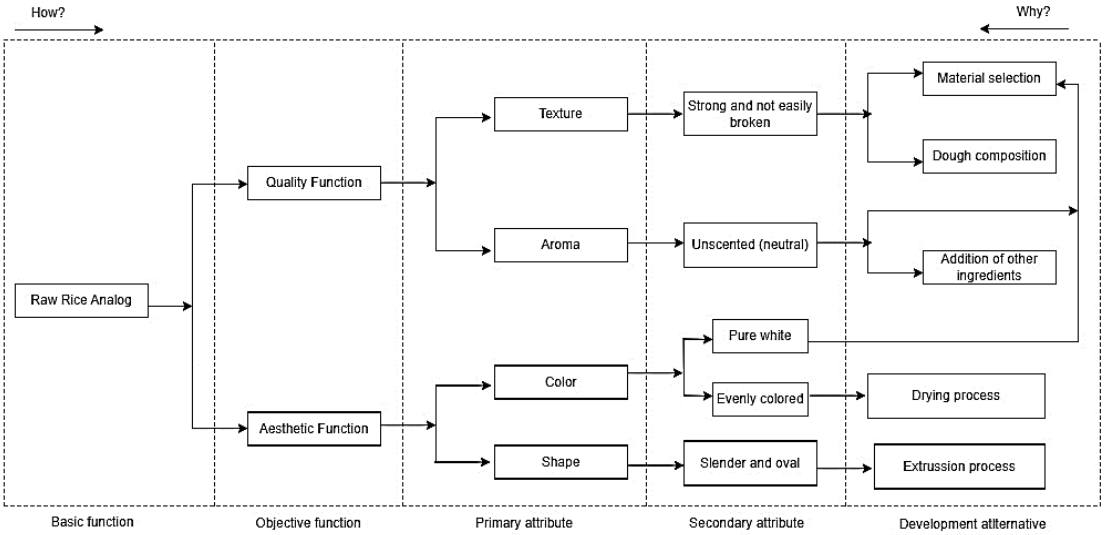

Figure 1. FAST diagram of raw analog rice

We focus analog rice attribute development on texture and aroma, which fall under the quality function. Achieving the desired texture, characterized by solid grains not prone to crumble, will involve ingredient selection and appropriate dough composition. Additionally, obtaining a neutral and unobtrusive aroma function will entail ingredient selection and adding other components.

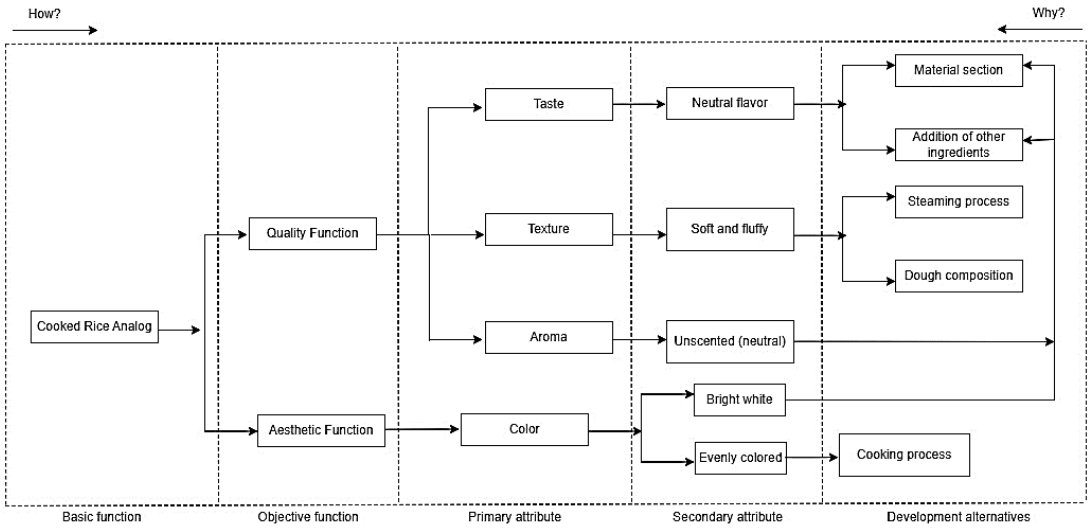

Figure 2. FAST diagram of cooked analog rice

The quality function consisting of flavour, texture, and aroma attributes is the top priority in producing neutral cooked rice with no distracting flavours and aromas. It is tasty and fluffy in terms of texture.

3.4 Development stage

We determined alternative concepts for the product by employing the Zero Level Concept diagram. In making analog rice, the variation in the formulation is the addition of glucomannan flour and pandan essence oil flavour. Other main ingredients used are the same, which are sago flour, mocaf, and supporting ingredients such as Glycerol Monostearate (GMS), Carboxy Methyl Cellulose (CMC), salt, water, and palm cooking oil. In the development stage, the concept of analog rice consists of 4 variations of alternative concepts (Figure 3).

Atribut	Bahan Baku	Bentuk	Warna	Tekstur	Rasa dan Aroma	Bahan Tambahan	Komposisi Bahan Tambahan
Konsep →	Tepung sagu dan mocaf →	Bulir beras pipih dan lonjong →	Putih, cerah, merata →	Beras tidak mudah rapuh & nasi empuk dan pulen →	Netral (tidak mengganggu) →	Tepung glukomanan dan *essence-oil* pandan →	→ 0 gram tepung glukomanan, 0ml pandan (kontrol) → 0 gram tepung glukomanan, 7ml pandan → 0.03 gram tepung glukomanan, 7ml pandan → 0.07 gram tepung glukomanan, 7ml pandan

Figure 3. Zero-level concept diagram of analog rice

Flour glucomannan can be added as thickeners, chewers, stabilizers, and texture formers in food products (Guna et al., 2020). Using porang flour derived from glucomannan has found widespread application, including its use as an additive in producing artificial rice. This incorporation offers the advantage of reducing blood cholesterol levels and the risk of diabetes (Setyono et al., 2021). In addition, adding pandan essence oil flavouring to the analog rice dough aims to cover the annoying taste and aroma. Analog rice has a disturbing taste due to its constituent ingredients. A musty aroma and taste have become a characteristic of flour and processed products derived from tubers (Cahyani, 2018). Picture and explanations of each analog rice concept can be seen in Table 3.

Table 3. Alternative raw rice and cooked rice analog concepts

Concept	Picture	Description
1		Control formulation (no glucomannan flour and pandan essence oil added)
2		Formulation with 7 ml pandan essence oil and no glucomannan flour added.
3		The formulation added 7 ml pandan essence oil and 0.03 grams of glucomannan flour (0.01%).
4		The formulation added 7 ml pandan essence oil and 0.07 grams of glucomannan flour (0.02%).

3.5 Recommendation stage

The organoleptic test assessed the products developed at the previous stage. The test samples consist of four raw analog rice samples and four cooked rice samples. The researcher will use the scores obtained from the organoleptic test to calculate the performance of each concept, so as to identify the concept with the highest score. Panelists assessment of the total score and average per attribute on each sample can be seen in Tables 4 and 5.

Table 4. Organoleptic score of raw analog rice

Attributes	Score	Concept 1 (Non Glucomannan + Non Pandan)	Concept 2 (Non glucomannan + Pandan 7 ml)	Concept 3 (Glucomannan 0.03 grams + Pandan 7 ml)	Concept 4 (Glucomannan 0.07 grams + Pandan 7 ml)
Texture	Total	143	152	158	166
	Average	4.3	4.6	4.7	5.0
Aroma	Total	135	156	159	162
	Average	4.1	4.7	4.8	4.9
Color	Total	158	167	164	172
	Average	4.7	5.1	4.9	5.2
Shape	Total	150	157	170	173
	Average	4.5	4.7	5.1	5.2

In the four attributes of raw analog rice, the highest value is concept 4 with the formulation of adding glucomannan 0.07 grams and pandan 7 ml.

Table 5. Organoleptic score of cooked analog rice

Attributes	Score	Concept 1 (Non Glucomannan + Non Pandan)	Concept 2 (Non glucomannan + Pandan 7 ml)	Concept 3 (Glucomannan 0.03 grams + Pandan 7 ml)	Concept 4 (Glucomannan 0.07 grams + Pandan 7 ml)
Taste	Total	135	141	139	156
	Average	4.1	4.2	4.2	4.7
Texture	Total	131	125	137	166
	Average	3.9	3.7	4.1	5.0
Aroma	Total	123	146	142	147
	Average	3.7	4.4	4.3	4.4
Color	Total	140	146	137	156
	Average	4.2	4.4	4.1	4.7

In the attributes of taste, texture, and color of cooked analog rice, the highest value is concept 4 with the formulation of adding glucomannan 0.07 grams and pandan 7 ml. As for the aroma attribute, the highest scores are concept 2 and concept 4. The diagram below provides an overview of the total scores for each attribute across the samples (Figure 4 and 5).

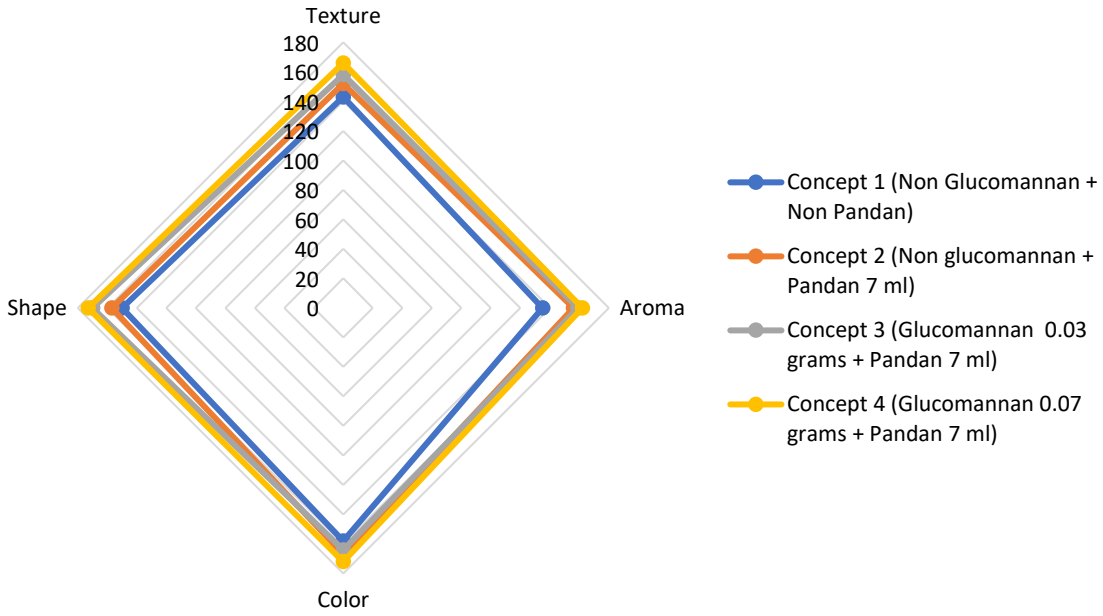

Figure 4. Radar chart of raw analog rice

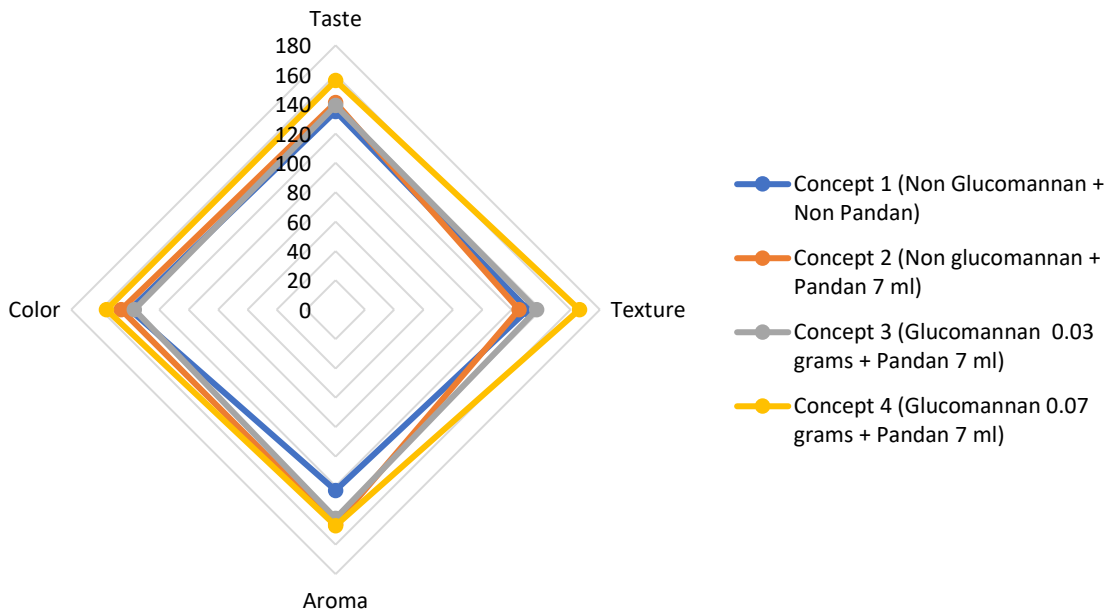

Figure 5. Radar chart of cooked analog rice

The formulation in concept 4, with the addition of 0.07 grams of glucomannan flour and 7 ml pandan essence oil, is preferred by most panellists compared to other concepts, characterized by the distribution of data shown in the diagram above. Value engineering employs performance and cost considerations to discover the optimal concept. The cost used here in this research covers materials only and does not include other costs. The performance calculation can be seen in Table 6, the cost calculation can be seen in Table 7, and result of performance score conversion to rupiah units can be seen in Table 8.

Table 6. Performance Score Analog Rice

	Concept 1	Concept 2	Concept 3	Concept 4
Raw Analog Rice Performance	147.673	158.141	162.869	163.386
Cooked Analog Rice Performance	132.337	139.561	138.734	156.251

Table 7. Cost Analog Rice (per 500 grams)

	Concept 1	Concept 2	Concept 3	Concept 4
Cost (for 500 grams of analog rice)	Rp20373	Rp23189	Rp23228	Rp23282

Table 8. Result of Performance Score Conversion to Rupiah Units

Raw Analog Rice				
Concept	Pn	Co	Po	Pn'
1	146.763	Rp22518	159.472	Rp20723.44
2	158.141	Rp22518	159.472	Rp22330.05
3	162.869	Rp22518	159.472	Rp22997.66
4	163.386	Rp22518	159.472	Rp23776.68
Cooked Analog Rice				
Concept	Pn	Co	Po	Pn'
1	132.337	Rp22518	141.72	Rp21026.97
2	139.561	Rp22518	141.72	Rp22174.79
3	138.734	Rp22518	141.72	Rp22043.39
4	156.251	Rp22518	141.72	Rp24826.66

Table 9. Value Calculation Results for Each Concept of Raw Analog Rice and Cooked Analog Rice

Raw Analog Rice				
Concept	Performance	Cost	Value	Ranking
1	20723.44	20373	1.01	2
2	22330.05	23189	0.96	4
3	22997.66	23228	0.99	3
4	23776.68	23282	1.02	1
Cooked Analog Rice				
Concept	Performance	Cost	Value	Ranking
1	21026.97	20373	1.03	2
2	22174.79	23189	0.95	3
3	22043.39	23228	0.94	4
4	24826.66	23282	1.06	1

Table 9 shows that raw analog rice and cooked analog rice concept 4 have the highest value compared to other concepts. Adding ingredients such as pandan essence oil of 7 ml and glucomannan flour of 0.07 grams to analog rice dough is more accepted by consumers because it improves the product's texture, taste, and aroma.

The panelists found the rice's texture firmer and less crumbly than the other samples. Adding glucomannan could enhance the texture of the cooked rice, making it more fluff and chewiness. Panellists with pandan fragrance can detect the aroma of cooked analog rice and rice because of the effect of pandan essence oil that makes the aroma on the ingredients covered.

Table 10. Chemical Content of Analog Rice

	Best concept analog rice	Paddy rice
Moisture content (%)	8.15	12
Ash content (%)	0.55	0.8
Fat content (%)	3.025	1.7
Protein Content (%)	4.545	8.4
Total carbohydrate (%)	83.74	77.1

Based on Table 10, analog rice's moisture content is lower than paddy rice, following the quality requirements for rice moisture content in SNI 6128: 2015, which is a maximum of 14% (Badan Standardisasi Nasional, 2015). The low moisture content is due to the raw material's low amylose content, which results in high water absorption (Kaemba et al., 2017).

The low protein content in analog rice is due to the lower protein content of sago flour than other ingredients. In 100 grams of sago flour, there are only 0.3 grams of protein content. In addition, the heating and extrusion process in making analog rice can also cause protein damage (Loebis et al., 2017). Hence, the protein content in analog rice is relatively low.

The fat content of analog rice is higher than rice because the manufacturing process uses several fat-containing raw materials such as palm oil and pandan essence oil. According to (Loebis et al., 2017), adding oil ingredients manufactures analog rice's largest source of fat.

This analog rice's most significant chemical content is carbohydrates at 88.277% because the raw materials used are sago and mocaf. Analog rice, which uses high carbohydrate ingredients in large quantities, will also produce analog rice with high carbohydrates. The heating factor of analog rice can also cause this high carbohydrate. The heating process can cause gelatinized starch to form and interact with other components such as protein and fat. This interaction can reduce the amount of fat and protein and increase the carbohydrate content (Finirsa et al., 2022).

4. CONCLUSIONS

Based on identifying the importance of attributes to consumers, product development priorities with the highest to lowest values are texture, aroma, colour, and shape for raw analog rice and taste, texture, aroma, and colour for cooked analog rice. The concept of raw rice and cooked analog rice with the highest value is concept 4, with the addition of 7 ml pandan essence oil and 0.07 gram glucomannan flour.

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Development of Cascara Tisane with The Addition of Dried Pineapple *(Ananas sativus)* and Rosella Flower *(Hibiscus sabdariffa)*

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Abstract

Coffee cherry skin, a form of coffee production waste that accounts for up to 60% of the total yield, contains natural antioxidants that have the potential to become functional foods. Cascara Tisane is a brewed beverage derived from dried coffee cherry skin. Adding other ingredients to this product can help increase consumer acceptance in Indonesia. In this study, the additional ingredients used were dried pineapple and rosella flowers. To determine the effect of adding these ingredients, it is necessary to identify the drying temperature and chemical and organoleptic characteristics to produce Cascara Tisane products according to the Indonesian National Standard (SNI). The research consisted of two stages, namely (1) the identification of the drying temperature of coffee cherry skin and (2) the formulation of the addition of dried pineapple and rosella. The drying temperatures used were 45 °C, 50 °C, 55 °C, and 60 °C. The sample formulation consists of four levels, namely code 126 (75% coffee cherry skin, 15% dried pineapple, 10% rosella): 216 (65% coffee cherry skin, 20% dried pineapple, 15% rosella); and 616 (55% coffee cherry skin, 25% dried pineapple, 20% rosella). Chemical characteristics analysis was conducted on moisture and ash contents, as well as antioxidant activity. Furthermore, a hedonic test was used to evaluate cascara tisane products' organoleptic characteristics (aroma, taste, color, and aftertaste) with a 5-point hedonic scale. The results showed the optimum drying temperature of coffee cherry skin at 45 °C, with the most preferred formula being formula 616.

Keywords: *cascara tisane, coffee cherry skin, drying temperature, dried pineapple, rosella*

1. INTRODUCTION

Coffee is the result of one of the main commodities of plantations in Indonesia (Sitanggang et al., 2013). Based on data from the United States Department of Agriculture (USDA), global coffee production will reach 170 million bags per 60 kg of coffee in 2022/2023. Indonesia is the world's 3rd largest coffee-producing country after Brazil and Vietnam. Indonesia is listed as the 3rd largest coffee-producing country in the world in 2022/2023, having produced 11.85 million bags of coffee. In detail, Indonesia produces 1.3 million bags of Arabica coffee and 10.5 million bags of Robusta coffee. The largest producing and exporting country after Vietnam is Indonesia. As'Ad (2019) said coffee cultivation in Indonesia is suitable for geographical conditions, tropical climates, and favorable temperatures.

According to Ariva et al. (2020), there are two post-harvest coffee processing types: wet and dry. The process commonly used is a wet process to process coffee beans into ground coffee or other products made from coffee beans. Meanwhile, Garis et al. (2019) said there is a by-product in the form of coffee cherry skin, which is still minimally utilized. Hundred kg of coffee is produced from the pulping process, consisting of 56.8 kg of coffee beans and 43.2 kg of coffee skin and flesh. In general, the utilization of coffee cherry skin is limited to processed animal feed and fertilizer, and it is not uncommon to throw it away.

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According to Suloi et al. (2019), the environmental impact that can occur if waste is directly disposed of can cause waste pollution in the form of organic pollution. Pollution occurs when waste is discharged into drainage so water will be polluted. Pollution occurs because the effluent from coffee comes out and is slowly dissolving in wastewater, causing anaerobic conditions. Bad smell is the most uncomplicated impact because the water content of the coffee cherry skin is high, reaching 75-80%, making it easy for pathogenic microbes to grow. Juwita (2017) said coffee cherry skin waste can also pollute the air. Coffee cherry skin can potentially be reprocessed into several products with higher economic value.

Secondary metabolites such as polyphenols have the potential as natural antioxidants contained in coffee skins. According to Etika (2019), some of the active compounds contained in coffee skins include tannins 1.8-8.56%; pectin 6.5%; caffeine 1.3%; chlorogenic acid 2.6%; caffeic acid 1.6%; and total anthocyanin 43%. Coffee cherry skin has been widely used to make a drink rich in antioxidants in the form of cascara tisane, but not many people know about cascara tisane products. The cascara tisane product is environmentally friendly because it comes from coffee production waste, thus opening up new market opportunities for the beverage industry in Indonesia.

Sibuea and Nainggolan (2022) show that as many as 68% of respondents had improved their food consumption. As many as 32% of the 125 respondents had not experienced any improvement in their food consumption during the COVID-19 pandemic. Improving food consumption with functional foods during the COVID-19 pandemic can be an alternative to support increased nutrition and body immunity. As many as 80.6% of respondents make and consume herbal drinks, which are rich in benefits for enhancing the immune system. The interest in making and consuming herbal drinks indicates a change in the consumption patterns of some people who are starting to be aware of healthy living (Sibuea & Nainggolan, 2022).

Tisane has the same serving process as tea drinks, so consumers are more familiar with tisane as tea. Tisane is a drink made from one part or a mixture of plant parts ranging from leaves, seeds, flowers, bark, stems and/or roots from various types of plants. The plant parts are dried and brewed with water. The difference between tisane and tea is that tisane does not always contain parts of the *Camelia sinensis* plant. In contrast, tea generally contains parts of the *Camelia sinensis* plant, such as leaves. Market acceptance of cascara tisane products with tea (*camelia sinensis*) generally lies in consumers' knowledge. Many consumers tend not to know about the existence of cascara tisane products, so sales of cascara tisane are still not optimal. One alternative to increase the product's existence is adding other ingredients to provide new aromas and flavors.

Pineapple in the tisane mixture is intended to obtain its aroma and sour taste with a bit of sweetness in the brew (Somatri, 2022). In addition, adding rosella flowers to tisane can give the brew a sour taste and red color, and rosella is commonly drunk as tisane because it has a high vitamin C content (Haidar, 2016). According to Ariva et al. (2020), it is drying using heating technology as an oven produces better product quality. An oven can reduce the moisture content in a short time and a significant amount. Based on the description above, researchers are encouraged to develop cascara tisane drink products by adding dried pineapple and rosella flowers in pouches with variations in coffee skin drying temperature on the chemical and sensory characteristics of the product.

2. MATERIAL AND METHODS

2.1 Tools and Materials

Plant materials used in producing coffee cascara tisane were robusta coffee skin, honey pineapple, and standard red rosella. The tools needed in the production were knives, buckets, trays, ovens, dehydrators, cutting boards, spoons, winnowing bowls, stories, filters, glasses, and analog scales. The tools used in testing the water content include weighing bottles, analytical balances (Fujitsu FS-AR210), and ovens (Memmert).

The tools used in testing antioxidant activity include measuring cups (Pyrex), beakers (Pyrex), test tubes (Pyrex), measuring pipettes, Erlenmeyer, dropping pipettes, stirrers, pycnometers, UV-Vis

spectrophotometers, and analytical balances (Fujitsu FS-AR210). The materials used in testing the antioxidant activity included the results of steeping the coffee skin tisane formula, methanol, and 100 ppm DPPH solution.

2.2 Identification of Drying Temperature of Coffee Cherry Skin (Stage I)

This study consisted of two stages, namely, the identification of the drying temperature of cascara tisane (Table 1) using an oven based on the results of chemical analysis (conducted at the first stage) and the determination of the product formulation with the addition of dried pineapple fruit and rosella performed at the following stage.

Table 11. Variation of Drying Temperature Cascara Tisane

Treatment	Drying Temperature
A	45 °C
B	50 °C
C	55 °C
D	60 °C

First, the process of washing the coffee cherry skin is carried out. The washed coffee cherry skin was then dried using the artificial heat drying. The process was carried out with the help of an oven with three repetitions at each temperature variation determined, namely 45 °C, 50 °C, 55 °C, and 60 °C. The drying temperature set does not exceed 60 °C because active compounds in plants cannot tolerate heat (Ariva, 2020). The drying process is carried out until it reaches the moisture and ash content according to the Indonesian National Standard (SNI 3836-2013) concerning packaged dry tea, which is a maximum of 8.0%. After that, the samples from stage I will be tested for moisture content, ash content, and antioxidant activity. Cascara, with moisture and ash content according to SNI and the highest antioxidant activity, will proceed to stage II.

2.3 Formulation of Dried Pineapple and Rosella in Making Cascara Tisane (Stage II)

Pineapple fruit is dried using a dehydrator at 50 °C for 18 hours until the moisture content and ash content comply with SNI 3836-2013, which is a maximum of 8%. The rosella used previously had been dried traditionally. However, the water and ash contents still exceeded the maximum provisions in SNI 3836-2013, so further drying was carried out until the water and ash content complied with the SNI. Cascara, pineapple, and rosella, which have been dried, are mixed into tea bags according to the formulation treatment. The tea bags used are made of heat-resistant, non-woven fabric and are equipped with straps to prevent the product inside from spilling out.

Table 12. The formulation for the Production of Cascara Tisane with The Addition of Dried Pineapple and Rosella with Comparative References

Formula	Coffee Skin			Dried Pineapple		Rosella	
	A*	B**	C***	A*	B**	A*	C***
Control	100%	100%	100%	-	-	-	-
126	75%	75%	50%	15%	25%	10%	50%
216	65%	65%	-	20%	35%	15%	-
616	55%	-	-	25%	-	20%	-

Note: (A* = which is conducted), (B** = Rahayu, 2020), (C*** = Felicia, 2022)

The total ingredients in each tea bag are weighed as much as 3 g with the formulation of the ingredients in Table 2. Once all the ingredients are placed in a tea bag, the cascara tisane is ready to be steeped before serving. The cascara tisane is brewed with 100-200 ml of 95 °C hot water and left

for 6-7 minutes before being ready to serve. The color of the brewing results is measured using a color chart. The color measurement used is limited to using the Munsell color chart due to limited equipment.

2.4 Chemical Testing (Stage I and Stage II)

2.4.1 Proximate Analysis

Testing for water content was carried out based on SNI 3836-2013 concerning dry tea, where the tea powder will be heated for 3 hours at 105 °C. The equation for calculating the moisture content is as follows:

$$Water\ Content\ (\%) = \frac{w1 - w2}{w1 - w0} \times 100\% \qquad (1)$$

Note:
w0 : empty cup weight (g)
w1 : weight of cup + material before drying (g)
w2 : weight of cup + material after drying (g)

The ash content test was carried out in accordance with SNI 3836-2013, where the material was weighed first as much as 1-2 g before being put into the ashing cup. The ashing temperature was 525 ± 25 °C until complete ashing took about 3 hours. The equation for calculating the ash content is as follows:

$$Ash\ Content\ (\%) = \frac{w2 - w0}{w1 - w0} \times 100\% \qquad (2)$$

Note:
w0 : empty cup weight (g)
w1 : weight of cup + material before ashing (g)
w2 : weight of cup + material after ashing (g)

2.4.2 Antioxidant Activity Testing

According to Tristantini *et al*. (2016), the antioxidant activity is tested using a solution steeping the product with hot water at 90-95 °C for 6-7 minutes. The test solution was prepared by adding 1 ml of sample solution, 2 ml of 100 ppm DPPH stock solution, and 2 ml of methanol. The test solution was homogenized using a vortex and incubated in a dark room at room temperature for 30 minutes. Absorbance measurement with a spectrometer at a wavelength of 517 nm and activity calculation with the equation as follows:

$$Antioxidant\ activity\ (\%) = \frac{(Abs\ DPPH\ kontrol - abs\ residual\ DPPH)}{Abs\ DPPH\ kontrol} \text{ x } 100\% \qquad (3)$$

2.5 Organoleptic Test

The organoleptic test was carried out using the hedonic test, which aims to determine the panelist's preference level for several samples based on their quality attributes. The panelists used in this study were 39 untrained panelists, most of whom were students who liked tea beverage products and had consumed herbal drinks. The Panelists were asked to assess the quality attributes of the cascara tisane, including taste, aroma, color, and aftertaste, with a rating scale of 1-4 ranging from very dislike to like very much. The sample is brewed with 100 ml of 95°C hot water and left for 6-7 minutes before being ready to serve. Samples are served in glasses with a random three-digit code aimed at avoiding bias. The number of samples tested was four samples.

2.6 Calculation of Added Value (Hayami Method)

The Hayami method is a good method and can be used to determine the amount of added value obtained by supply chain actors, determine output value and productivity. The added value is calculated based on the amount of costs incurred to process an input to obtain income. The several calculation components start from the number of workers, labor wages, electricity costs, material acquisition costs,

raw material prices, finished material prices, and selling prices. Added value can be said to be low if the ratio value is <15%, added value is said to be moderate if the ratio value is 15% - 40%, and added value is said to be high if the ratio value is> 40% (Yosifani, 2021).

2.7 Statistical Analysis

The test data results for water content, ash content, and antioxidant activity were analyzed using one-way ANOVA and followed by the Tukey test at the 0.05 level using IBM SPSS Statistics 25 to determine real differences.

3. RESULTS AND DISCUSSION

3.1 Identification of Drying Temperature and Chemical Testing Results of Dried Coffee Cherry Skin

Cascara tisane is an herbal drink whose main ingredient comes from coffee skin. The skin of the coffee used is a type of Robusta coffee skin obtained from coffee plantations in the highlands of Mount Merapi, Yogyakarta. The skin of red coffee cherries, the by-product of peeling coffee beans, is often not utilized optimally. However, it still contains many benefits for the body, including high antioxidant activity (Ariva, 2020). Based on stage I, the red coffee skin is washed first to remove the slime still attached to the coffee skin. The coffee skin is then subjected to limited drying using only an oven with temperature variations of 45, 50, 55, and 60 °C with a long time to adjust until the water and ash content meet the SNI for dry tea in packs.

Cascara that has been dried is limited to using an oven with varying temperatures starting from 45, 50, 55, and 60 °C; chemical tests are carried out in the form of moisture content, ash, and antioxidant activity. Chemical testing aims to compare the product with SNI 3836-2013 Dried Tea in Packages. In addition, chemical testing aims to determine the effect of variations in drying temperature on the material. So, chemical testing results are carried out to obtain cascara results per SNI 3836-2013.

Table 13. Chemical Test Results (%) Cascara Drying Temperature Variation

Component (%)	Drying Temperature Treatment (°C)				SNI No. 3836 of 2013
	45	50	55	60	
Water Content	6,86 ± 0,74^{c}	6,12 ± 0,17^{bc}	5,14 ± 0,06^{ab}	4,59 ± 0,26^{a}	Max. 8,0%
Ash Content	3,68 ± 0,14^{a}	3,36 ± 0,21^{a}	3,21 ± 0,07^{a}	3,12 ± 0,99^{a}	Max. 8,0%
Antioxidant Activity	52,57 ± 0,70^{c}	45,30 ± 3,61^{bc}	42,70 ± 1,87^{ab}	35,01 ± 0,23^{a}	-

Note: a, b, c, = similar letter notations show no significant difference based on the Tukey test at the 95% level of confidence

Based on Table 3, it can be seen that the higher the temperature, the lower the water content. The drying time used for each variation of uniform drying temperature is 5 hours. Two factors that influence the drying process of a material are the drying air and the material's physical properties. The intended drying air is related to the drying temperature, air humidity, and drying airflow volume. At the same time, the nature of the material that affects the drying process starts from the size of the material and the initial moisture content before the drying process is carried out. Drying using an oven produces water and cascara ash content according to standards, the maximum being 8,0%. The type of material, the method of ashing, and the time and temperature used for drying affect the ash content of a food. The higher the drying temperature used to dry the cascara can reduce the water content of the cascara, which will affect the mineralization process of organic matter in the tea (Ariva, 2020).

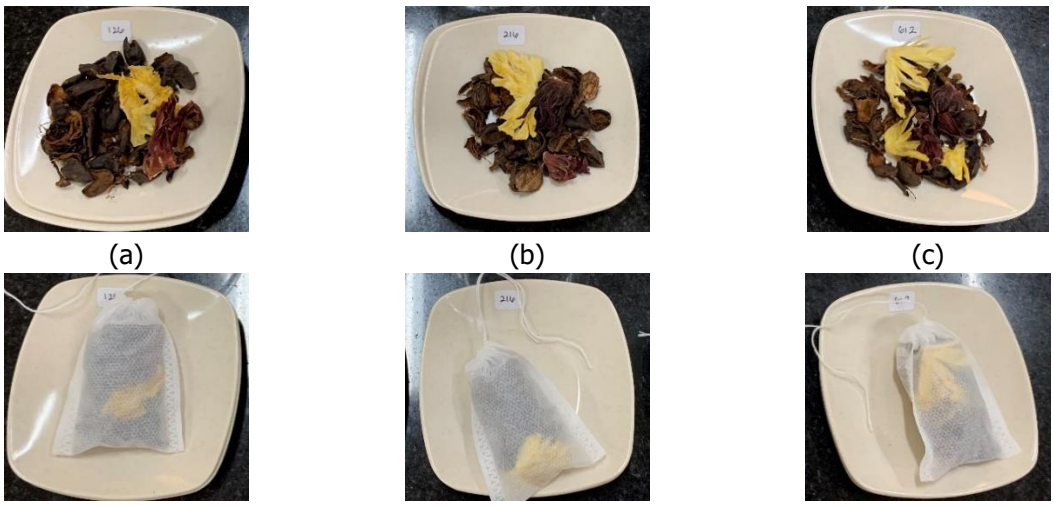
Based on Table 3. the results of testing the antioxidant activity with variations in drying temperature showed that the higher the temperature, the lower the antioxidant activity. Antioxidants are properties that can capture free radicals in the body to prevent various diseases. The method used to test antioxidant activity is the DPPH method. According to research by Hutasoit et al. (2021),

antioxidant levels will also be degraded when it reaches very high temperatures. Heating can damage the cell walls of antioxidant compounds and break chemical bonds.

The higher the temperature and the longer the drying time, the secondary metabolic compounds that act as antioxidants are lost and damaged. Thus, coffee skins with a drying temperature of 45°C were used in the next stage, namely formulations with the addition of dried pineapple and rosella. This is because the coffee skin with a drying temperature of 45 °C produces the highest antioxidant activity compared to other temperatures and is in accordance with the SNI for packaged dry tea for water and ash contents.

3.2 Formulation of Dried Pineapple and Rosella in Making Cascara Tisane

Based on stage II, product formulation with the addition of dried honey pineapple and rosella. Drying of dried honey pineapple and rosella is limited to using only a dehydrator with a temperature of 50 °C for a long time until the moisture and ash content are in accordance with SNI for packaged dry tea. Figure 2 shows the product appearance of the cascara tisane formula with the addition of dried pineapple and rosella.



(a) (b) (c)

(d) (e) (f)

Figure 1. Formula Cascara Tisane with the Addition of Dried Pineapple and Rosella Flower

Notes: (a) Formula 126: 75% cascara, 15% dried pineapple, 10% rosella
(b) Formula 216: 65% cascara, 20% dried pineapple, 15% rosella
(c) Formula 616: 55% cascara, 25% dried pineapple, 20% rosella
(d) Formula 126 in teabag: 3 g
(e) Formula 216 in teabag: 3 g
(f) Formula 616 in teabag: 3 g

Drying using a dehydrator is generally used to dry fresh ingredients such as fruits, flowers, and herbs. Drying using a dehydrator is highly recommended in the manufacture of dried food because it has an ideal temperature and can maintain the appearance and content of the ingredients. Pineapple fruit is dried using a dehydrator at 50 °C for 18 hours until the moisture content and ash content comply with SNI 3836-2013, which is a maximum of 8%. The rosella used previously had been dried traditionally. However, the water and ash contents still exceeded the maximum provisions in SNI 3836-2013, so further drying was carried out until the water and ash content complied with the SNI.

In addition, fruits that are dried in the oven will change their aroma and color due to the unstable heat from the oven. Meanwhile, a freeze dryer can be used, but it is not recommended for tea blends that will be stored for a long time (Somantri, 2022). Adding dried honey pineapple and rosella aims to give the cascara tisane a fruity and sweet-sour taste.

3.3.1 Chemical Test

Based on Table 4, the results show that the more dried pineapple and rosella are added, the more the water content increases. The increase is because the water content in pineapple is relatively high. However, compared with SNI No 3836 of 2013, the moisture and ash contents of all formulas are in accordance with the maximum provisions of 8.0%. Adding more pineapple and rosella fruit to the tisane formula can increase antioxidant activity. Formula 616 has the most dried pineapple and rosella compared to the other two formulas, resulting in the highest antioxidant activity.

Table 14. Chemical Test Results (%) Cascara Tisane Formula with Code

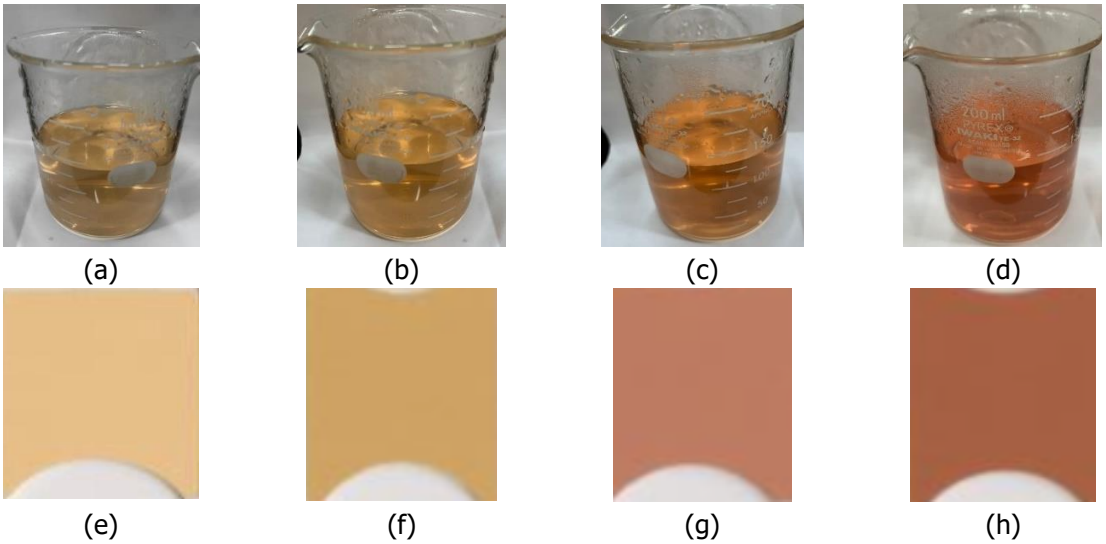
Component (%)	Product Formula				SNI 3836-2013
	Control	126	216	616	
Water Content	6,86 ± 0,74[a]	7,75 ± 0,43[b]	7,82 ± 0,55[b]	8,04 ± 0,39[b]	Max. 8,0%
Ash Content	3,68 ± 0,14[a]	3,33 ± 0,40[a]	3,36 ± 0,64[a]	3,44 ± 0,59[a]	Max. 8.0%
Antioxidant Activity	52,56 ± 0,71[a]	88,28 ± 0,86[b]	89,63 ± 1,83[b]	91,34 ± 0,21[c]	-

Note: a, b, c, = similar letter notations show no significant difference based on the Tukey test at the 95% level of confidence

These results are in line with those cited by Mappa et al. (2021), that Pineapple is a source of antioxidants from various phytochemicals containing phenolics and flavonoids, where antioxidants work by capturing free radicals, so they can inhibit the growth of cancer cells and become anti-cancer agents. In addition, according to Malinda (2020), rosella flowers (Hibiscus Sabdariffa L.) are red due to their anthocyanin content. Anthocyanins function as antioxidants that can be used as a cure for degenerative diseases. The conjugated double-bond system is capable of making anthocyanins act as natural antioxidants with a mechanism for capturing radicals.

3.3.2 Organoleptic Test

Figure 2 shows the color difference in the brewing results of each formula. The cascara tisane is brewed with 100-200 ml of 95°C hot water and left for 6-7 minutes before being ready to serve. The more rosella added, the more red the brew tends to be. Based on the color produced by the control brew or coffee skin without adding dried pineapple and rosella, the overall color is bright yellow. The color measurement used is limited to using the Munsell color chart due to limited equipment. Formula 126 has a color of 10 YR with 7/8, which means it is called bright yellow but not brighter than the control brew. Formula 216 is 2.5 YR with 5/8, which means it is red overall. Formula 616 is 2.5 YR with 4/8, red but darker than Formula 216.



(a) (b) (c) (d)

(e) (f) (g) (h)

Figure 2. The results of steeping cascara tisane in 150 ml of water with Munsell's Color Chart

Notes: (a) Control
(b) Formula 126
(c) Formula 216
(d) Formula 616

The hedonic or preference test is included in one of the organoleptic tests using the affective method. The affective method tests panelists' subjective attitudes toward food products based on their organoleptic properties. Panelists in the hedonic test were asked to rate their likes or dislikes for the product in the form of the rating scale provided. The rating scale used starts from a scale of 1, which is very dislike to 4 likes very much.

The panelists used were untrained panelists of 39 people. According to Setyaningsih et al. (2018), the minimum number of untrained panelists consists of 25 laypeople who are freely chosen based on ethnicity, social level, and education. Untrained panelists cannot carry out discrimination tests, so they can only assess test parameters based on the level of liking panelists themselves. Hedonic tests generally use untrained panelists because they only assess the level of liking for the product. The panelists are considered to be the start of consumer testing in developing cascara tisane products with the addition of dried pineapple and rosella. Four samples of tisane were tested for each panelist with a random three-digit code. The quality parameters tested by panelists were color, taste, aroma, and aftertaste.

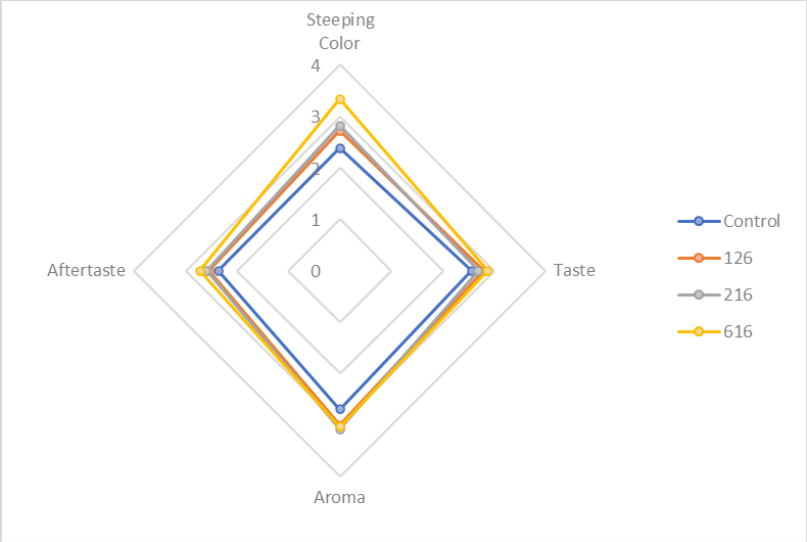


Figure 3. Level of Like of Panelists for Cascara Tisane Products

According to Rahayu (2020), the color parameter is the main parameter used to determine consumer acceptance of a product. Color assessment is subjective, which can affect the results of the product assessment. The more attractive the color seen by the panelist, the higher the assessment of the product color. Figure 4.5 shows the level of preference for the color quality of the cascara tisane formula with the addition of 25% dried pineapple and rosella 205, which has a higher value than other formulas.

According to Wilanda et al. (2021), Taste is the second factor after an assessment based on the visible appearance of a beverage product. If the drink's appearance is attractive, it can arouse the appetite or willingness to taste the drink. The next stage in the assessment is related to the drink's taste, which is determined using the senses of smell and taste. The highest value of 2.87 is found in formula 616, adding dried pineapple 25% and rosella 20% of the total ingredients. Thus, adding dried pineapple and rosella can increase the panelists' preference for cascara tisane products compared to no additions.

Adding dried pineapple makes the tisane product smell sweet, sour, and fresh. Volatile components in ethyl and methyl esters are natural components in pineapple that produce the distinctive aroma of pineapple (Wibowo et al., 2014). The highest value was found in formula 216, where 20% dried pineapple and 15% rosella were added. The highest value shows that adding dried pineapple and rosella has a higher preference level than without the addition. The aftertaste is the remaining taste that remains on the palate even though the product has been swallowed completely. Is there a sticky taste, a little bit in the throat, or is it completely clean (Billah, 2018).

The taste left by the tisane product is slightly sour and fresh, typical of pineapple and rosella. The remaining taste is because pineapple and rosella have slightly sour and sweet tastes (Somatri, 2022). The highest value was found in formula 616 with the addition of 25% dried pineapple and 20% rosella of the total ingredients. Thus, the more dried pineapple and rosella were added, the more panelists' preference for the resulting aftertaste increased. Based on the overall results of the average level of preference on the attributes of color, taste, aroma, and aftertaste, formula 616 has the highest level of preference.

3.4 Calculation of Added Value of Cascara Tisane

Table 15. Calculation of Added Value Cascara Tisane

Direct Processing Fees	Amount (IDR)
Labor	1
Average Wages of Labor	30,000
Electricity	16,052
Oven 800 W	
Dehydrator 347 W	
Amount	46,052
Material Acquisition Costs	10,000
Raw Material Prices	500
Finished Product Prices	15,000
Selling Prices	15,500
Value-added	22%

Table 5 shows an increase in added value of 22%, and the calculation of added value is done using the Hayami Method. The Hayami method is suitable for determining the amount of added value obtained by supply chain actors, output value, and productivity. Value acquisition plus is calculated based on the costs issued to process an input with income generation.

Value added is the difference in product value before and after production to produce products that can increase income. The several calculation components start from the number of workers, labor wages, electricity costs, material acquisition costs, raw material prices, finished material prices, and selling prices (Yosifani, 2021). The workforce is assumed to be one person with a wage of IDR 30,000 per hour.

Then, the electricity costs for using the oven and dehydrator are IDR 46,052, which is based on the price per kWh from the calculation of the watts of the oven and dehydrator. The price of raw materials for making a product is Rp. 25,000 to produce approximately 50 tea bags. As for the price of the finished product, it adjusts to the price range of cascara tisane products that are already on the market. According to Yosifani (2021), added value can be said to be low if the ratio value is <15%, added value is said to be moderate if the ratio value is 15% - 40%, and added value is said to be high if the ratio value is> 40%. Based on the value-added category, according to Ariyanti (2021), the added

value of a cascara tisane product of 22% is still relatively moderate. Hence, an evaluation still needs to be carried out, starting from the acquisition of raw materials and the production process used to the selling price of the product to increase added value.

4. CONCLUSIONS

The coffee cherry skin drying temperature of 45 ^{o}C resulted in the highest antioxidant activity, moisture content, and ash content per SNI No. 3836 of 2013. Adding dried pineapple and rosella to the formula affected the water content and increased antioxidant activity but did not affect the ash levels. The most preferred cascara tisane formula uses the addition of 25% dried pineapple and 20% rosella, with the highest antioxidant activity according to SNI No. 3836 of 2013 for water and ash content.

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Analysis of the Effectiveness of Instagram as a Media Promotion for Akkar Juice Bar Products

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Abstract

The number of internet users in Indonesia has been rising annually. A growing number of people are using social media including Instagram as a communication tool for digital marketing. Since the beginning of the company, Akkar Juice Bar has utilized Instagram to reach out to and interact with customers as well as to introduce its products. Using the CRI (Customer Response Index) with AISAS (Attention, Interest, Search, Action, Share) method, this study aims to measure Instagram's effectiveness as a promotional tool for Akkar Juice Bar. Based on the findings of this analysis, promotion recommendations are made. Instagram's effectiveness as a marketing medium is evaluated by a CRI calculation with a modified AISAS model. These calculations include CRI AIS of 77.17%, CRI AISS of 72.72%, CRI AIAS of 60.85%, and CRI AISAS of 57.34%. The four obtained CRI model values provide valuable information in general. To make the greatest impact of promotions, it is advised to use Instagram Ads for advertising, run consumer-driven campaigns and competitions, reward consumers who share, feature customer testimonial posts, and make posts more intense.

Keywords: *AISAS, effectiveness, Instagram.*

1. INTRODUCTION

The number of internet users in Indonesia has been increasing year by year. According to data from Datareportal (2023), as of January 2023, there were 213 million internet users in Indonesia, which has consistently risen over the past decade. One of the social media platforms widely accessed by internet users is Instagram, which is used as a platform for sharing information, sharing moments through photos and videos, and even for conducting business. According to Datareportal (2023), as of January 2023, Instagram is the second most widely used platform, with 86.5% of internet users aged 16 to 64 using Instagram, totaling 89.15 million users. By April 2023, Instagram has the potential to reach 1.63 billion users with advertising (Datareportal, 2023).

Based on Datareportal (2023), 36.5% of social media users in Indonesia primarily use social media as a tool to search for products for their purchases. With the large number of internet and social media users in Indonesia, along with easy and fast access, this presents an opportunity for businesses to market their products. Online marketing communication provides a broader and faster reach, as advertisers have plenty of space to provide information to potential customers at a lower cost than offline marketing communication (Krizanova et al., 2019).

Akkar Juice Bar is a healthy food and beverage business that uses Instagram as a promotional platform. Akkar Juice Bar is a culinary venture that provides healthy beverages and food such as cold-pressed juices, plant bae, smoothie glass, salad roll, smoothie bowl, salad bowl, and fruit bowl. Since its inception, Akkar Juice Bar has been leveraging Instagram to introduce its products and reach out and communicate with customers. The Instagram social media platform of Akkar Juice Bar makes it convenient for consumers and potential customers to access and stay updated on product and program-related information quickly. By June 2023, the Instagram account @akkarjuicebar has amassed approximately 5300 followers. Akkar Juice Bar is highly active in promotion on the Instagram social media platform, evidenced by the frequency of posts comprising photos and videos, totaling around 530 posts to date. Additionally, Akkar Juice Bar regularly shares information through Instagram stories and engages with consumers by reposting Instagram stories, commenting, and liking posts. However, the effectiveness of using Instagram as an online marketing platform for Akkar Juice Bar's products remains to be discovered.

Meanwhile, the Customer Response Index (CRI) can be used to determine weaknesses in marketing communication (Best, 2013). The CRI method can multiply awareness, consumer

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comprehension, interest, purchase intentions, and purchasing actions. According to Ishikawa & Tsujimoto (2008) in Sugiyama & Andree (2011), consumer behavior, which used to follow the AIDMA model (Attention - Interest – Desire – Memory - Action), has changed to AISAS (Attention – Interest – Search – Action – Share). In the changing information environment, Dentsu recommends a new consumer behavior model called AISAS (Sugiyama & Andree, 2011). The modeling of AISAS is non-linear because each stage in AISAS can be skipped or repeated.

This research aims to measure the effectiveness of Instagram as a promotional medium for Akkar Juice Bar using the CRI AISAS method and provide promotion recommendations based on the analysis of Instagram's effectiveness for Akkar Juice Bar. This research was conducted by gathering primary data through interviews and questionnaire distribution and secondary data through a literature review. Questionnaires are distributed to individuals who follow or have visited and interacted with the Instagram account @akkarjuicebar, have purchased Akkar Juice Bar products, and are at least 17 years old.

2. MATERIAL AND METHODS

2.1 Materials and Tools

The materials used are data from the Content Validity Ratio (CVR) questionnaire and the final questionnaire, which includes identity information and questionnaire questions. The tools used are questionnaires and Microsoft Office.

2.2 Study Method

2.2.1 Population and Sample

The population is a general area consisting of objects and subjects determined by the researcher, where the area has specific qualities and characteristics (Sugiyono, 2016). The population in this study is unknown.

The sample is a part of the population, including characteristics and quantity (Sugiyono, 2016). From the existing population, a sample was taken using a non-probability sampling technique known as purposive sampling. Non-probability sampling is a technique for taking a sample without giving every member of the population an equal chance to be used as a sample (Sugiyono, 2016). According to Sugiyono (2018), purposive sampling is a technique for sample selection based on specific considerations. Sample selection in this study is limited to respondents who follow or have visited and interacted with the Instagram account @akkarjuicebar, have purchased from Akkar Juice Bar, and are at least 17 years old. The sample size used in this study referring to the Cochran formula written in Equation 1.

$$n = \frac{z^2 pq}{e^2} \qquad (1)$$

Explanation:
n = Sample size
z = Value in the normal curve with a 5% margin (1.96)
p = Probability of success 50%
q = Probability of failure 50%
e = Margin of error 10% (Sugiyono, 2019).
Then, the calculation from the Cochran formula is written in Equation 2.

$$n = \frac{(1.96)^2 (0.5)(0.5)}{(0.10)^2} \qquad (2)$$

n = 96.04 rounded to 97

From this calculation, the minimum sample size is 97 respondents with a 10% margin of error. A 10% margin of error indicates a 10% possibility of an error rate within the sample, and 90% of the data from the sample is considered accurate (Wahyudi, 2017).

2.2.2 Data Collection

In this research, data collection was conducted through interviews, the distribution of questionnaires, and a literature review. Interviews were conducted with Akkar Juice Bar to obtain the information needed for the research. Data collection through questionnaires in this study was done online using Google Forms, which were distributed to respondents limited to those who follow or have

interacted with the Instagram account @akkarjuicebar, have made purchases from Akkar Juice Bar, and are at least 17 years old. The questionnaire distribution in this scope of research was conducted globally as the study aimed to assess Instagram's effectiveness in influencing consumers worldwide, both within and outside the Special Region of Yogyakarta (DIY). The distributed questionnaire was a closed-ended one containing various questions with a Guttman scale, allowing respondents to choose between "Agree" and "Disagree.

2.2.3 Data Analysis

a. Content Validity Ratio Test (CVR)

The Lawshe's Content Validity Ratio (CVR) test is a content validity test in research questionnaires used to measure the importance of specific items (Hendryadi, 2017). This test is conducted by asking panelists or experts to rate each questionnaire item as "Essential," "Essential but Not Useful," or "Not Essential." The calculation formula for CVR is written in Equation 3 as follows:

$$CVR = (ne - (N/2)) / (N/2) \quad (3)$$

Explanation:
CVR = content validity ratio
ne = number of panelists who answered "Essential"
N = total number of panelists

b. Validity Test

The validity test is a test that shows the level of validity of an instrument in the form of questions on a questionnaire by comparing the calculated r value and the table r value (Sitinjak et al., 2004). The validity test for Guttman scale statements is performed with a minimum sample size of 50 (Nazir, 2009 in Purwanto, 2018). The results of the Guttman scale questionnaire indicate that the response "Agree" is valued at 1 and "Disagree" is valued at 0 because the type of questionnaire used is dichotomous. The "Disagree" response is assumed to be an error value in this questionnaire. The validity test for the Guttman scale is conducted by calculating the scalability and reproducibility coefficients. The instrument is considered good if it has a scalability coefficient > 0.60 and a reproducibility coefficient > 0.90 (Singarimbun, 2018 in Adhefia et al., 2021). Here are the formulas for calculating the scalability coefficient as written in Equation 4 and the reproducibility coefficient in Equation 5.

$$Kr = 1 - \frac{e}{n} \quad (4)$$

$$Ks = 1 - \frac{e}{p} \quad (5)$$

Explanation:
Kr = reproducibility coefficient
Ks = scalability coefficient
n = total possible answers (number of questions × number of respondents)
e = number of errors
p = expected number of errors

c. Reliability Test

Reliability testing is a measurement tool used to assess the consistency of responses in a questionnaire when measuring variables. A reliable result indicates the consistency of an individual's responses to the given questionnaire items (Nugraha, 2022). Reliability testing in the Guttman scale is performed by calculating the KR-20 value using the formula in Equation 6.

$$Kr = \left(\frac{n}{n-1}\right)\left(\frac{S^2 - \Sigma pq}{S^2}\right) \quad (6)$$

Explanation:
Kr = reliability
p = proportion of subjects who answered correctly
q = proportion of subjects who answered incorrectly
pq = Sum of the product of p and q
n = number of items
S = standard deviation (square root of variance)

In the assessment of reliability, an instrument can be considered reliable if it has a coefficient of reliability (KR) value greater than 0.70 (Fraenkel, Wallen, & Hyun, 2012 in Yusup, 2018).

d. Customer Response Index (CRI)

According to Best (2013), effective marketing communication efforts can begin with building awareness and understanding messages between customers and business actors. The CRI model is shown in Figure 1.

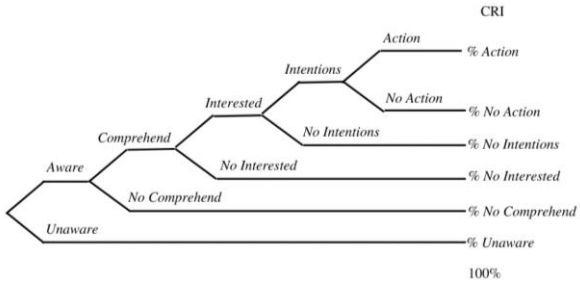

Figure 1. CRI Model

The CRI model in this study refers to previous research by Febrianto (2018), and the CRI model is modified using the AISAS concept, resulting in the following four models:

1. CRI AISAS

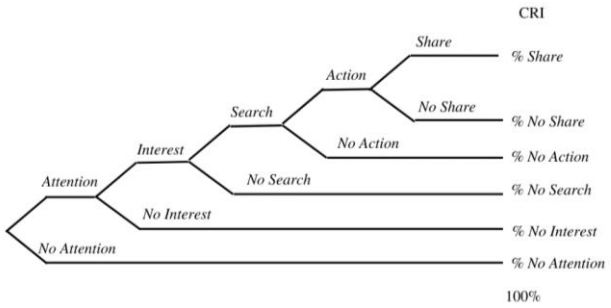

Figure 2. CRI AISAS

In this concept, the formula for calculating CRI is as follows:
CRI AISAS = Attention × Interest × Search × Action × Share
Consumer no share = Attention × Interest × Search × Action × No Share
Consumer no action = Attention × Interest × Search × No Action
Consumer no search = Attention × Interest × No Search
Consumer no interest = Attention × No Interest
Consumer no attention = No Attention

2. CRI AISS

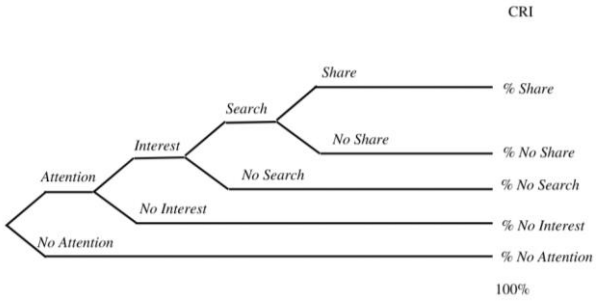

Figure 3. CRI AISS

In this concept, the formula for calculating CRI is as follows:
CRI AISS = Attention × Interest × Search × Share
Consumers no share = Attention × Interest × Search × No Share
Consumers no search = Attention × Interest × No Search

Consumers no interest = Attention × No Interest
Consumers no attention = No Attention

3. CRI AIAS

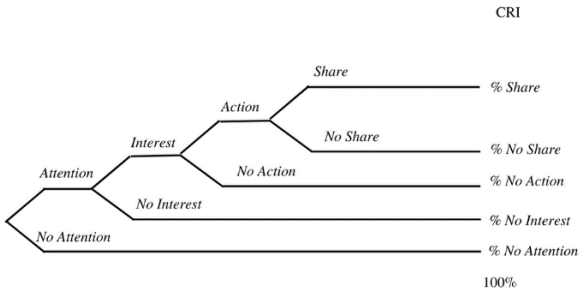

Figure 4. CRI AIAS

In this concept, the formula for calculating CRI is as follows:
CRI AIAS = Attention × Interest × Action × Share
Consumers no share = Attention × Interest × Action × No Share
Consumers no action = Attention × Interest × No Action
Consumers no interest = Attention × No Interest
Consumers no attention = No Attention

4. CRI AIS

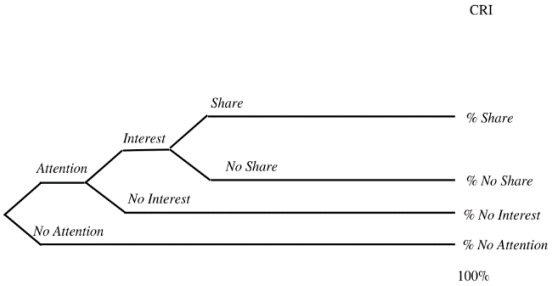

Figure 5. CRI AIS

In this concept, the formula for calculating CRI is as follows:
CRI AIS = Attention × Interest × Share
Consumers no share = Attention × Interest × No Share
Consumers no interest = Attention × No Interest
Consumers no attention = No Attention
From the CRI calculation with AISAS modification, the CRI values can be classified in Table 1 as follows:

Table 1. Range of Customer Response Index Values

Range of values (%)	0 – 39.99	40.00 – 59.99	60.00 – 79.99	80.00 - 100
Classification	Less	Average	Good	Very Good

Source: Jun et al. (2021).

The four CRI models have a hierarchical relationship depicting four possible consumer response processes. These consumer responses can then be used as a plan for marketing communication that can capture the hearts of consumers, thus creating a clear path to achieving purchases and building consumer reach (Sugiyama & Andree, 2011). The differences between the four CRI models lie in consumer response. From these CRIs, the results of consumer responses can be understood using the non-linear AISAS marketing communication concept, allowing us to identify at which stage consumers are not responding significantly from

the four models, thus providing recommendations for evaluating and improving marketing communication response.

3. RESULTS AND DISCUSSION

3.1 Content Validity Ratio (CVR)

The CVR (Content Validity Ratio) test was conducted by distributing questionnaires to 8 panelists, comprising three panelists from the Agricultural Industrial Technology lecturers at UGM who have an understanding of marketing in the field and five panelists from Akkar Juice Bar (Owner/Managing Director, Finance Director, Commercial Associate, Commercial Manager, Customer Service). When analyzing the CVR test results, there is a minimum standard value based on the number of evaluators or subject matter experts (SME) used. According to Lawshe (Bashooir and Supahar, 2018), the minimum standard CVR for eight panelists is a minimum value of 0.75. The CVR test results indicate that out of 17 questions, two questions have values below 0.75, thus deemed invalid. These invalidated questions are discarded and not included in the research questionnaire.

3.2 Validity Test

The validity test is conducted on the questionnaire responses of sample respondents to determine the validity of the measurement instrument used in the study. In this test, a sample of 50 respondents is used. The validity test results for statements with a Guttman scale in this research questionnaire are declared valid because they have a reproducibility coefficient of 0.91 and a scalability coefficient of 0.82.

3.3 Reliability Test

The reliability test assesses the consistency of the measurement instrument used in the research questionnaire. The calculation of KR-20 resulted in a reliability coefficient (KR) of 0.739. This value is > 0.70, indicating that the instrument is reliable.

3.4 Respondents Characteristics

From 104 respondents in this study, the age distribution of the respondents is as follows 61.5% of the respondents are aged 17-25 years, 32.7% are aged 26-35 years, and 5.8% are aged 36-45 years. The gender distribution of the respondents is 83.7% female and 16.3% male. Based on occupation, 38.5% of the respondents are students, 20.2% work as entrepreneurs, 12.5% are self-employed, 5.8% work as private employees, and 23% have other occupations such as PNS, freelancers, illustrators, homemakers, and content creators. Among the respondents, 50% are domiciled in Sleman, 19.2% in Yogyakarta City, 14.4% in Bantul, and the rest in other areas. Out of the respondents, 40.4% first heard about Akkar Juice Bar from recommendations by friends or relatives, and 38.5% of first-time consumers learned about Akkar Juice Bar through Instagram.

3.5 Calculation of Customer Response Index

The Customer Response Index (CRI) in this research is used to determine the responses given by consumers from the questionnaire distributed to 104 respondents. The percentage of responses from respondents classified in the AISAS model is presented in Table 2.

Table 2. Percentage of AISAS Questionnaire Responses

No	Variable	Response	Percentage
1	*Attention*	*Attention*	89.74%
		No Attention	10.26%
2	*Interest*	*Interest*	94.47%
		No Interest	5.53%
3	*Search*	*Search*	94.23%
		No Search	5.77%
4	*Action*	*Action*	78.85%
		No Action	21.15%
5	*Share*	*Share*	91.03%
		No Share	8.97%

Source: Processed Data (2023)

The percentage results in the CRI model show that out of all respondents who paid attention, it was 89.74%, indicating that respondents paid attention to the activities carried out by Instagram @akkarjuicebar in their efforts to introduce products and branding. The percentage of respondents interested after seeing the activities on Akkar Juice Bar's Instagram was 94.47%. At the interest stage, interest arises as a response from those who previously paid attention to activities such as posts and other actions carried out on Akkar Juice Bar's Instagram. 94.23% of respondents conducted further information searches about Akkar Juice Bar on Instagram. Subsequently, 78.85% of respondents took action by deciding to purchase Akkar Juice Bar products after learning information from Instagram. Furthermore, 91.03% of respondents shared information about Akkar Juice Bar with relatives, friends, or family via Instagram.

Based on the percentage data from the AISAS questionnaire responses, calculations for CRI AISAS were performed using four modified models as follows:

1) CRI AISAS Model

Table 3. Calculation of CRI AISAS Model

No	Variable	Formulation	Calculation	Result
1	*AISAS*	*Attention × Interest × Search × Action × Share*	89.74% × 94.47% × 94.23% × 78.85% × 91.03%	57.34%
2	*No Share*	*Attention × Interest × Search × Action × No Share*	89.74% × 94.47% × 94.23% × 78.85% × 8.97%	5.65%
3	*No Action*	*Attention × Interest × Search × No Action*	89.74% × 94.47% × 94.23% × 21.15%	16.90%
4	*No Search*	*Attention × Interest × No Search*	89.74% × 94.47% × 5.77%	4.89%
5	*No Interest*	*Attention × No Interest*	89.74% × 5.53%	4.96%
6	*No Attention*	*No Attention*	10.26%	10.26%

Source: Processed Data (2023)

The value generated from CRI AISAS is 57.34%. This indicates that there is still 42.66% that requires action to improve to reach an optimal CRI of 100%. From 42.66%, 10.26% of respondents showed no attention towards Akkar Juice Bar's Instagram activities, resulting in a loss of 10.26% of responses. Additionally, 5.53% of respondents had no interest, leading to a loss of 4.96% of responses. Furthermore, 5.77% of respondents did not search, causing a loss of 4.89% of responses. Moreover, 21.15% of responses had no action, resulting in a loss of 16.90% of responses. Finally, 8.97% of responses did not share, leading to a loss of 5.65% of responses.

2) CRI AIAS Model

Table 4. Calculation of CRI AIAS Model

No	Variable	Formulation	Calculation	Result
1	*AIAS*	*Attention × Interest × Action × Share*	89.74% × 94.47% × 78.85% × 91.03%	60.85%
2	*No Share*	*Attention × Interest × Action × No Share*	89.74% × 94.47% × 78.85% × 8.97%	6%
3	*No Action*	*Attention × Interest × No Action*	89.74% × 94.47% × 21.15%%	17.93%
4	*No Interest*	*Attention × No Interest*	89.74% × 5.53%	4.96%
5	*No Attention*	*No Attention*	10.26%	10.26%

Source: Processed Data (2023)

The value generated from CRI AIAS is 60.85%. This indicates that there is still 39.15% that requires action to improve to reach an optimal CRI of 100%. From 39.15%, 10.26% of respondents showed no attention towards Akkar Juice Bar's Instagram activities, resulting in a loss of 10.26% of responses from the respondents. Additionally, 5.53% of respondents had no interest, causing a loss of 4.96% of responses. In this model, respondents did not go through the search stage. Furthermore, 21.15% of responses had no action, which led to a loss of 17.93% of responses, and 8.97% of respondents not sharing caused a loss of 6% of responses.

3) CRI AISS Model

Table 5. Calculation of CRI AISS Model

No	Variable	Formulation	Calculation	Result
1	*AISS*	*Attention × Interest × Search × Share*	89.74% × 94.47% × 94.23% × 91.03%	72.72%
2	*No Share*	*Attention × Interest × Search × No Share*	89.74% × 94.47% × 94.23% × 8.97%	7.17%
3	*No Search*	*Attention × Interest × No Search*	89.74% × 94.47% × 5.77%	4.89%
4	*No Interest*	*Attention × No Interest*	89.74% × 5.53%	4.96%
5	*No Attention*	*No Attention*	10.26%	10.26%

Source: Processed Data (2023)

The value generated from CRI AISS is 72.72%. This indicates that there's still 27.28% that requires action to improve and reach an optimal CRI value of 100%. Within this 27.28%, 10.26% of respondents showed no attention to Akkar Juice Bar's Instagram activities, resulting in a loss of 10.26% in responses. 5.53% of respondents had no interest, leading to a loss of 4.96% in responses. Additionally, 5.77% of respondents didn't engage in searching, causing a loss of 4.89% in responses. In this model, respondents didn't progress to the action stage. Furthermore, 8.97% of respondents not sharing caused a loss of 7.17% in responses.

4) CRI AIS Model

Table 6. Calculation of CRI AIS Model

No	Variable	Formulation	Calculation	Result
1	*AIS*	*Attention × Interest × Share*	89.74% × 94.47% × 91.03%	77.17%
2	*No Share*	*Attention × Interest × No Share*	89.74% × 94.47% × 8.97%	7.61%
3	*No Interest*	*Attention × No Interest*	89.74% × 5.53%	4.96%
4	*No Attention*	*No Attention*	10.26%	10.26%

Source: Processed Data (2023)

The value generated from the AIS CRI is 77.17%. This indicates that there's still 22.83% that requires action to improve the CRI value to its optimal level of 100%. Within this 22.83%, 10.26% of respondents did not pay attention to Akkar Juice Bar's Instagram activities, resulting in a loss of 10.26% of responses from these respondents. Additionally, 5.53% of respondents had no interest, causing a loss of 4.96% in responses. In this model, respondents did not go through the search and action phase. Furthermore, 8.97% of respondents did not share, leading to a loss of 7.61% of responses from these respondents.

Table 7. Summary of CRI Measurement Results

	AISAS	AIAS	AISS	AIS
	57.34%	60.85%	72.72%	77.17%
	More than	More than	More than	More than
No Share	5.65%	6%	7.17%	7.61%
No Action	16.90%	17.93%		
No Search	4.89%		4.89%	
No Interest	4.96%	4.96%	4.96%	4.96%
No Attention	10.26%	10.26%	10.26%	10.26%

Source: Processed Data (2023)

The data shows that the promotional efforts of Akkar Juice Bar using the social media platform Instagram with the CRI AISAS model fall within the 'Average' category, with values 57.34% between 40.00% and 59.99%. The CRI AIAS, CRI AISS, and CRI AIS models are also categorized as 'Good,' with values between 60.00% and 79.99%. These results can be considered effective since the percentage values for the CRI AISAS, CRI AIAS, CRI AISS, and CRI AIS models are in the 'Average' and 'Good' categories and are more significant than the respective percentages for 'no share,' 'no action,' 'no search,' 'no interest,' and 'no attention.' Based on these findings and the promotion activities conducted by Akkar Juice Bar on Instagram, the Instagram account can be classified as being in the intermediate stage, as the effectiveness falls within the 'Average' and 'Good' categories. Furthermore, it is still in the growth phase, and therefore, it can be further optimized to achieve a very high level of effectiveness.

3.6 Recommendations

The results of CRI AISAS show that the "no action" stage has the highest value compared to the stages of "no attention," "no interest," "no search," and "no share." Consequently, prospective consumers tend to go through the stages of attention, interest, search, and only a few proceed to the action stage of purchasing the product. This is because Akkar Juice Bar is still a developing product striving to enhance its presence in the food and beverage industry. Word-of-mouth reviews play a significant role in convincing consumers to take action in purchasing the product. Word-of-mouth communication is created through a cycle involving the elements of search and sharing as active, spontaneous, and intentional actions (Sugiyama & Andree, 2011). Moreover, increasing the motivation of potential consumers to buy the product is crucial, considering Akkar Juice Bar's unique offering of cold-pressed juice, which aligns with the "Start Small for our Health and Planet" campaign. Additionally, implementing ad recall is essential to build the brand image of Akkar Juice Bar for greater recognition and consumer trust. Ad recall is the most influential variable in Instagram advertising, impacting purchase intentions through daily photo or video updates, thus nurturing purchasing interest (Reynaldo et al., 2019). Currently, Akkar Juice Bar is conducting promotions through collaborations with influencers, communities, other products, exhibition events, and paid ads for specific posts. Here are some recommendations to enhance consumer action behavior in purchasing the product.

Table 8. Alternative Recommendations

	Alternative Recommendations
Word of mouth communication	It is recommended to schedule paid content through Instagram Ads with specific targeting based on consumer criteria who have the potential to be interested in Akkar Juice Bar. It is advised to run campaigns or challenges on Instagram involving consumers.
Motivating consumers	It is recommended to display testimonial posts from loyal customers of the product to motivate the audience to take action. Providing rewards through points or discounts on their next purchase to customers who share posts, stories, or reviews about Akkar Juice Bar on Instagram. Utilizing Instagram's live feature to interact directly with Instagram audiences interested in Akkar Juice Bar.
Add recall	It is suggested to increase the frequency of posts with daily updates so that the audience can easily remember the Akkar Juice Bar brand compared to similar brands.

The recommendation can be used as an alternative to improve customer communication with active responses from the Instagram audience and to target the appropriate audience. The industry will gain insights into online marketing communication on Instagram that has been carried out so far, allowing them to identify areas for improvement and enhancement to optimize their marketing communication.

4. CONCLUSIONS

The result of measuring the effectiveness of Instagram as a promotion medium for Akkar Juice Bar using a modified CRI AISAS model yielded a CRI AIS value of 77.17%, CRI AISS of 72.72%, and CRI AIAS of 60.85%, indicating an effectiveness rating in the "Good" category. Furthermore, the CRI AISAS value of 57.34% falls into the "Average" effectiveness category. CRI AIS has the highest value, where consumer behavior response patterns begin with attention and interest and end with sharing. Overall, the results from the four CRI models obtained are effective. Recommendations for promotion strategies on the Instagram account @akkarjuicebar include advertising through Instagram Ads, conducting campaigns and challenges involving consumers, rewarding consumers for sharing, showcasing customer testimonial posts, and increasing the frequency of posts.

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A Comprehensive Review of Possible Resistant Starch in *Getuk*: Its Formation, Health Effects, and Potential Applications as Prebiotics

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Abstract

This review aims to give a thorough understanding of how resistant starch is produced, how it affects health, and how it probably contains in traditional Indonesian snack called getuk. Resistant starch, a type of starch that resists digestion in the small intestine, has drawn a lot of attention. In order to learn more about resistant starch formation in getuk, this review includes a thorough study of the relevant databases, research articles, and scientific literature that is currently available. It explains the effects of various processing techniques, including cooking and cooling on the possible formation of resistant starch in the snack. The potential health implications of resistant starch consumption in getuk are also examined in this review. It has been discovered that resistant starch provides a number of advantages, such as improved glycemic management, prolonged satiety, gut microbiota modulation, increased mineral absorption, and a decreased risk of obesity, type 2 diabetes, and colorectal cancer. The primary cause of these effects is attributed to the fermentation of resistant starch by colonic bacteria, which results in the production of short-chain fatty acids and other bioactive substances. The review looks at Getuk's potential uses as a resistant starch carrier in the creation of functional foods. The snack is a perfect candidate for adding extra bioactive substances such as fiber, and prebiotics to improve its nutritional profile and functional qualities because of its distinctive texture, flavor, and cultural importance. Overall, this review emphasizes the production of resistant starch during processing of getuk and indicates the potential health advantages of its ingestion. It offers insightful information about the importance of this traditional Indonesian snack as a carrier of resistant starch and its prospective uses in the creation of functional meals. To fully utilize getuk as a source of resistant starch in the production of functional foods, additional study is required to optimize processing methods, assess consumer acceptability, and explore novel formulations.

Keywords: *Gelatinization, Getuk, Resistant Starch, Retrogradation, Steaming*

1. INTRODUCTION

Getuk is a thaditional Indonesian food, made from steamed cassava, which is then mashed finely and topped with grated coconut (Lestari, et al., 2014). The nutritional content per serving (70 g) as reported by Lestari, et al., (2014) is as follows: carbohydrates make up 45.92% of the total, protein accounts for 1.79%, fat contributes 1.18%, water 50.07%, and minerals comprise 1.04%. The main component of *getuk* is carbohydrates. Besides cassava (Manihot esculenta), other carbohydrate sources can be used as the main ingredient for *getuk*, such as purple sweet potatoes (*Ipomoea batatas*) (Basuki et al., 2013), chinese yam (*Dioscorea esculenta*) (Koir, et al., 2017), bananas (*Musa paradisiaca*) (Lestari & Susanto, 2015), and *Dioscorea hispida* (Atmaja, 2019).

The process of making *getuk* displays a wide range of techniques across different regions in Indonesia. These techniques encompass variations in the types of sugars utilized, such as granulated sugar, fine sugar, and palm sugar. Some methods involve cold extrusion during production, resulting in *getuk lindri*, while others include frying processes to improve both flavor and shelf life (*getuk goreng*). Furthermore, manufacturers have experimented with crafting *getuk* products in a variety of colors and flavors to appeal to consumers. In essence, the fundamental process of making *getuk* involves steaming a source of carbohydrates, adding sugar, and then mashing and shaping the mixture (Muhami, 2018). Notably, original *getuk* from Magelang, Central Java, boasts a softer texture compared to traditional

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varieties, most likely attributed to the incorporation of solid fats in one of its key ingredients during production.

The potential health benefits of *getuk* are associated with its preparation process, particularly steaming. Modifying the steaming process for *getuk* starch can reduce starch digestibility and increase the level of resistant starch. Resistant starch is defined as a fraction of starch or starch product that resists degradation, making it difficult to be digested and absorbed by the small intestine due to its resistance to amylase enzymes. Consequently, resistant starch can be categorized as a beneficial dietary fiber with advantages such as colon cancer prevention, hypoglycemic and hypolipidemic effects, prebiotic properties, reduction in gallstone formation risk, inhibition of fat accumulation, and enhanced mineral absorption. Foods containing resistant starch can be considered functionally beneficial for the body (Sugiyono, et al., 2009).

The exploration of making *getuk* using various tubers is quite extensive, but the recorded research in this area is very limited. Research in Indonesia primarily focuses on incorporating substitutions to enhance nutritional value, shelf life, and appeal (Ningsih, et al., 2017), (Safitri, et al., 2016), (Chastelyna, et al., 2023) (Basuki, et al., 2013) (Atmaka & Sigit, 2013). This review can offer a fresh perspective on the processing of *getuk*. *Getuk* prepared with variations in steaming, such as autoclaving, has the potential to yield resistant starch. This resistant starch can have prebiotic effects on gut microflora, as it can function as dietary fiber

2. MATERIAL AND METHODS

The method used in the preparation of this review article is a literature study. The literature used consists of journals and books published. The journals obtained are both international and nationally accredited SINTA national journals published online, with an ISSN. Literature searches were conducted using Google Scholar and several journal websites, using keywords such as: "Getuk," "Prebiotic," "Resistant Starch," "Steaming," "Gelatinization," and "Retrogradation."

The selection of the main journal is based on journals that present research results related to *getuk*, especially various manufacturing processes, and modifications of various types of starch in tubers that produce resistant starch. Supporting journals are those that support data from the main journal and literature for this review article.

3. RESULTS AND DISCUSSION

3.1 The Steaming Process of *Getuk* and Gelatinization

The preparation of *getuk* encompasses several stages, including steaming, blending, and shaping. The making of *getuk* is done using the following method: (1) Cassava is washed, peeled, and then soaked in clean water for 24 hours. (2) The cassava is cut into small pieces, then steamed at a temperature of 80 - 100˚C for 60 minutes. (3) The steamed cassava is mashed and mixed with other ingredients such as sugar, salt, water, and solid fats (margarine and butter). Steaming, in particular, plays a pivotal role in this process, and the steaming duration can differ according to various sources. Some research suggests a 30-minute steaming period, as documented by Lestari & Susanto (2015), Handayani & Sujiman (2019), and Chastelyna, et al., (2023). Conversely, alternative sources recommend a steaming time ranging from 45 to 60 minutes, as indicated by Basuki, et al., (2013), Atmaka & Sigit (2013), and Aji & Utama (2020). The variance in steaming durations may be attributed to different methods and variations in the production of *getuk*.

The transformation of *getuk* into its signature chewy and elastic texture is primarily attributed to the phenomenon of starch gelatinization, which takes place during the cooking and cooling stages of its preparation. Starch gelatinization is a critical process that profoundly influences the final texture and quality of *getuk*. This transformation is brought about by the interplay of various factors, including heat and moisture.

The gelatinization of starch is a complex molecular process in which the starch granules absorb water, swell, and eventually burst, leading to a remarkable change in their physical properties.

Gelatinization occurs due to the reaction of amylose and amylopectin in starch when exposed to high temperature and high water content. The double helix structure of amylopectin expands and unravels, breaking hydrogen bonds due to the high temperature. Water enters the starch granules, releasing amylose and coating the granules. Water binds to the hydroxyl groups of sugar in amylose and amylopectin, causing the starch granules to swell, resulting in a thick texture (Mailhot, 1988).

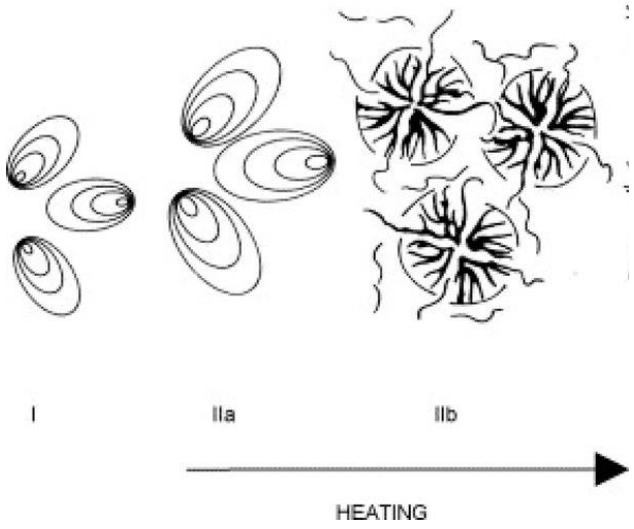

Figure 1. Starch gelatinization process (Wang, et al., 2015)

Food scientists employ advanced tools and techniques to examine the precise occurrence of starch gelatinization. In this context, a widely used instrument is the Rapid Visco Analyzer, which is capable of providing detailed insights into the starch's behavior as it is subjected to controlled heating and cooling cycles (Steffe, 1996). Through this analysis, researchers can better understand the gelatinization kinetics, peak viscosity, and pasting properties of the starch in *getuk*, shedding light on the factors that contribute to its unique texture.

It's important to note that the specific attributes of starch gelatinization in *getuk* can vary based on the type of starch used and its source. Starches derived from different botanical sources, such as tapioca, wheat, and rice, exhibit distinct gelatinization behaviors. Tapioca starch, for instance, typically achieves the highest peak viscosity rapidly but may show lower viscosity upon cooling. In contrast, wheat starch is known for its lower viscosity during the cooking process. Rice starch, on the other hand, takes a longer time to reach its peak viscosity but exhibits higher viscosity during the cooling phase. The choice of starch in the *getuk*-making process can significantly impact the resulting product's texture and quality, highlighting the importance of understanding starch gelatinization dynamics (Imanningsih, 2012; Howling, 1980; Manners, 1968).

3.2 Retrogradation and Resistant Starch

Resistant starch is a fraction of the starch that is not digested in the small intestine and enters the colon unchanged, where fermentation by resident microorganisms occurs, resulting in the formation of short-chain fatty acids (SCFAs) (Bojarczuk, et al., 2022). Resistant starch is divided into five types, depending on the different resistance mechanisms to digestion in the human body. Resistant starch can be analyzed through in vitro starch digestibility by imitation the condition of digestive enzymes. In various starches, studies reported that cereals showed lower resistant starch content compared to potato and legumes with an exception of maize which has slightly higher resistant starch value than potato starch. Legumes which have higher amylose content has been reported to show higher resistant starch content than corn, cereals and tuber starches (Remya and Jothi 2015). Percentage of resistant

starch in different source of starch is compared in Table 1. Cassava may not be the highest content of resistant starch, however Katayama, et al., (2011) reported that variety methods of cooking can control the resistant starch levels.

Table 1. Resistant starch content in different various starches

Source	Resistant Starch (%)
Par-boiled rice	2.7±0.09
Wheat	2.7±0.01
Mung bean	5.1±0.19
Banana	3,3±0.00
Cassava (M4)	2.1±1.08
Sweet potato	3.3±0.38
Potato	4.0±0.03

Source: Remya and Jothi (2015)

Retrograded starch is a specific subset of resistant starch (Resistant starch type 3), forms as a consequence of cooling after the gelatinization process in starch-based materials. This transformation is marked by a significant molecular reconfiguration, particularly in the way hydrogen bonds within amylose and amylopectin molecules reestablish themselves. During this process of retrogradation, these bonds reform into a more robust and crystalline structure, creating a notable change in the starch's physical attributes (Haralampu, 2000).

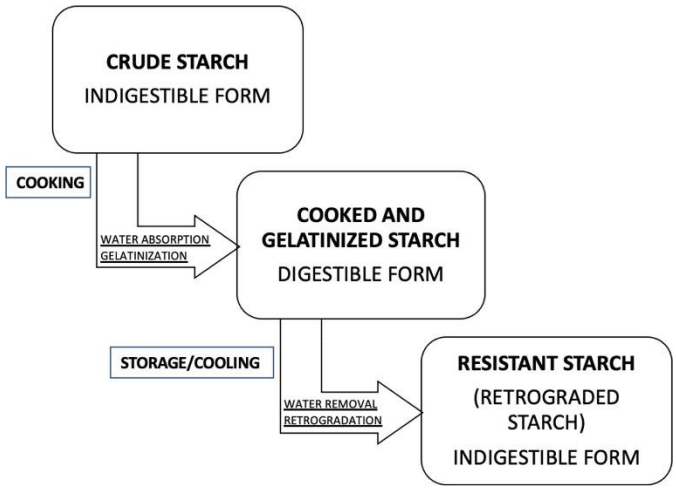

Figure 2. Resistant starch formation from retrograded starch (Bojarczuk, et al., 2022)

Resistant starch, on the other hand, is a broader category encompassing starches that exhibit resistance to digestion by enzymes within the human small intestine. This resistance results from structural alterations in the starch molecules, making them less susceptible to enzymatic breakdown. Resistant starches, although evading digestion in the small intestine, play a crucial role in the large intestine. There, they become substrates for fermentation by the resident gut microflora, ultimately producing short-chain fatty acids. These fatty acids have implications for gut health and can offer various health benefits (Reyes-Moreno & Paredes-Lopez, 1993) (Miksusanti, et al., 2020).

The process of retrogradation is a dynamic one, and its outcome is influenced by various factors. These factors include the number of cycles involving heating and cooling, the ratio of starch to water, the temperature during heating, as well as conditions related to drying and storage (Palguna, et al., 2013). Notably, the ratio of starch to water, or the quantity of water used, is a significant factor affecting the level of resistant starch obtained. A smaller ratio or reduced water content can lead to decreased levels of resistant starch due to the suboptimal completion of the gelatinization process (Sugiyono, et al., 2009).

Interestingly, studies have demonstrated that specific processing steps involving heat, such as heating, steaming, and the subsequent cooling of starch-containing materials, can be employed to deliberately enhance the content of resistant starch in various starch types (Rosida & Yulistiani, 2013), (Zhang, et al., 2009), (Ardhiyanti, et al., 2017). These findings underscore the significance of understanding the dynamics of starch transformations and the controllable factors that can influence the development of resistant starch, which has applications not only in the food industry but also in nutrition and human health. Research in this field continues to provide insights into harnessing the potential of resistant starch for beneficial purposes, both in food products and for its impact on gut health.

3.3 Resistant Starch as Prebiotics

Resistant starch serves a vital role as a prebiotic, acting as a substrate source for the microflora in the large intestine. This prebiotic function arises from its ability to function as a dietary fiber, as indicated by studies such as Hedemann & Knudsen (2007) and Sunarti (2018). Resistant starch can effectively influence the composition of the microbiota in the large intestine. Notably, the type of resistant starch plays a role in shaping the microbial balance. Type B starch (resulting from heat processing) stimulates the growth of *Bifidobacterium spp.,* while Type A starch (raw starch) induces the growth of *Atopobium spp* (Vieira, et al., 2013).

The retrogradation process, characterized by cooling after heating, plays a crucial role in the prebiotic activities of starch. For instance, in the case of corn starch, retrogradation over a 3-hour period has been shown to exhibit higher prebiotic activity for *B. Longum* and *L. Plantarum* compared to retrogradation over 0-2 hours (Interpares, et al., 2015). In another example, starch from banana, when subjected to autoclaving followed by retrogradation, displayed higher prebiotic activity compared to commercially available FOS (fructooligosaccharides), especially concerning three potential probiotic candidates: *L. acidophilus*, *L. plantarum sa28k*, and *L. fermentum 2B4* (Putra, 2020).

Furthermore, butyrogenic genera present in the human large intestine have the capability to ferment resistant starch, leading to the production of short-chain fatty acids (SCFA) like acetic acid, propionic acid, and butyric acid. These SCFAs are known to possess anti-carcinogenic properties, making them beneficial for gut health (Lesmes, et al., 2008) (Kamada, et al., 2013) (Prado-Silva, et al., 2014). The role of resistant starch in promoting the growth of specific beneficial bacteria and the production of health-promoting compounds like SCFAs underscores its importance not only in the context of nutrition but also for its potential contributions to overall well-being and disease prevention.

4. CONCLUSIONS

The process of making *getuk* involves steaming cassava for a long time, and cooling occurs when the ingredients are mixed to form a chewy texture. In the process of making *getuk* it is suspected that starch retrogradation occurred which caused *getuk* to contain resistant starch. Resistant starch is proven to increase the prebiotic activity of processed food. Optimization of processing *getuk* through the variation of cooking such as autoclaving can lead the *getuk* processing to produce resistant starch. *Getuk* with high resistant starch has the possibility to give health benefits as prebiotics.

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