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PREFACE

By the Grace and Blessings of Allah the Almighty, we would like to present, with great pleasure, the Volume 02 number 02 of *Food ScienTech Journal* (FSJ). This journal is part of the Universitas Sultan Ageng Tirtaya series of journal.

This journal was envisioned and founded to represent the growing needs of food technology as an emerging and increasingly vital field, now widely recognized as an integral part of agriculture and human living. Its mission is to become a voice of the food technology and science community, addressing researchers and practitioners in areas ranging from chemistry to management, from microbiology to industry, presenting verifiable methods, findings, and solutions.

The journal is intended as a forum for practitioners and researchers to share their research, idea, and solutions in the area of food science and technology. We would like to request for the reader to participate on writing the articles in this journal.

Thank you for your kind attention and support, hopefully this journal will provide lots of benefits for you and society.

Serang, December 2020

Editorial Team

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APPLICATION OF REFRIGERATED AND FROZEN SORGHUM MALT SLURRIES IN THE PRESERVATION OF STARTER CULTURES FOR OBUSHERA FROM UGANDA

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ABSTRACT

Industrial production of traditional fermented beverages is limited by lack of quality commercial starter cultures. *Saccharomyces cerevisiae* MNC21Y and *Lactobacillus plantarum* MNC21 can be used to ferment cereal beverages such as Obushera. These cultures are unavailable as commercial starters due to lack of appropriate propagating and distributing procedures. The purpose of this study was to evaluate the use of refrigerated and frozen sorghum slurries as carrier media for the starters. Starters were propagated in sorghum slurries (30°C for 24 h) and stored at 5°C and -18°C for 90 days. Viability of *Saccharomyces cerevisiae* and *Lactobacillus plantarum* was determined by cell counts after surface plating and pour plating, respectively. Fermentation ability was determined by inoculating sorghum slurries with starters and monitoring pH, acidity and flavor development. Viability was higher for starters stored at 5°C (*S. cerevisiae*: 6 log cfu.g^{-1} and *Lb. plantarum*: 7-9 log cfu. g^{-1} during 90 days) than those at -18°C (*S. cerevisiae*: 2 cfu.g^{-1} and *Lb. plantarum*: 4 log cfu.g^{-1} after 30 days). Refrigerated starters acidified Obushera (pH ≤ 4.5) faster (10-20 h) than frozen ones (18-24 h). Refrigerated or frozen *S. cerevisiae* + *Lb. plantarum* starters in sorghum malt slurries can remain viable for at least one or three months, respectively and produce Obushera with characteristic flavors.

Keywords: *Lactobacillus plantarum*, *Saccharomyces cerevisiae*, Sorghum, Starter cultures, Viability

INTRODUCTION

Globally, traditional fermented foods are important as dietary sources of nutrients such as carbohydrates, proteins, fiber, minerals and vitamins (Fusco, 2017). Fermentation of these foods contributes to enhancing nutritional value, increasing sensory diversity, prolonging product shelf life and ensuring food safety (Tamang, 2016; Fusco, 2017). Traditional fermented foods are also associated with health promoting effects which are be attributed to the probiotic effects of some of the starter cultures (Tamang, 2016; Fusco, 2017).

Obushera is a collective name for popular traditional fermented or non-fermented cereal beverages consumed in western, southwestern and central Uganda (Mukisa, 2012). The beverages are mainly produced from flour of either malted or un-malted sorghum or millet grain. Obushera is used as weaning food, thirst quencher and as a beverage on social functions such as wedding ceremonies (Mukisa, 2012). The production of Obushera has for long been largely carried out by local artisans. Industrial scale production of the product in Uganda only started in 2008 with Multiline International Limited introducing Obushera under the brand name 'Bessa'. Several companies currently produce packaged and branded Obushera. Despite these developments, the production of Obushera still relies on a spontaneous fermentation.

Spontaneous fermentations are initiated by the natural flora present on raw materials, utensils, processors or the environment. The fermentations result from the competitive

activity of the diverse flora with organisms better adapted to the substrate eventually dominating (Wirawati *et al.* 2019). Adopting spontaneous fermentations for industrial processes is challenging because initiation of fermentation takes a relatively longer time compared to when starter cultures are used and the fermentations may proceed in an unpredictable and uncontrollable manner (Wirawati *et al.* 2019). The processes are also associated with high risks of failure and inconsistencies in quality attributes and safety (Wirawati *et al.* 2019; Byakika *et al.* 2019). Developing starter cultures is one of the vital steps towards standardizing traditional fermentations for industrial commercial production (Soro-Yao *et al.* 2014). Through this approach, starters with desirable properties such as fast acidification and flavor production can be identified and applied thus ensuring reduction in processing time, consistent product quality and safety (Soro-Yao *et al*. 2014; Mukisa, 2012).

Starter culture combinations of *Saccharomyces cerevisiae* MNC21Y and *Lactobacillus plantarum* MNC21 can potentially be used for production of an acceptable product with a flavor profile similar to that of traditionally produced Obushera (Mukisa, 2012; Mukisa *et al*. 2017). Application of these starters also enables production of Obushera in 10 – 12 hours as opposed to 24 hours or more as is expected in traditional spontaneous fermentations. These starters are, however, not yet commercially available for use by Obushera processors since no starter carriers or starter culture delivery methods for these particular starters have been developed or evaluated to date.

Starter cultures may be preserved and distributed in liquid, spray-dried, frozen or lyophilized forms (Kringelum and Kragelund, 2010). The media used to carry starter cultures include milk derived carriers such as reconstituted skimmed milk (RSM) liquid nitrogen and nutritive media (Kringelum and Kragelund, 2010; Parente, Cogan and Powel, 2017). While starter cultures in these media exhibit maximum survival, the expense of the storage conditions limits the use of these carriers. Additionally, starter culture preparations usually contain other costly ingredients such as cryoprotectants (sodium glutamate, sucrose, lactose) and growth factors (Leroy and Vuyst, 2009).

Locally available plant materials such African locust bean, soy bean, starch can be used as cost effective means for propagation and distribution of starter cultures (Leroy and Vuyst, 2009; Aderibigbe, Visessanguan and Jureeporn, 2015). Slurries of millet or sorghum can potentially be used for the production, distribution and storage of these starters since Obushera produced from these slurries supports the growth of *S. cerevisiae* and *Lb. plantarum* (Mukisa, 2012). The use of millet or sorghum malt slurries, which are locally available and affordable raw materials, could potentially be a more economically feasible alternative for starter culture preservation and distribution. There is, however, need to establish the viability and activity of these starters under cold storage. Therefore, the purpose of this study was to investigate the potential of using refrigerated and frozen slurries of sorghum as carrier media for Obushera starter cultures.

MATERIALS AND METHODS

Sorghum malt preparation

SESO 3, a red seeded sorghum variety obtained from the National Semi-arid Resources Research Center in Serere, Uganda was used to prepare sorghum malt. The sorghum grain was placed on a suspended wire mesh and sorted to remove chaff. The grain was then washed using pressurized water. Ten kilograms of grain were soaked in 15 liters of potable water containing 0.3% sodium hydroxide (Merck, Germany) and allowed to steep for 6 h. The water was drained and the steep vessel refilled with fresh water. The grains were steeped for a further 10 h after which the water was drained and the grain transferred to germination beds at 25°C. Germination was halted after two days when the rootlets of the grain reached 1 cm long. The grain was spread out in a 2 cm thick layer in a drying chamber at 65°C. The grain was considered dry if it broke ‘cleanly.’ The dried sorghum malt was stored in moisture proof bags at room temperature (25-27°C) till further use.

Propagation of microbial strains

Lactobacillus plantarum MNC 21 and *Saccharomyces cerevisiae* MNC21Y isolated

from Obushera were used in the study. *Lb. plantarum* MNC21 was grown in 100 ml of MRS broth (CONDA, Madrid, Spain) at 30°C for 24 h. *S. cerevisiae* MNC21Y was grown in 100 ml of Yeast Mold Broth (CONDA, Madrid, Spain) at 30°C for 24 h. The cells were separately centrifuged at 7500 x g for 10 min (Centrofriger – BL II, JP Selecta, Barcelona, Spain) and the pellets washed thrice using sterile quarter strength Ringer's solution (Oxoid Limited, Basingstroke, Hampshire, England). The pellets were then separately suspended in 10 ml of sterile quarter strength Ringer's solution.

Preparation and inoculation of sorghum malt slurries

Dried sorghum malt was milled using a Wondermill (Grote Molen Inc., Pocatello, USA) at the bread texture control setting. At this setting, 99% of the resulting flour passed through a 1000 mm mesh and 85% through a 500 mm mesh. The sorghum malt was mixed with potable water to make a slurry of 12.5 % total solids. The slurry was heated with continuous stirring to 90°C and held at that temperature for 15 min. The hot slurry (200 ml) was then aseptically transferred to sterile 250 ml glass bottles and allowed to cool to 30°C. The porridge was inoculated with 6.0 log cfu.ml^{-1} of *Lb. plantarum* MNC 21 and *S. cerevisiae* MNC 21Y cultures and incubated at 30°C for 24 h. Samples were drawn at 0, 4, 8, 12 and 24 h to measure cell counts, pH and titratable acidity.

Storage of starter cultures in fermented sorghum malt slurries

Starter cultures can be stored in a refrigerator at 2 – 5°C or frozen with cryoprotectant at −20°C to −40°C, −80°C or −196°C (Parente, Cogan and Powell, 2017). Other authors have reported storing starters at −20°C to 10°C (Kringelum and Kragelund, 2010). In this study 5°C and −18°C were used because they are the common chiller and freezer cabinet temperatures, respectively observed for refrigerators in Uganda (Makumbi et al, 2015). Therefore, most processors of Obushera with access to refrigerators are likely to store the starters at either 5°C or −18°C. To store the starter cultures, 50 ml of the fermented sorghum malt slurries were distributed in sterile 100 ml plastic bottles. Some of the bottles containing the fermented sorghum malt slurries were stored in a refrigerator and the rest in a freezer.

Determining the fermentation ability of the stored starter cultures

Samples were drawn periodically to determine cell counts and fermentation ability of the stored cultures. Fermentation ability of the stored cultures was determined by inoculating 500 ml of freshly prepared and sterile sorghum malt slurries (12.5% total solids) with 1% (v/v) of the stored starter cultures. The inoculated slurries were incubated at 30°C for 24 h. Samples were drawn periodically to determine pH and titratable acidity (0, 4, 6, 12 and 24 h), and flavor development (24 h).

Acidity and pH Analysis

The pH was measured using a pH meter (Mettler-Toledo AG model, Mettler-Toledo Group, Schwerzenbach, Switzerland). Titratable acidity was determined by titrating 10 ml of the sample against a 0.1M solution of sodium hydroxide using phenolphthalein as the indicator (Horwitz, 2000).

Flavor development by the stored starter cultures

The starter culture combination of *Saccharomyces cerevisiae* MNC21Y and *Lactobacillus plantarum* MNC21 is known to produce acceptable sensory attributes (aroma, taste, texture and color) which are similar to those of the traditional product (Mukisa, 2012; Mukisa *et al.* 2017). Therefore, beside evaluating viability and acidification potential of the stored culture, this study assessed the production of the typical flavor of Obushera. Flavor development was determined by the researchers (n = 3) who were all familiar with Obushera. The products were sniffed to detect for the characteristic flavor of Obushera. Samples were scored on consensus as follows: +++ = strong flavor development; ++ = mild flavor development; + = weak flavor development; ND = not detected.

Microbiological analyses

The Serial dilutions were prepared using ¼ strength ringer's solution (Oxoid Limited,

Basingstroke, Hampshire, England). Enumeration of *Lactobacillus plantarum* MNC21 was carried out by pour plating selected serial dilutions in MRS agar (CONDA, Madrid, Spain) and incubating at 30°C for 48 h. Enumeration of *Saccharomyces cerevisiae* MNC21Y was carried out by surface plating selected serial dilutions of the culture in Potato Dextrose Agar (CONDA, Madrid, Spain) with chloramphenical supplement and incubating at 30°C for 72 h. Microbial counts were determined at days 0, 5, 10, 20, 30, 40, 50, 60, 70, 80 and 90 during storage of starters at 5°C and only up to day 30 for starters stored at -18°C.

Statistical analysis

Means were subjected to one way analysis of variance (ANOVA) to test for significant differences at a 5% level of significance. The least significant difference test (Fisher's LSD) was used to determine means that were significantly different from one another after the ANOVA test. All statistical analyses were performed by XLSTAT (2010, Addinsoft, Paris, France). Experiments were carried out in triplicate.

RESULT AND DISCUSSION

Changes in cell counts during storage

Figure 1 summarizes counts of the of *L. plantarum* MNC21 and *S. cerevisiae* MNC21Y mixed culture stored in sorghum malt slurries at -18°C and 5°C. *L. plantarum* MNC21 generally had higher ($p < 0.05$) counts than *S. cerevisiae* MNC 21Y throughout the storage period. There was a drastic decline in cell counts during storage at -18°C with both *L. plantarum* MNC21 and *S. cerevisiae* MNC21Y counts dropping below the desired concentration of 6.0 log cfu.ml^{-1} in ≤ 5 days. For cultures stored at 5°C, cell counts remained above the desirable level (6.0 log cfu.ml^{-1}) throughout storage for 90 days.

The drastic decline in cell counts of the cultures stored at -18°C is associated with cellular freeze damage. Cellular damage is majorly due to intracellular ice crystal formation which damages the cellular structures (Meneghel *et al.* 2017). In addition, the formation of extracellular ice in the suspension medium results in high solute

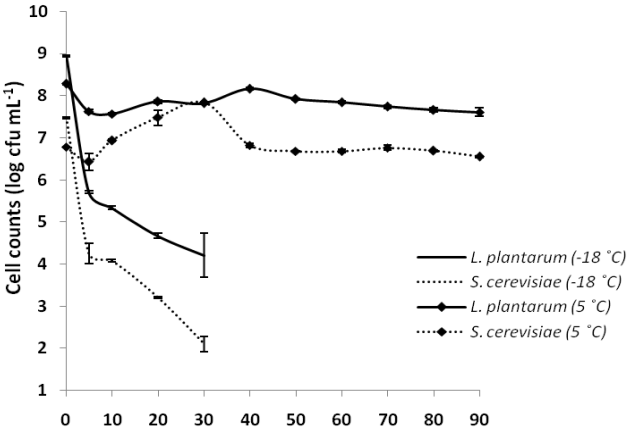

Figure 1. Counts of cultures stored at -18 ºC and 5 ºC. Error bars show standard deviations of three independent fermentations

concentration which results in osmotic stress (Meneghel *et al.* 2017). This may explain why the viability of the cells stored at refrigeration temperature (5°C) was higher ($p < 0.05$) than for those stored at freezing temperature (-18°C). Addition of cryo-protectants such as glycerol, glucose, sucrose or skim milk to cell suspensions prior to freezing has been reported to minimize the effects of cellular freeze damage (Tedeschi and De Paoli, 2011). In the current study the absence of a cryo-protectant in the Obushera most likely contributed to the observed sharp decline in cell viability of frozen cultures.

Fermentation ability of the stored starter cultures

Figure 2 and 3 show the fermentation ability (changes in pH and acidity) of the mixed *L. plantarum* MNC21 and *S. cerevisiae* MNC21Y culture stored at -18°C and 5°C. The fermentation ability varied with time of storage ($p < 0.05$) and was most efficient on day 0. However, unlike cultures stored at 5°C (Figure 3), the fermentable activity of cultures stored at -18°C (Figure 2) declined sharply in the subsequent days of storage. On day 0 it took approximately 6 h only for cultures stored at either temperature to drop the pH of the Obushera below the desirable value (pH ≤ 4.5). Thereafter for cultures stored at -18 ºC this pH value was obtained between 15 – 24 h of fermentation while it took a shorter time (6 – 18 h) for cultures stored at 5°C.

Titratable acidity increased to 0.43% on day 0 but the increase was much lower (0.1 - 0.04%) on days 5 – 30 for cultures stored at -

18°C. For cultures stored at 5°C, increase in titratable acidity was 0.43 – 0.13% between days 0 – 40 and 0.09 – 0.05% between days 50 - 90.

The trend in fermentation ability of the cultures is directly related to cell viability. The high fermentation ability of cells stored at 5°C (Figure 3) is attributed to high cell counts (Figure 1). A drop in cell viability results in reduced cell metabolism which is observed as a reduction in the rate of fermentation thus leading to low acid production (Figure 2 and 3). Rapid acidification of Obushera is always desirable because it inhibits growth of pathogens which comprise majority of the microbial population at the start of fermentation (Mukisa, 2012). The pathogens are not only a food safety concern but may also produce off flavors when they grow in the product (Muyanja, 2001).

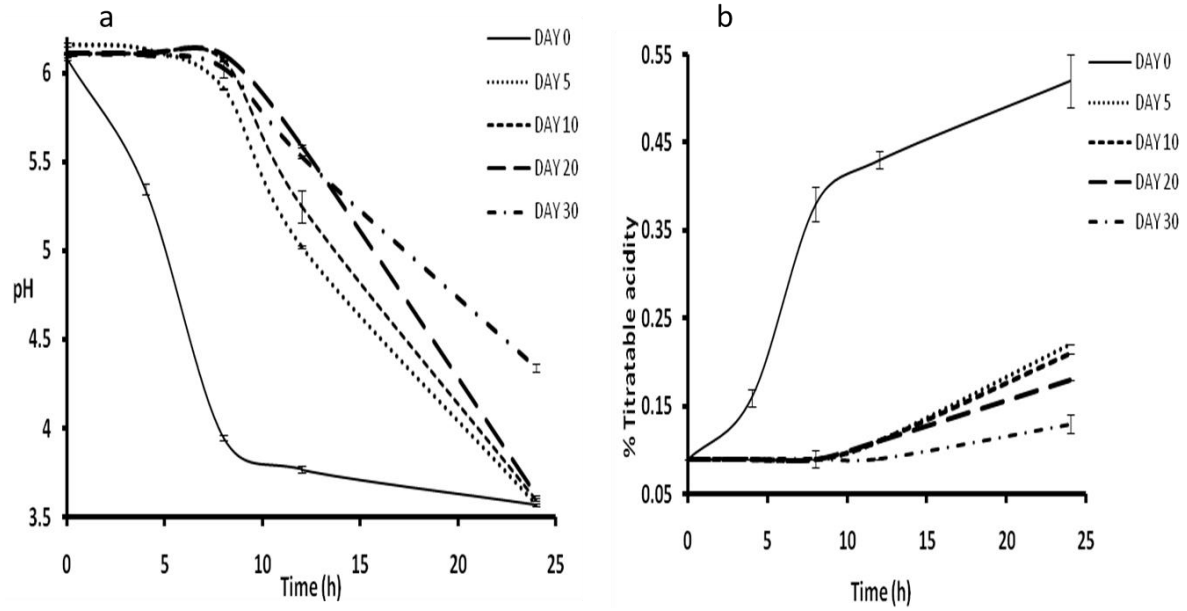

Figure 2. Changes in pH (a) and titratable acidity (b) of Obushera fermented using the *L. plantarum* MNC21 and *S. cerevisiae* MNC21Y mixed culture stored at -18 ºC. Error bars show standard deviations of three independent fermentations

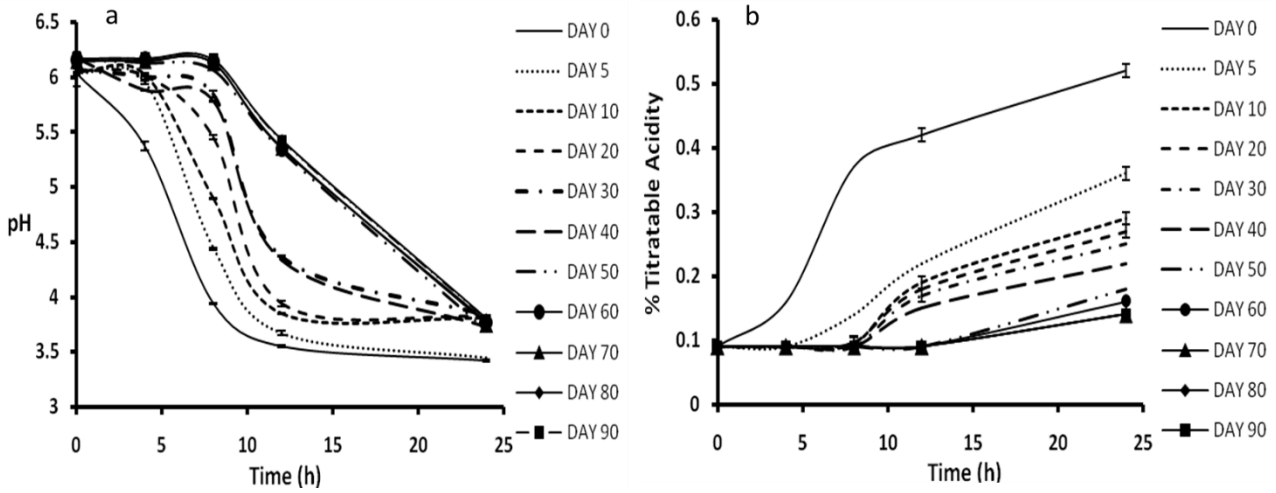

Figure 3. Changes in pH (a) and titratable acidity (b) of Obushera fermented using the *L. plantarum* MNC21 and *S. cerevisiae* MNC21Y mixed culture stored at 5 ºC. Error bars show standard deviations of three independent fermentations.

Flavor development

Table 1 summarizes the intensity of flavor development in Obushera at 24 h of fermentation. Strong flavor development for cultures stored at -18°C was observed only on day 0 after which weak flavor development was noted for the rest of the days. For cultures stored at 5°C, a strong flavor characteristic of Obushera was observed up to the 40th day of storage after which there was mild flavor development.

Table 1. Intensity of flavor development in Obushera at 24 h of fermentation

Day of storage	**Intensity of characteristic flavor of Obushera**	
	Cultures at -18 ºC	**Cultures at 5 ºC**
0	+++	+++
5	+	+++
10	+	+++
20	+	+++
30	+	+++
40	ND	+++
50	ND	++
60	ND	++
70	ND	++
80	ND	++
90	ND	++

+++ = strong flavor development; ++ = mild flavor development; + = weak flavor development; ND not detected.

The strong flavor development observed on day 0 of storage (Table 1) was due to the high cell viability (Figure 1). *L. plantarum* and *S. cerevisiae* produce organic compounds and volatile acids which are responsible for the characteristic flavor of fermented Obushera (Mukisa, 2012). At high cell viability cells exhibit high metabolism which results in high production of flavor compounds. This explains why weak flavor development was noted at reduced cell viability on days 5 – 30 of storage for the frozen starter. In contrast, strong flavor development lasted longer due to the higher viable counts of the starter culture that was kept at refrigeration temperatures. Reduction in intensity of flavor for refrigerated cultures after day 40 could be due to reduction in cell metabolism probably due to cellular damage caused by prolonged refrigeration and or prolonged exposure of cells to lactic acid and other cellular toxins.

CONCLUSION

The purpose of this study was to investigate the potential of using refrigerated and frozen slurries of sorghum as carrier media for Obushera starter cultures. The study has shown that refrigerated (5°C) and frozen (-18°C) slurries of sorghum can be used to store the Obushera starters (*S. cerevisiae* MNC21Y and *Lb. plantarum* MNC21) for 90 days and 30 days, respectively. Therefore, refrigerated and frozen storage of lactic and yeast starters in cereal malt slurries can be adopted as an inexpensive technology for starter culture storage and distribution among small and medium scale processors of fermented foods and beverages. Further studies should evaluate the use of cryoprotectants in improving the shelf stability of the starter cultures.

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APPLICATION OF SWOT AND ANP METHODS IN ORDER TO SELECT THE AGROINDUSTRIAL DEVELOPMENT STRATEGY BASED ON TAPAI IN BONDOWOSO

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ABSTRACT

Tapai is one of the products that become the flagship and image of Bondowoso district. So, the existence of cassava is very supportive to the continuity agroindustry based on Tapai. The main purpose of this research is determining methods that can be used to select the agro-industrial development strategies. One of the decision-making methods that can be used for the selection of agro-industrial development strategies is the Analytic Network Process (ANP) method. In the formulation of strategies is also used SWOT analysis. Based on the research, a priority strategy is obtained, namely the WO strategy, namely strengthening capital for the Tapai agroindustry business and increasing promotion by conducting training.

Keywords: ANP, Tapai, SWOT analysis

INTRODUCTION

One of the potential food crops that can encourage the economic development in Bondowoso Regency is cassava. Where cassava in third ranks of main agricultural product which has the largest harvest area and production volume in Bondowoso Regency (BPS, 2018). Based on this, the cassava commodity is a potential for Bondowoso Regency. This potential sector encourages farmers and community in Bondowoso Regency to process cassava in order to create an added value to increase their income. According to the results of research, processed cassava products that have the potential to be a regional superior product are Tapai and it's processed products (Hermanuadi, 2018). There are so many products based on Tapai in Bondowoso Regency, so the availability of Tapai is very meaningful for several agroindustries that produce them.

The strategy formulation of an organization and industry always follows the dynamics internal and external strategic environment that is adjusted with the mission of the organization/industry. The presence of competitors, the dynamics of social, political, and subsequent technological developments can be analyzed by SWOT matrix. SWOT analysis is a process that involves four areas into two dimensions. It has four components: 'Strengths', 'Weaknesses', 'Opportunities', 'Threats'. Strengths and weaknesses are internal factors and attributes of the organization, opportunities and threats are external factors and attributes of the environment. SWOT analysis is typically drawn out in a four-quadrant box that allows for a summary that is organized according to the four section titles. The following table is a SWOT analysis, with its four elements in a 2x2 matrix (Gurel, 2017).

One of the decision-making methods that can be used for the selection of agro-industrial development strategies is the Analytic Network Process (ANP) method. ANP is used to measure the complexity of a mega project based on supporting factors so that it becomes a reference in managing mega projects (Zhao *et al.,* 2014). ANP is able to determine the order of priority between projects that have proven to be economically profitable based on the level of project risk and the delay in execution time (Beltran *et al.,* 2014). In

previous research, the ANP method was used in decision support in determining the strategy for developing robusta coffee in Jember, where ANP could help stakeholders in making decisions by ranking alternatives (Kasutjianingati, 2020).

The purpose of the research is to obtain the weight of the criteria and sub-criteria for the development strategy of the Tapai agro-industry in Bondowoso Regency using the Analytic Network Process (ANP) method. The results of the research are expected to maintain the existence and availability of Tapai so that several Tapai-based processed agroindustries can fulfill the consumer demand in the market. So that by carrying out this analysis, steps or strategies that need can be taken to support the development of a agroindustry based on Tapai in Bondowoso Regency can be obtained or formulated.

MATERIALS AND METHODS

This research is a holistic qualitative research in which all factors are taken into account as a whole, depending on each other for the benefit of all. Therefore, much more theory is needed because it must be adapted to the phenomena developing in the field (David, 2013). The framework for developing agroindustry based on Tapai in Bondowoso Regency (Figure 1) was obtained through a survey and direct inquiries from the agroindustry, in this case, UMKM that process products based on Tapai, so the actual conditions being faced are known. Supported by the opinion of experts that are compared between theory and reality, so that strategic issues can be obtained. These alternative strategies are the result of weighting the SWOT analysis which is then prioritized using the ANP method.

In this research, the method used is a case study. The case study method is the right strategy if the researcher has little opportunity to control the events to be investigated and the focus of the research lies on contemporary phenomena in the context of real life (Hermanuadi *et al.*, 2020).

Methods

Research Techniques and Data Collection

The research technique used is survey method. The data used are primary data and secondary data. Primary data is obtained directly from respondents through observation and interviews guided by questionnaires. Secondary data were obtained from related institutions, such as the Central Bureau of Statistics, the Department of Agriculture, journals, books, and internet media in accordance with this research.

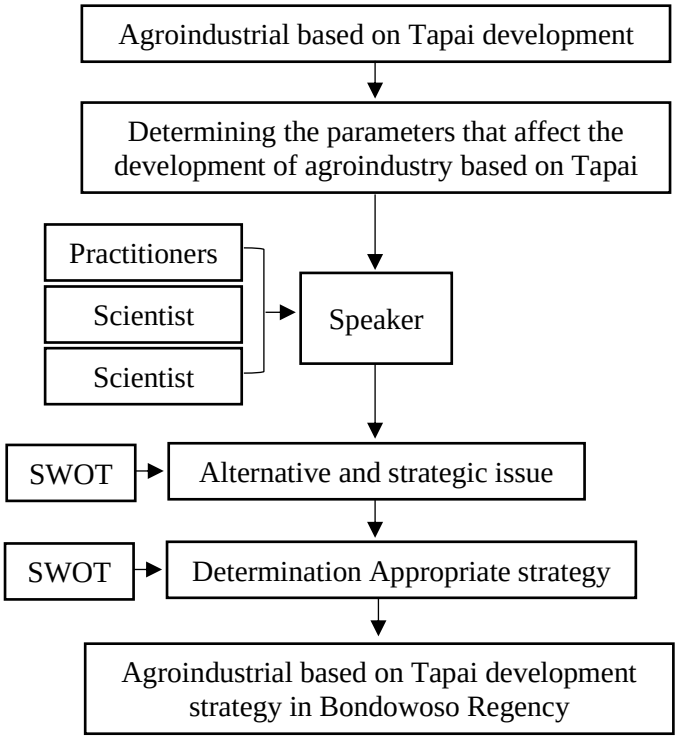


Figure 1. Agroindustrial based on Tapai development research framework in Bondowoso Regency

Respondent Determination Techniques

The number of industries based on Tapai in Bondowoso Regency is 506 and a sample size of 5 industry players is determined purposively with the provisions that the industry players sampled (respondents) are UMKM owners based on Tapai and have been running for at least 5 years. Apart from samples from industry players, informants who were determined purposively were also taken, namely 2 academics and 1 head of the Industry and Trade Office of Bondowoso Regency.

Analysis Technique

The analysis technique in this study was carried out in 2 stages, namely by using descriptive qualitative analysis (SWOT) to complement the results of the qualitative analysis which were then quantified using the ANP method. By using this approach it is

expected to obtain a holistic analysis result. SWOT analysis (Strength, Weakness, Opportunity, Threat) is an analysis tool used to identify various factors that influence strategy formulation (Suwarsono, 2002). The qualitative approach to SWOT analysis can produce strategic alternatives that can be taken by the company by looking at the relationship between SWOT factors (Marimin, 2004). These alternative strategies have different ways to improve the performance of an organization (Sammut, 2015).

Analytic Network Process or ANP is a mathematical theory that allows a decision maker to deal with interconnected factors (dependence) and systematic feedback (feedback). These connections are oriented only to elements in lower levels. A network has clusters of elements, with the elements in one cluster being connected to elements in another cluster (outer dependence) or the same cluster (inner dependence). A hierarchy is a special case of a network with connections going only in one direction.

The priorities derived from pairwise comparison matrices are entered as parts of the columns of a super matrix. The super matrix represents the influence priority of an element on the left of the matrix on an element at the top of the matrix with respect to a particular control criterion. A super matrix along with an example of one of its general entry matrices is shown in Figure 2.

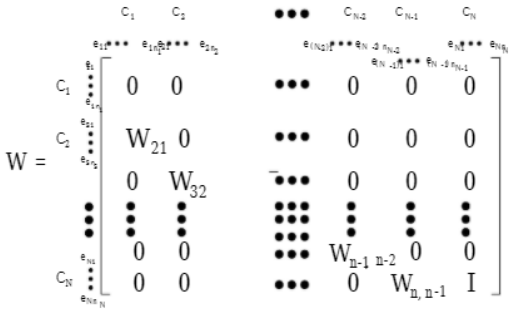


Figure 2. A super matrix of Hierarchy

ANP is a method of decision making based on the many criteria (parameters) developed by Thomas L. Saaty. This method is a new approach to qualitative methods which is a continuation of the previous methods, namely the Analytic Hierarchy Process (AHP) (Saaty, 2008). According to Aziz (2003), ANP is used to solve problems that depend on alternatives and existing criteria.

An ANP network can have criteria and alternatives in it, which are now called nodes. Besides using a hierarchical network, decision making can also be done by creating a feedback network. This network more accurately describes the conditions of a very complex research problem as stated earlier. The ANP method is able to improve the weaknesses of AHP in the form of the ability to accommodate the linkages between criteria or alternatives (Saaty, 2006).

RESULTS AND DISCUSSION

IFE (Internal Factor Evaluation) Matrix

Based on the interviews and validation that has been carried out, there are 13 indicators that are internal indicators (strengths and weaknesses) of the agroindustry Tapai in Bondowoso Regency. Assigning weights to each factor based on the consideration of "very important" (0.1) up to "very unimportant" (0.0), which factors are likely to have an impact.

Further ratings are calculated for each factor by providing a scale ranging from 4 (outstanding) to 1 (poor) based on the influence of these factors on the development of Agro-industrial Based on Tapai Based on the calculations in Table 1, it can be seen that the total internal matrix of strength is 1.49 and the total internal matrix of weakness is 1.52 so that the total score of the overall internal matrix is 3.01.

Table 1. Internal Factors Matrix of Agro-industrial Based on Tapai in Bondowoso Regency

NO	DOMINANT INTERNAL FACTORS STRENGTHS	Amount	Rating	Weight	Weight x Rating
1	Taste and Product Quality	5	1	0,04	0,05
2	The supporting facilities of the operation	6	2	0,05	0,07
3	Experience in Industry	13	3	0,10	0,32
4	Product practicality (easy to carry)	13	3	0,10	0,32
5	The labeling of packaging	11	3	0,08	0,23
6	There is already a job description	16	4	0,12	0,48

7	Customer loyalty	4	1	0,03	0,03
NO	WEAKNESSES	Total	Rating	Weight	Weight x Rating
1	Limited source of funds	11	2,75	0,08	0,23
2	Lack of promotion	12	3,00	0,09	0,27
3	Products are not optimal	15	3,75	0,11	0,42
4	The technology used is still simple	5	1,25	0,04	0,05
5	The level of education of workers is still low	16	4,00	0,12	0,48
6	Products are easily damaged	6	1,50	0,05	0,07
TOTAL		133		1,00	3,01

EFE (External Factor Evaluation) Matrix

Based on the interviews and validation conducted, 11 indicators were obtained which are external indicators (opportunities and threats) of the agroindustry Tapai in Bondowoso Regency. Based on the calculations in Table 2, it can be seen that the total external opportunity matrix is 1.80 and the total external threat matrix is 1.11 so that the total external matrix score is 2.92.

Table 2. External Factors Matrix of Agro-industrial Based on Tapai in Bondowoso Regency

NO	DOMINANT EXTERNAL FACTORS OPPORTUNITIES	Total	Rating	Weight	Weight x Rating
1	Technological developments are advancing	13	3	0,12	0,38
2	The image of eating is typical of the area	7	2	0,06	0,11
3	Open market domestic and overseas	14	4	0,13	0,44
4	Higher population growth	16	4	0,14	0,57
5	Training and coaching from local governments	11	3	0,10	0,27
6	The absence of a fixed supplier of raw materials	4	1	0,04	0,04
NO	THREAT	Total	Rating	Weight	Weight x Rating
1	Fluctuating production costs	4	1,00	0,04	0,04
2	Raw materials are hard to come by	7	1,75	0,06	0,11
3	Raw materials are seasonal	11	2,75	0,10	0,27
4	Bondowoso area is less strategic	12	3,00	0,11	0,32
5	The absence of substitution products	13	3,25	0,12	0,38
TOTAL		112		1,00	2,92

IE Matrix for Positioning

The value obtained from the IFE and EFE matrices will be entered into the Internal-External matrix to map the position of the Tapai agroindustry in Bondowoso Regency. This Internal-External Matrix positions the production in a nine-cell view. This IE matrix is based on two key dimensions, namely the total IFE weight score on the X axis and the EFE weight score on the Y axis. Based on the IFE and EFE Matrix, it can be seen that the position on the X axis at point 3.01 and the position on the Y axis at point 2.92.

The SWOT matrix is a tool used to help determine strategies by considering strengths, weaknesses, opportunities and threats. The SWOT matrix consists of the SO (Strengths Opportunities) strategy, the WO (Weakness Opportunities) strategy, the ST (Strengths Threats) strategy and the WT (Weakness Threats) strategy. Based on the analysis through the IE matrix, it can be found that the Tapai agroindustry in Bondowoso Regency is in quadrant IV. Where companies that are in the 4th quadrant include companies described as Keep and Maintain (Rangkuti, 2006), this quadrant is very suitable for implementing the following strategies:

- SO strategy
  1. Maintaining the quality of the Tapai produced with the latest technology and expanding the marketing network (S1, S4, S5, S6, S7, O1, O2, O3, O5).
  2. Maintain and improve the performance of the existing supply chain by creating

an institutional system in the form of a cooperative (S2, S3, O4, O6).

• WO strategy

1. Strengthen capital for the Tapai agro-industry business and increase promotion by conducting training (W1, W2, W3, W4, W5, W6, O1, O2, O3, O4, O5, O6).

• ST strategy

1. Developing clean Tapai production, improving quality through good post-harvest, and making regulations for business partners (S1, S2, S2, S3, S4, S5, S6, S7, T1, T2, T3, T4, T5).

• WT strategy

1. Creating good cooperation with investors (W1, W2, W3, W4, W5, W6, T1, T2, T3, T4, T5, T6)

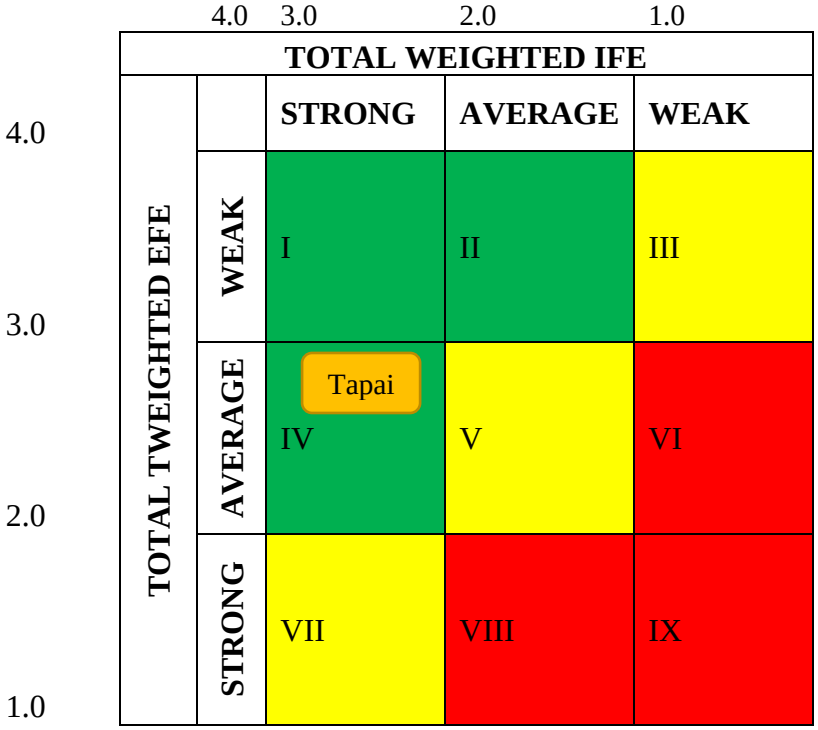


Figure 3. Matrix of IE Agroindustri Based on Tapai in Bondowoso Regency

Analytical Network Process (ANP)

In determining strategic priorities using the Analytical Network Process (ANP) approach, modeling is first carried out using Super Decisions software. From ANP modeling, a pairwise comparison matrix was carried out. In the pairwise comparison matrix, there is a relationship between the elements in one cluster (inner dependence) and the relationship between elements between different clusters (outer dependence) (Sugiyono, 2012). Figure 4 shows the ANP model using Super Decisions.

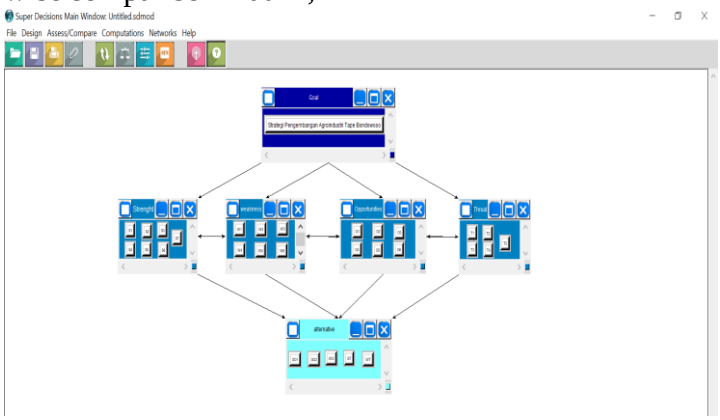


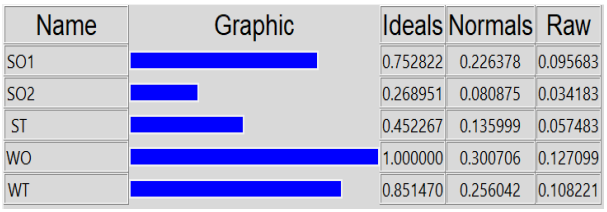
Figure 4. ANP model of agroindustry Tapai development strategy using Super Decisions

Tapai Agroindustry Strategy Priority in Bondowoso Regency

After ANP modeling, pairwise comparisons, prioritization of production

development strategies is obtained with the help of Super Decision Software. From the results of calculations using Super Decisions, the priority for the development of the Tapai agroindustry development strategy in Bondowoso Regency is obtained. Figure 5 shows the ranking of each available alternative. Based on the above, it can be seen that the alternative strategy with the highest value is the WO strategy, namely:

Strengthen capital for the Tapai agroindustry business and increase promotion by conducting training. Strengthening capital can be done by providing guidance, institutional empowerment development and farm management by establishing cooperatives or Tapai associations. The institutional role is very much needed in the development of the Tapai Agroindustry, it aims to make a good welfare allocation at the farmer level. With the background of farming conditions such as low land ownership scale, traditional farming systems and various product quality, the development of the Tapai agroindustry requires an institution such as the Cassava Farmers Association. This must be supported by adequate human resources.



Name	Graphic	Ideals	Normals	Raw
SO1		0.752822	0.226378	0.095683
SO2		0.268951	0.080875	0.034183
ST		0.452267	0.135999	0.057483
WO		1.000000	0.300706	0.127099
WT		0.851470	0.256042	0.108221

Figure 5. Results of priority analysis of the Tapai agroindustry development strategy using Super Decisions

CONCLUSION

Based on the research that has been carried out by researchers in determining the strategy for the development of the Tapai agroindustry in Bondowoso Regency, it can be concluded that there are 5 alternative strategies obtained in the Tapai agroindustry development strategy in Bondowoso Regency. The priority strategy is carried out using the (ANP) approach. Based on calculations using Super Decisions, a priority strategy is obtained, namely the WO strategy, namely strengthening capital for the Tapai agroindustry business and increasing promotion by conducting training.

ACKNOWLEDGEMENT

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RESEARCH OF INSTANT POWDER DRINK DAYAK ONION *(Eleutherine Palmifolia,* (L.) Merr) AND PINEAPPLE *(Ananas Comocus* (L.) Merr)

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ABSTRACT

Instant powder drink is food processed in the form of powder, easily dissolved in the water, practical in serving and has a long shelf life because of it's low water content. In this study instan powder drink were made using the raw material from the mixing of dayak onion juice with pineapple juice. This research used a completely randomized design (RCD) with 5 treatments and 3 replication. Data were analyzed statistically using ANOVA and continued with Duncan's New Multiple Range Test (DNMRT) at the 5% level. The treatment in this study was the mixing of dayak union juice and pineapple juice in the formulation A (90:10), B (80:20), C (70:30), D (60:40), E (50:50). From the results of receiving the instant powder drink of dayak union and pineapple juice ranges from usual preference to like. The most preferred treatment is treatment E with colour value of 3,25 (ordinary), aroma of 3,65 (like) and taste of 3,70 (like). The study aims to determine the best composition of instan powder drink in terms of organoleptic and chemical, physical and microbiological characteristic.

Keywords: dayak onion, instant powder drink, oven, pineapple

INTRODUCTION

Instant powder drink is food processed in the form of powder, easily dissolves in water, practical in serving and has a long shelf life because of its low water content. This instant drink can be produced using natural herbs that are nutritious for the body. One of the innovations of instant powder drinks can be made from dayak onions and pineapples. The processing of dayak onions into powdered drinks can increase the value of dayak onion products so that dayak onions can be better known to the wider community.

Dayak onions (*Eleutherine palmifolia* L. Merr) are well known as medicinal plants. This dayak onion plant is easy to find because it can be planted anywhere and the harvest time is relatively short, which is 2- 3 months. In the dayak bulb contains phytochemical compounds, namely alkaloids, glycosides, flavonoids, phenolics, steroids and tannins (Hidayah, *et al.*, 2015). These compounds can potentially be a source of antioxidants in the dayak plant.

Pineapple is one of the fruits that is high in vitamin C and also contains potassium, calcium, lodium, sulfur, chlorine, acid, biotin, vitamin B12, vitamin A and bromelin enzymes (Wati, 2010). In addition, pineapple is a food product that is easily available and also has a fairly affordable price. It is hoped that the bitter taste of dayak onions from saponin and tannin can be eliminated by interacting with other taste components so that it can reduce the primary taste (Latifaningsih, 2012). The combination of sugar and acid content is thought to minimize the bitter taste of dayak onions so that the addition of pineapple can improve the taste of the dayak drink and increase the vitamin C content and give the product a fresh effect.

MATERIALS AND METHODS

Materials

The material used in the manufacture of instant powder drinks is Dayak onions which are ready for harvest and are not damaged which are obtained in Payakumbuh. While the

pineapples used are honey pineapples with the sunpride brand that are ripe obtained from fruit sellers in the Padang market, maltodextrin (CV. Citra Kimia), tween 80, tropicana slim brand stevia sugar, the solution used for the analysis is distilled water, a solution iodine, starch indicator, DPPH, methanol and others.

The equipment used in processing are knives, scales, basins, blenders, aluminum spoons, mixers, trays. The equipment used in the analysis are pH meter, burette, beaker glass (pirex), measuring flask, measuring cup, dropper pipette, aluminum cup, oven, porcelain cup, erlenmeyer, filter paper, plastic container, cotton wool, desiccator, spectrophotometer (UV-1800, Shimadzu), stopwatch, aluminum foil, furnace, test tube, petridish and others.

Methods

Experimental Design

Research Methods This study used a completely randomized design (CRD) with five treatments and each treatment was repeated three times.

A = 90% dayak juice: 10% pineapple juice
B = 80% dayak juice: 20% pineapple juice
C = 70% dayak juice: 30% pineapple juice
D = 60% dayak juice: 40% juice pineapple
E = 50% Dayak juice: 50% pineapple juice

Instan Powder Drink Production

The process making instan powder in this study by using foam matt drying method. Dayak onions and pineapples are blended and the juice is taken to be used as a base for making instant powder drinks. Dayak onion juice and pineapple juice are measured according to the formulation then mixed in a container. Then added 20% maltodextrin and tween 80 1% of the volume of Dayak juice and pineapple juice. Beat the mixture using a mixer for 10 minutes until foam forms. After that the foam is poured on a baking sheet that has been covered with aluminum foil.

The samples were then dried at tempering at 70°C for 8 hours. After drying the dry plates are mixed with stevia sugar and then mashed to become a powder and sieved with a 60 mesh sieve to homogenize the size of the powder. Then the powder is packed using a pp plastic clip. Meanwhile, the stages of making instan powder dayak onion and pineapple juice can be seen in Figure 1.

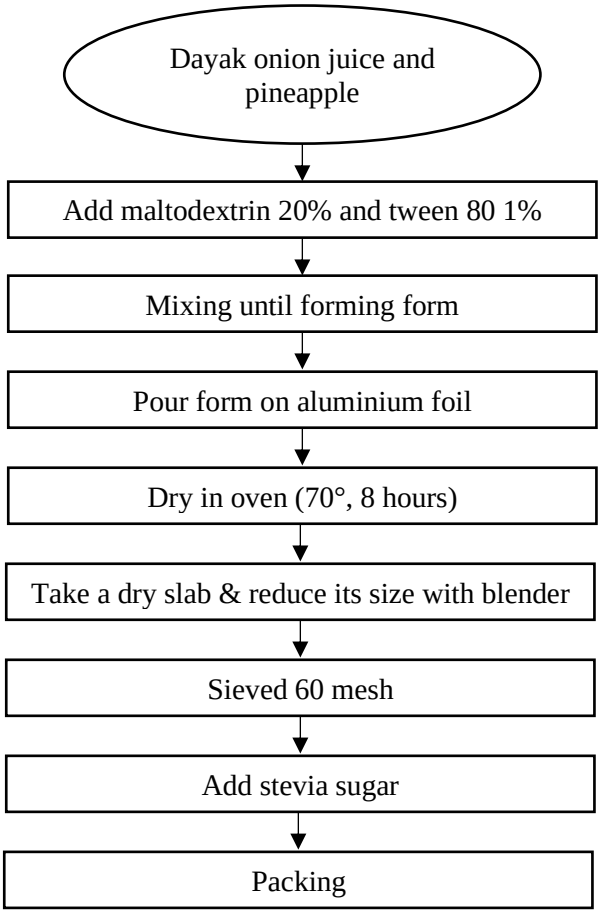

Figure 1. Flow chart of the process of making instan powder mixing onion dayak and pineapple juice

The analysis consisted of physical, chemical, microbiolgy and organoleptic tests. Physical analysis were Time Soluble in Water (Permata and Sayuti, 2016), Water Insoluble Section (SNI 01-2891-1992), chemical analysis namely Water Content using Gravimetric Method (AOAC, 1995), Ash Content (AOAC, 1995), Analysis of Antioxidant Activity with DPPH (AOAC, 2005), Vitamin C Levels (Sudarmadji and Suhardi, 1984), microbiological analysis, namely Total Plate Test (Fardiaz, 1993) and Organoleptic Test (Setyaningsih, 2010).

RESULTS AND DISCUSSION

Representation of the powder instan dayak juice and pineapple juice can be seen in Figure 2.

Physical Analysis

a. Time For Soluble

Based on the analysis of variance, it shows that the mixing of Dayak juice with pineapple juice is statistically significant (α <0.05) to the dissolving time of the instant powder drink produced. The fastest time to dissolve the mixing drink was found in treatment A (90% Dayak extract: 10% pineapple juice). Because product treatment A have low water content. Based on the research by Yohana (2016), the higher the water content of powder products, the more soluble time it takes for powdered drinks to dissolve in water, and vice versa, instant drink powder ingredients which have low water content are soluble in water.

b. Insoluble Portions

Based on the analysis of variance, it shows that the mixing of Dayak juice with pineapple juice is statistically significant (α <0.05) to the insoluble material of the instant powder drinks produced. From the data above, it can be seen that the highest insoluble material was found in treatment A, namely 5.16%. This is because dayak onion have the greatest water insoluble particles so that the more dayak onion juice is added, the higher the water insoluble material in the product.

(a)

(b)

Figure 2. Product of powder drink (a) in powder form (b) in solution form.

Table 1. Physical analysis

Parameter	Treatments				
	A	B	C	D	E
Time for soluble (second)	50.01 ± 0.84	52.89 ± 0.63	54.82 ± 0.77	57.03 ± 0.46	57.86 ± 0.34
Insoluble portions (%)	5.16 ± 0.27	4.78 ± 0.28	4.49 ± 0.16	4.38 ± 0.17	3.95 ±0.32

Chemical Analysis

Variety of water content, ash content, vitamin c, antioxidants can be seen in Table 2.

a. Water content

Based on the analysis of variance, it shows that the mixing of Dayak juice with pineapple juice is statistically significant (α <0.05) to the moisture content of the instant powder produced. From the data above, it can be seen that treatment E has the highest percentage of water content, namely 3.19%. The greater the addition of pineapple juice will increase the moisture content of the resulting powder drink. This is because the pineapple used in this study has a water content that is quite large, namely 88.26%, while Dayak onions have a water content of 59.22%.

Based on SNI 01-4320-2004, the maximum water content of powder drinks is 3%. In this study, treatments A, B and C already have water content according to SNI, while treatments D and E have not met the water content according to SNI.

b. Ash content

Ash is an inorganic residue which is obtained by ashing or heating at high temperatures> 450 ° C and / or decomposing organic components with strong acids. This inorganic residue consists of various kinds of minerals whose composition and amount depend on the type of foodstuff and the analysis method used (Yenrina, 2015).

Based on the analysis of variance, it shows that the mixing of Dayak juice with pineapple juice is not statistically significant (α <0.05) on the ash content of the instant drink pollen produced. It can be seen from the data in the table above that the greater the addition of Dayak juice, the higher the percentage of ash content. Ismanto's research (2014) states that the addition of Dayak onions with the highest concentration in making nuggets produces a product with the highest ash content. This is due to the high inorganic mineral content in Dayak onions.

c. Activity of Antioksidan

Antioxidants are compounds that can inhibit free radicals. Free radicals in the body can cause various dangerous diseases, with the presence of antioxidant compounds in the body it can prevent disease. In this study, the free radicals that were inhibited by the sample antioxidants in the antioxidant activity test were DPPH (1,1diphenyl-2-picrylhydrazyl).

Based on the analysis of variance, it shows that the mixing of Dayak juice with pineapple juice is statistically significant (α <0.05) on the antioxidant activity of the instant drink powder produced. The strongest antioxidant activity value was found in treatment A with an inhibition percentage of 32.84%. While the weakest antioxidant activity was found in treatment E with an inhibition percentage of 14.51%. With the greater the concentration of Dayak juice in the manufacture of this powder drink will increase the antioxidant activity.

d. Vitamin C

Based on the analysis of variance, it shows that mixing Dayak onion juice with pineapple juice has a statistically significant difference (α <0.05) on the vitamin C levels of the instant powder drink produced. From the data in the table it can be seen that treatment E has the smallest vitamin C content, namely 115.68 mg/100g, while treatment A has the largest vitamin C content, namely 163.61 mg/100g. The more Dayak juice additions to making this powder drink will produce products that have high vitamin C levels. In Ismanto's research (2014) states that the higher the addition of Dayak extract, the higher the vitamin C levels in the nuggets.

Table 2. Chemical analysis

Parameter	Treatment				
	A	B	C	D	E
Water content (%)	2.84 ± 0.55	2.92 ± 0.59	3.00 ± 0.70	3.04 ± 0.25	3.19 ± 0.23
Ash content (%)	0.70 ± 0.05	0.65 ± 0.19	0.62 ± 0.15	0.61 ± 0.12	0.59 ± 0.16
Antioxidant (%)	32.84 ± 6.67	29.27 ± 6.82	21.52 ± 6.01	18.31 ± 4.05	14.51 ± 2.09
Vitamin C (mg/100g)	163.61 ± 8.82	151.66 ± 12.71	146.37 ± 10.82	129.41 ± 7.39	115.68 ± 10.82

Microbiological Analysis

Total Plate Count

The total plate count analysis results can be seen in the Table 3. The total plate count test in instant powder drinks is one way to determine the number of microbes present in a sample using PCA media. In the analysis of the total plate number of instant powder drinks, the pour method is used. From the table above, it can be seen that the instant powder drink which has the highest total plate number is in treatment E of 2.5 x 103, while the lowest total plate number is in treatment B 1.9 x 103.The results obtained in this study are in accordance with the established standards (SNI 01-43202004) which is a maximum of 3.0 x 103 cfu / g.

The total plate value is influenced by extrinsic factors, namely conditions in the environment and unhygienic handling and storage of raw materials or processed products, which can lead to contamination of raw materials or processed products with microbes originating from the processing environment and during storage (Damongilala, 2009).

Table 3. Total plate count

Treatment	ALT (cfu/g)
A	2.4×10^3
B	1.9×10^3
C	2.0×10^3
D	2.4×10^3
E	2.5×10^3

Organoleptic Test

The result organoleptic instan powder drink test is shown in table 4.

a. Colour

Based on the analysis of variance, it shows that mixing Dayak onion juice with pineapple juice has a statistically significant difference (α <0.05) on the organoleptic value of the color of the instant powder drink produced. The highest average value was found in treatment A of 3.85, while the lowest average value of color organoleptic was found in treatment E of 3.25.

Based by the color of the instant pollen brew, the mixing of Dayak juice and pineapple juice is red. This is because the Dayak bulb is red in color, which indicates a high content of anthocyanin compounds.The addition of dayak onion juice make the colour of the powder drink is so getting red.

b. Aroma

Based on the analysis of variance, it shows that the mixing of Dayak juice with pineapple juice has a statistically significant difference (α <0.05) on the organoleptic value of the aroma of instant powder drinks produced. The highest average value was found in treatment E of 3.65, while the lowest average value of organoleptic smell was found in treatment A of 3.15.

In the study, it was found that the greater the addition of pineapples, the stronger the aroma of pineapples was. According to Muljohardjo (1988) in Imanda, (2019) states that one of the losses incurred in the drying process is the loss of flavor compounds or volatile volatile compounds.

c. Taste

Based on the analysis of variance, it shows that the mixing of Dayak juice with pineapple juice has a statistically significant difference (α <0.05) on the organoleptic value of the aroma of instant powder drinks produced. The highest average value was found in treatment E of 3.70, while the lowest average value of organoleptic aroma was found in treatment A of 2.75.

Taste is influenced by several factors including temperature, chemical compounds, concentration and interactions with other taste components. The taste with added more pineapple more likely because with the addition of more pineapple juice, make the bitter component in dayak onion juice is getting less, so that the sour taste in pineapple can mask the bitter taste of dayak onion. The taste of this instant powder drink also comes from stevia sugar which gives it a sweet taste. The sweet taste produced by stevia comes from stevioside compounds which are non-carcinogenic natural sweeteners. These stevioside compounds are generally found in the leaves of the stevia plant (Noor and Isdianti, 2013 in Imanda, 2019).

Table 4. Organoleptic test

Parameter	Treatment				
	A	B	C	D	E
Color	3.85 ± 0.93	3,50 ± 0.76	3.45 ± 0.76	3.25 ± 0.59	3.25 ± 1.02
Smell	3.15 ± 0.59	3.15 ± 0.75	3.25 ± 0.57	3.30 ± 0.55	3.65 ± 0.93
Flavor	2.75 ± 1.12	2.90 ± 0.85	3.15 ± 1.09	3.50 ± 1.00	3.70 ± 0.98

Note: 1 = very disliked, 2 = disliked, 3 = ordinary, 4 = liked, 5 = very liked

CONCLUSION

Based on this research, it was found that at product acceptance based on organoleptics, the best treatment was chosen which was the formulation dayak onion juice : pineapple juice (50:50) product with a color value score (3.25), smell (3.65), taste (3.70), as well as the results of physical, chemical and microbiological analysis of the product, namely water soluble time of 57.86 seconds, the insoluble portion of 3.95% water, 3.19% moisture content, 0.59% ash content, 14.51% antioxidant activity, 115.68 mg / 100g vitamin C content, and a total plate number of 2.5 x 103. In this study the mixing of Dayak juice with pineapple juice had a significantly different effect on water content, water solubility time, water insoluble portion, antioxidant activity, vitamin C levels in the instant powder drink produced, but did not significantly influence the ash content analysis.

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CORN SILK TEA EXTRACT AS ANTIDIABETIC: A REVIEW

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ABSTRACT

Diabetes Mellitus type 2 usually occurs in people who are overweight and have less physical movement. Usually, that disease triggers by sedentary lifestyle. Patients with diabetes mellitus are characterized by high blood glucose levels (hyperglycemia) due to a lack of insulin secretion, insulin action, or both. Decreasing blood sugar levels can be done in several ways, namely by diet and consumption of drugs. One of the efforts to help speed up diabetes treatment is to consume corn silk tea. Corn silk is one part of corn that has not been fully utilized and contains flavonoids, which are believed to reduce blood glucose levels. Flavonoids in corn silk reduce blood glucose levels by stimulating insulin secretion by pancreatic β cells, activating insulin receptors, and repairing damaged pancreatic β cells through antioxidant activity; flavonoids also inhibit the breakdown of carbohydrates. The process of making corn silk tea can be done in several procedures. Before making, corn silk can be dried or not dried; making the extract can be boiled for a long time or only for a short time. The difference in the manufacturing process affects the tea content and its effect on blood sugar levels. Corn silk tea that has been formulated to be drunk regularly in a repetition can reduce blood sugar levels in respondents with high blood sugar levels.

Keywords: Diabetes mellitus, functional drinks, corn silk

INTRODUCTION

Most people use corn for consumption with various kinds of processing. The part of corn that is often used is the fruit, while during the processing process, there are parts of the corn that have not been used effectively, such as corn silk. Corn silk is considered more as a food industry waste as a result of cleaning corn during processing. However, based on previous research, corn silk has chemical properties that are beneficial to the body's health.

One of the chemical composition in corn silk that can be used to lower blood sugar levels is flavonoids. Flavonoids are a class of compounds that can treat Diabetes Mellitus type 2. Diabetes Mellitus type 2 usually occurs in people who are overweight and have less physical movement. Usually, that diseases triggers by sedentary lifestyle. Patients with diabetes mellitus are characterized by high blood glucose levels (hyperglycemia) due to lack of insulin secretion, insulin action, or both (Sudoyo, 2009).

The efficacy of flavonoids has been widely researched and scientifically proven to reduce blood glucose levels significantly. Therefore, corn silk is processed into the main ingredient in making functional drinks that can help lower blood sugar levels and help accelerate the healing of diabetes mellitus.

CORN SILK

Corn silk is defined as the female flower of corn arranged in a cob inside the axillary of the leaf. Each corncob has a stalk with short segments with leaves which are the bandages and the cobs. The pistil is arranged in several rows on the cob (Haryadi, 2011). Meanwhile, the definition of corn silk from other sources, namely the pistil and stalk of the fruit of *Zea mays* L., is in the form of slender, limp, slightly shiny threads, with a length of 10-25 cm and a diameter of approximately 0.4 mm. Corn silk (silk) as a result of elongation of the ducts from

the mature ovary on the cob. Corn silk grows to a length of 30.5 cm or more so that it extends from the end of the cob. Silk length of maize on corn cobs and corn husks (Subekti *et al*., 2008).

Based on research, corn silk contains protein, vitamins, carbohydrates, calcium salts, potassium, magnesium, and sodium, essential oils, steroids such as sitosterol and stigmasterol, and antioxidant compounds such as alkaloids, saponins, tannins, and flavonoids (Nuridayanti, 2011). It was further explained that one of the antioxidant compounds is a flavonoid compound. The flavonoid compounds that can be isolated from corn silk extract are the maysin, c glycosylflavones. In addition, it also contains volatiles, terpenoids, cinnamic derivatives, glucose, rhamnose, sodium, potassium, zinc, iron and chloride (Hasanudin *et al*., 2012).

Besides containing antioxidant compounds, corn silk has properties as traditional medicine. The benefits contained in corn silk can be obtained through processing from corn silk, one of which is herbal drinks. Herbal drinks consist of herbal plants that are consumed in the form of drinks, namely infusions of plant parts that are boiled or brewed with boiling water. Herbal drinks are famous for their aroma, antioxidant properties, and their application in the health sector (Ismiati, 2015).

THE PROCESS OF MAKING CORN SILK TEA

Based on literature review there are various ways to make corn silk tea and corn silk extract. The manufacturing process is not always the same. There are some differences in both the procedure, the materials and tools used. The manufacturing procedure is often different, such as the drying process, including the temperature and time. There are boiling, including boiling time and medium temperature, the brewing process, and others. Besides, there are also differences in the raw materials used, such as corn silk from different corn varieties. Most previous studies used corn silk from the maize variety, which is characteristic of the area around the study site. These differences positively affect the results of research both in terms of content, quality, and benefits of corn silk tea and the effects obtained after the consumption.

Based on the results of research by Akbar *et al*. (2019), the process of making corn silk extract begins by sorting the corn to remove the damaged parts and dirt. The sorted corn silks are washed with running water, which functions to remove other impurities that are stuck and not visible, then the corn silk is drained. The washed corn silk is then reduced in water content by drying it so that microbes cannot grow in it. The obtained corn silk is dried in the sun for 2-3 days 5 long. Corn silk that has been dried then made into powder using a blender. This is done to uniform the sample size and reduce the sample's surface area, which can cause the breakdown of the cell wall by the solvent faster and simultaneously, thus optimizing the extraction process. The fine corn silk powder is then extracted by boiling it with water for 5 minutes with 10 ml of water to add 1 gram of corn silk. The stew of corn silk is then filtered using a filter cloth to separate the residue.

Whereas in the research of Hidayah *et al*. (2019), there are differences in the manufacturing process. Making tea involves the preparation of raw materials, which includes purchasing corn silk from the farmer and drying. Corn silk weighing 150g is dried at 50oC, then boiled in 300 ml of boiling water for 5 minutes, then filtered without adding sugar. In this study, dry corn silk was not mashed first but instead went straight to the boiling stage. The formulation used is 1:2 corn silk water ratio.

In Garnida *et al*. (2018) research, making tea begins with preparing eight weeks old sweet corn silk. Raw material sorting is the initial step that needs to be done to get quality corn silk. The sorted material is stored in a basin and washed in running water to clean up other scraps or dirt. Then it is drained, which is intended to reduce the water content in the corn silk that has been washed. The corn silk that has been drained is then divided into the first tray for a drying temperature of 60oC, with a drying time of 5 hours. The drying temperature affects the vitamin C level and the color of the corn silk herbal tea brew. The 60oC drying temperature gives an ash content of 4.31%, vitamin C content of 1.40%, flavonoid content of 0.04% (w / w).

Meanwhile, based on Kusumastuti (2017) research, making corn silk tea with the

Zea mays L species begins with the drying process. Before boiling, the collected corn silks are dried, then as much as 5g of dry corn silk is boiled in 100 ml of water, which has a temperature of 70 oC. After that, brew it for 5 minutes and filter it to be given to older adults with diabetes mellitus.

CHEMICAL CONTENT OF CORN SILK

Corn silk contains chemical compounds that are useful for health. One of the substances in corn is beta-sitosterol, which is useful for reducing blood cholesterol levels (Harun *et al*., 2011). Corn silk (*Zea mays* L.) also contains flavonoid compounds that function to stimulate insulin activation, thereby lowering blood sugar levels. Flavonoids as exogenous antioxidants for the body can stimulate the repair of damaged cells in the body by stabilizing free radicals and complementing the lack of electrons in free radicals that can cause oxidative stress. Reducing oxidative stress can reduce insulin resistance to sugar, thereby preventing pancreatic β cell dysfunction (Koloay *et al*., 2015).

Flavonoids are polyphenolic compounds, which are slightly acidic and can dissolve in bases. Because they have polyhydroxy compounds (hydroxyl groups), making it polar to dissolve in polar solvents such as methanol, ethanol, acetone, water, butanol, dimethyl sulfoxide, dimethyl formamide. The presence of a glycoside group attached to a flavonoid group tends to cause flavonoids to dissolve easily in water. Flavonoids are red, purple, blue, and yellow substances found in plants (Ritonga *et al*., 2013).

BENEFITS OF CORN SILK TEA AS AN ANTIDIABETES

The role of flavonoids is significant in fighting diabetes mellitus than other treatment methods (Mohan and Nandhakumar, 2014). Flavonoids can regenerate pancreatic beta cells and help stimulate insulin secretion (Dheer and Bhatnagar, 2010).

Flavonoids reduce blood glucose levels by stimulating insulin secretion by pancreatic β cells, activating insulin receptors, and repairing damaged pancreatic β cells through antioxidant activity. Flavonoids can also inhibit the breakdown of carbohydrates into glucose and inhibit glucose absorption in the small intestine (Hanhineva *et al*., 2010).

Flavonoids affect carbohydrate metabolism in several ways. First, flavonoids interfere the amylase enzyme's function, an enzyme in saliva that starts the process of digestion of carbohydrates, because it causing in impairing of carbohydrate break down. Second, flavonoids inhibit the action of the enzymes sucrose and glucosidase, which are essential for the digestion of carbohydrates in the small intestine. The result is a reduction in carbohydrate absorption and a lower blood glucose level. This is why corn silk is useful in breaking down gallstones, by reducing carbohydrate levels in the body. Since carbohydrates are the primary source of body fat, flavonoids reduce the amount of cholesterol that enters the gall bladder, absorb excess fat in gallstones and reduce the possibility of new stones forming and prevent the buildup of cholesterol against other stones that have formed (Indriani *et al*. 2010).

Flavonoids work by stimulating glucose uptake in peripheral tissues, regulating the activity and expression of enzymes involved in carbohydrate metabolic pathways, and acting like insulin by affecting insulin signaling so that it has an impact on reducing fasting blood sugar (Cazarolli *et al*., 2008). Flavonoids also modulate lipid metabolism, thereby reducing the complications of DM due to abnormalities in lipid profiles and insulin resistance (Zhao *et al*., 2007).

Flavonoids are protective against damage to β cells as insulin producers and can increase insulin sensitivity. Antioxidants can suppress beta-cell apoptosis without altering the proliferation of pancreatic beta cells. The action mechanism inhibits GLUT2, inhibiting the enzyme phosphodiesterase, and reducing oxidative stress in people with Diabetes Mellitus. Another mechanism is the ability of flavonoids, especially quercetin, to inhibit GLUT 2 (the major transporter of glucose in the intestine under normal conditions) in the intestinal mucosa to reduce glucose absorption. This results in a reduction in the absorption of glucose and fructose from the intestine, so further lowering the blood glucose levels (Ajie, 2015).

Another research study was conducted on the effectiveness of corn silk extract on reducing blood sugar levels of male white rats

Wistar strain induced by alloxan. The result was that corn silk extract had the effect of reducing blood sugar levels and the most effective dose was 2.52 g / KgBW (Koloay *et al*., 2015). Several previous studies have shown that corn silk has the potential to reduce blood glucose levels in Wistar rats, but these studies have not been able to prove the effectiveness of corn silk extract in reducing fasting blood glucose in humans with type 2 diabetes mellitus (diabetes mellitus).

Based on the results research by Akbar *et al*. (2019) the best formula is tea with 40% corn silk content, because it gives the best consumer response. The water, ash, protein, fat, and carbohydrate content in this formula were 99.6%, 0.20%, 0.14%, 0%, and 0.06%, respectively. Corn silk tea also contains 0.03% flavonoid compounds. The chemical content of corn silk tea is considered to have the potential to be used as an alternative for functional drinks.

In Hidayah *et al*. (2019), it was found that 150 g of corn silk tea dried at 50 oC and boiled with 300 ml of water for 5 minutes and drunk regularly for 14 consecutive days can reduce sugar levels blood in respondents as much as 58 g / dl. This study's results can prove the theory of functional food in reducing fasting blood sugar levels in type 2 diabetes mellitus patient. Corn silk tea can be used as a supporting therapy in reducing fasting blood sugar levels in type 2 diabetes mellitus patient.

Meanwhile, based on the research of Kusumastuti (2017), it was found that the average intake of 100 ml of corn silk tea with 5 grams of dry corn silk consumed by a sample of people with diabetes for seven days showed a significant effect on blood sugar levels. All samples are 34 people consist of 26 womens and 8 mens. Samples classified into 3 age group, 51-55 years n=9, 56-60 years n=11 and 61-65 years n=14. Drink corn silk tea regularly affects reducing blood sugar levels. This is because the more flavonoids that are consumed, the more optimal it will work in reducing blood sugar levels.

The average value of blood sugar levels before and after treatment is shown in the table below:

Table 1. Blood sugar levels before and after administration of corn silk tea

	x **± SD (mg/dl)**	**Difference (mg/dl)**
Before	228,99 ± 14,88	
		21,15 ± 1,63
After	207,84 ± 16,51	

Source : Kusumastuti (2017)

The results in table 1 shows that the average blood sugar level before treatment was 228.99 ± 14.88 mg/dl and after treatment, the average blood sugar level was 207.84 ± 16.51 mg/dl, the difference in blood sugar levels was 21.15 ± 1.63 mg/dl. This result was due to the effectiveness of the corn silks processing, specifically dried corn silk. According to Wulandari (2009), dry corn silk has an optimal antioxidant activity compared to wet corn silk. In addition, the flavonoid content will also increase at a brewing temperature of 60-80^{o}C.

CONCLUSION

Corn silk is defined as the female flower of corn arranged in a cob inside the axillary of the leaf. Corn silk (*Zea mays* L.) contains flavonoid compounds that function to stimulate insulin activation, thereby lowering blood sugar levels. Corn silk can be processed into functional drinks by several processes. The differences in manufacturing process include procedure, materials, and tools affects the tea content and its effect on blood sugar levels. Corn silk dried before being boiled has a high flavonoid content compared to wet corn silk. Corn silk tea that has been formulated to be drunk regularly can reduce blood sugar levels in respondents with high blood sugar levels.

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THE EFFECT OF FREEZING ON THE PROCESSING OF DRIED REBON SHRIMP AS A FORM OF LOCAL FOOD DIVERSIFICATION

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ABSTRACT

Rebon shrimp is one of the seafood species of crustaceans which has a very small size compared to other types of crustaceans. But behind its small shape, rebon shrimp has tremendous benefits. Rebon shrimp is quite easy to find in the market and is in the cheap category compared to other shrimp prices. Rebon shrimp is a food ingredient that rots easily so that processing and preservation is needed to maintain its quality. One of them is freezing and drying. This method can extend shelf life and inhibit the growth of bacteria, molds and yeasts. It can increase the selling value of rebon shrimp. This is also done as an effort to support local Indonesian food. The purpose of this study was to obtain the best process in making dried rebon shrimp. In this study, two methods were carried out, namely: method A without freezing and method B with freezing. This research was conducted using a randomized block design with one factor of rebon shrimp with 2 treatments and 3 replications. The parameters tested were water content, rehydration time and organoleptic test. The results of analysis of various water content and rehydration time showed a very significant difference. From the research results, the highest water content was found in rebon shrimp with freezing is 5.4% and the lowest in rebon shrimp without freezing is 4.8%. The longest rehydration time for rebon shrimp with freezing is 2 minutes and the fastest rehydration time for rebon shrimp without freezing is 1 minute. The sensory test showed different results. For color and texture, the most preferred is dried rebon shrimp with freezing, while for aroma and appearance, the most preferred is dried shrimp with no freezing treatment.

Keywords: Rebon Shrimp, Drying, Freezing,

INTRODUCTION

Rebon shrimp is one of the seafood species of crustaceans which has a very small size compared to other types of crustaceans. Therefore, this shrimp is called "rebon" shrimp. In society, they are often categorized as marginalized shrimp. But behind its small shape, rebun shrimp has tremendous benefits.

Rebon shrimp is an excellent source of animal protein. 100 grams of fresh rebon shrimp contain as much as 59.4% protein (Poedjiadi, 2005). Meanwhile, for rebon shrimp iron contains 21.4 grams or equivalent to 8 times the iron content of 100 grams of beef (Mahmud et al. 2009). Rebon shrimp is very effective in improving nutrition for malnourished children. Another advantage of rebon shrimp is its high calcium. 100 grams of fresh rebon shrimp contains 757 mg of calcium. Thus, consuming rebon shrimp is very good for the

body. Besides that, rebon shrimp also has a high enough phosphorus content.

Apart from being a rich source of protein, calcium and iron nutrients, it turns out that there is a unique benefit from rebon shrimp that can be difficult to obtain from other types of crustaceans, namely different skin. Unlike other types of crustaceans, which are usually only eaten with the flesh without the skin, all the rebon shrimp can be eaten. This is mainly due to their very small size so that it is not possible to remove the skin or head like when eating other crustaceans. As a result, this is precisely what has become one of the advantages of rebon shrimp compared to other crustaceans and other protein sources (Astawan, 2009). Apart from being rich in calcium, shrimp shells actually contain a unique substance found in insect and crab shells, namely chitosan (Nasir, 2005).

Rebon shrimp is quite easy to find in the market and is in the cheap category compared to other shrimp prices. Besides that, rebon shrimp after harvesting will experience changes that take place gradually leading to decay that occurs due to autolysis, enzymatic and microbiological activities that cause deterioration of quality (Syahrin et al. 2016). Therefore processing and preservation is needed to maintain its quality. One of them is freezing and drying. This method can extend shelf life and inhibit the growth of bacteria, molds and yeasts. In addition to extending the drying shelf life of rebon shrimp, it can increase the selling value of rebon shrimp. This is also done as an effort to support local Indonesian food (Fatty, 2012).

The development of local food diversification is very supportive of food security, especially in relation to food diversity, overcoming nutritional problems and strengthening the community's economy. If the downstream side (processing and marketing) is productive, it will also boost productivity in the upstream sector, so that food security as reflected in the fulfillment of food for households, availability of sufficient food, both quantity and quality, safe, equitable and affordable can be realized (Marsigit, 2010). With the diversification of fishery products, it is hoped that it can become an attraction for people to consume fish and other fishery products and it is hoped that new products that are healthy, nutritious and quality at affordable prices can be created so that people's interest in consuming fishery products increases (Putra, 2015).

MATERIALS AND METHODS

Tools and Materials

The tools used in this study were a basin, knife, cutting board, steamer pan, porcelain dish, digital scale, freezer, oven, water bath, desiccator. The materials used in this study were rebon shrimp purchased from market, lime, water, aluminum foil, label paper, tissue roll.

Method

This research was conducted using a randomized block design with one factor of rebon shrimp with 2 treatments and 3 replications. The treatments that are applied are as follows:

A1: No Freezing

A2: By Freezing

The parameters tested were the water content test, rehydration time and organoleptic test.

$$Y_{ij} = \mu + \tau_i + \beta_j + \varepsilon_{ij}$$

Y_{ij} = Observation on treatment -*i* and group *j*

μ = General average

τ_i = Effect of treatment-i

β_j = Effect of group j

ε_{ij} = random effect on treatment -*i* and group -*j*

Data were analyzed for variances (ANOVA), and if the results shows that there is a significant difference, followed by the Least Significant Difference (LSD) test on the interval 95% confidence in the Minitab® 17.1.0 application.

Method A1 (processing of dried rebon shrimps without freezing treatment)

Rebon shrimp washed and then added with lime. Dried salting process with the addition of 20% salt for 12 hours. The boiled shrimp that has been salted is then boiled and then dried in an oven at 60 °C 6 - 8 hours

Method A2 (processing of dried rebon shrimps with freezing treatment)

Rebon shrimp is washed and then added with lime. Dried salting process with the addition of 20% salt for 12 hours. The salted rebon shrimp are then boiled and then frozen at -17 °C for 24 hours. The frozen rebon shrimp are then oven-dried at 60 ° C for 6 - 8 hours.

Water Content (AOAC, 2005)

The procedure for testing the moisture content is to put the empty cup in the oven for at least 2 hours, then put the empty cup in the desiccator for 30 minutes until it reaches room temperature and weigh the empty weight (A). Then put ± 2 g of mashed sample into a cup (B) and weigh it again, then put the plate that has been filled with the sample in the oven for 12 hours at a temperature of 100 ° C to 105 ° C. After that, the plates were transferred using a clamp to a desiccator ± 30 minutes then weighed (C).

$$\% \text{ water content: } \frac{(B-C)}{(B-A)} \text{ x } 100\%$$

Information:

A: the weight of the empty cup, expressed in g

B: weight of empty cup + initial sample, expressed in g

C: weight of empty cup + dry sample in g

Rehydration Time (Yoanasari, 2003)

A total of 49 grams of sample added warm water (60 °C) little by little while stirring until the dried rebon shrimp became mushy, then recorded the time

Organoleptic Test (Setyaningsih et al. 2010)

Organoleptic testing is a subjective test of several panelists to determine whether or not a product is feasible for public consumption. The test is carried out by a semi-trained panel of 20 people by comparing the existing product with the specifications on the scoresheet, then evaluating it. The sensory test includes color, aroma, appearance and texture with a value interval of 1 to 5. Value 1 indicates very much dislike, value 2 indicates dislike, value 3 states quite like, value 4 states like, value 5 states very like.

RESULTS AND DISCUSSION

Water Content

The results of analysis of various water content showed a very significant difference (Table 1). During the freezing process, heat transfer occurs from the high temperature fish body to the low temperature refrigerant. Therefore, the water content in the fish's body will turn into ice crystals.

Table 1. Results of average water content

Treatment	Result
A1	4.8 % ± 0,887 [a]
A2	5.4% ± 0,887 [b]

Information:

* Value is the average of 3 replications ± standard deviation

* Notation with different lowercase letters indicates significantly different (P <0.05)

In this study, the highest water content was found in rebon shrimp with freezing is 5.4% and the lowest in rebon shrimp without freezing is 4.8%. This can occur due to the appearance of gaps in the specimens as water

outlet so that the drying process becomes faster. According to Sasongko (2015), the drying process can affect the weight of the final product produced. The drier the product, the lower the water content in the product so that the weight is also lower.

Rehydration Time

Rehydration time analysis results showed a very significant difference (Table 2). The longest rehydration time for rebon shrimp with freezing is 2 minutes and the fastest rehydration time for rebon shrimp without freezing is 1 minute.

Table 2. Results of average rehydration time

Treatment	Result
A1	1 menit ± 0 [a]
A2	2 menit ± 0 [b]

Information:
* Value is the average of 3 replications ± standard deviation
* Notation with different lowercase letters indicates significantly different (P <0.05)

The freezing treatment before drying causes the formation of ice crystals which increase the structure and size of the cells. treatments that affect the elasticity of the cell wall will affect the volume and time of rehydration. the greater the cell structure causes the longer rehydration time needed. The product produced after drying will experience changes on its surface, namely open porous allowing the rehydration process to be very fast (Izza, 2005)

Organoleptic Test

Color

Organoleptic test results can be seen in the Figure 1. The highest level of panelist preference for rebon shrimp with freezing is 3.06, while the lowest level of preference for panelists was for rebon shrimp without freezing is 2.81. The freezing method protects the surface from heat due to drying. This is because of the ice crystals that cover the surface of the shrimp. The red color is formed due to the carotenoid content in the shrimp. The Carotenoid that plays the most role in shrimp red color is astaxanthin.

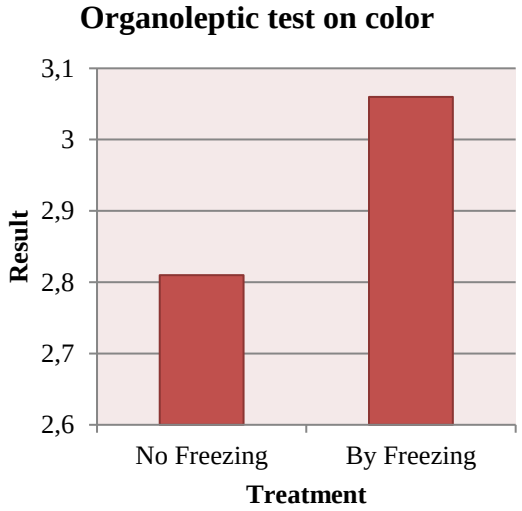

Figure 1. Organoleptic test results on color of dried rebon shrimp

Aroma

Organoleptic test results can be seen Figure 2. The highest level of preference for the panelists was for rebon shrimp without freezing is 3 while the level of preference for the panelists with the lowest value for rebon shrimp with freezing is 3.08.

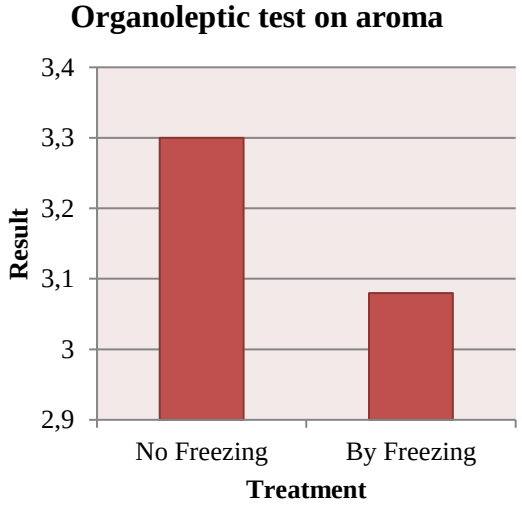

Figure 2. Organoleptic test results on aroma of dried rebon shrimp

The value from organoleptic test because the freezing method can maintain product stability, including changes in aroma. The aroma of rebon shrimp has a distinctive aroma, this is because rebon shrimp contains amino acids that play a role in aroma, namely phenylalanine, tyrosine and tryptophan (Syarif et al. 2017). The aroma contained in food will provide a sensation of volatile compounds received by the nasal cavity (Rachmawati et al. 2016).

Texture

Organoleptic test of texture results can be seen in the Figure 3. The panelist's preference level with the highest value for rebon shrimp with freezing is 3.1, while the panelist's preference level with the lowest value for rebon shrimp without freezing is 3.07.

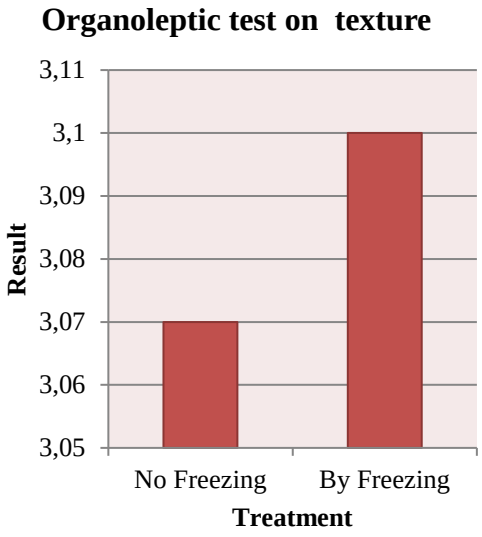

Figure 3. Organoleptic test results on texture of dried rebon shrimp

This is because the freezing method can maintain the structural stability of the material so that shrinkage and deformation after drying is very small. Food texture is one of the organoleptic attributes that affect panelist acceptance of food, texture also affects the appearance of food (Sari et al. 2015).

Appearance

Organoleptic test results on appearance can be seen in the Figure 4. The highest preference level of panelists for rebon shrimp without freezing was 3.1, while the lowest preference level for rebon shrimp with freezing was 2.83.

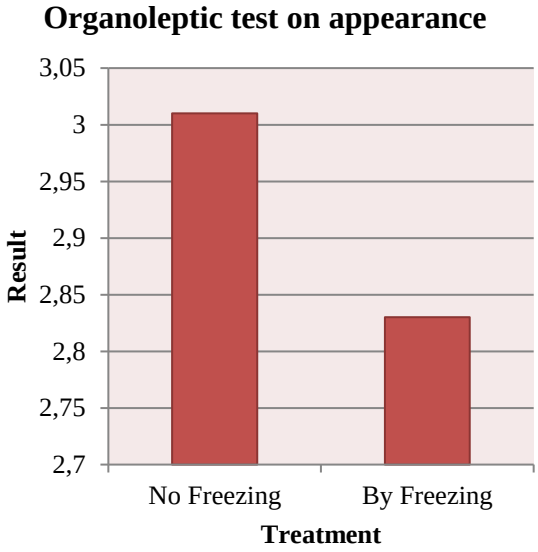

Figure 4. Organoleptic test results on appearance of dried rebon shrimp

The freezing method caused irregular gaps and swelling in rebon shrimp. This happens because of the enlargement of the volume due to the emergence of ice crystals. Besides that, drying causes a less attractive appearance due to the browning reaction. According to Badaruddin (2009), in the heating process there is also a browning reaction which can cause unwanted color or brown due to prolonged heating or the use of too high a temperature.

CONCLUSION

From the research results, it can be concluded that the best water content and rehydration time were dried rebon shrimp

with no freezing treatment. The organoleptic test showed different results. For color and texture, the most preferred is dried rebon shrimp with freezing, while for aroma and appearance the most preferred is dried rebon shrimp with no freezing treatment.

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QUALITY ASSURANCE OF TILAPIA FISH (*Oreochromis niloticus*) FRESHNESS WITH TREATMENT OF WEEDING

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ABSTRACT

Fresh fish is a fish that has the same properties as live fish, both in appearance, smell, taste and texture. This research aimed to determine the quality of a fishery product. This research aimed to determine the freshness test of tilapia in a sensory way and see the different characteristics of different fish conditions. Method research measured yield, morphometric, and organoleptic. The treatment used was low temperature. Low temperature storage (0-5 ^{o}C) in tilapia (*Oreochromis niloticus*) by treatment without weeding can reduce the rate of deterioration in post-death tilapia quality even though the results are not significant with the average organoleptic value of tilapia freshness which is 7-9 in the range of days 0-2.

Keywords: *Fish Freshness, morphometric, organoleptic, yield*

INTRODUCTION

Fresh fish is a fish that has the same properties as live fish, both in appearance, smell, taste and texture. Fresh fish according to SNI 01-2729, 1-2006 are fishery products with fish raw materials which are treated as follows: reception, washing, weeding or without weeding, weighing, cooling and packing (BSN, 2006). Freshness of fish can be classified into 4 categories according to Hadiwiyoto (1993), namely fish that still have excellent freshness (observation score 9), Fish with good freshness (observation score 7-8), Fish with moderate freshness (observation score 5-6) and fish that are no longer fresh (observation score 1-4).

Tilapia (*Oreochromis niloticus*) is a fish that is beneficial because it has advantages such as being resistant to environmental conditions, omnivorous, able to digest food efficiently, has a rapid growth rate compared to other species and has a high nutrient content (Suyanto, 2002). The species *O. niloticus* is an euryhaline species characterized by rapid growth and resistance to pathogens also resistant to low temperatures (Welcomme, 1988; Trewavas, 1983). This research aime to determine the freshness test of tilapia in a sensory way and see the different characteristics of different fish conditions.

MATERIALS AND METHODS

Tools and Materials

The material used was tilapia (*O. niloticus*). The tool used was an organoleptic scoresheet based on SNI 01-2729,1-2006, a container for fish, a scalpel, tissue, cloth, stationery and refrigerator.

Method

Each sample of fish to be tested was coded to distinguish one fish sample from another. Then organoleptic testing was done

by using scoresheet for assessment standards. The research process can be seen in Figure 1.

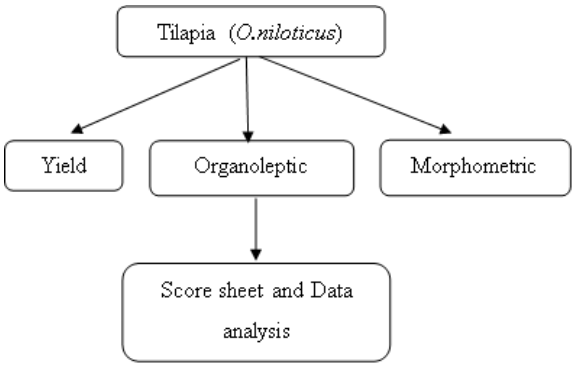

Figure 1. Research procedure

Yield

Before preparing the fish the full weight was weighed first, then the boundary between the head and the stomach was cut until it reaches the abdominal limit, then separate the skin, meat, and innards. The weight of each meat and offal is weighed first. Then calculate the yield with the following formula:

$$\text{Yield (\%)} = \frac{\text{meat weight x } 100\%}{\text{Fish Weight}}$$

RESULTS AND DISCUSSION

Morphometric

Morphometrics is one characteristic that is related to the size and length of parts of an organism. The morphometrics measured are the weight and length of tilapia. The total weight of tilapia is 203 grams, total length is 22.6 cm, and the raw length is 18 cm. This morphometrix measurement shows the condition of fresh tilapia in terms of size and weight. This is very necessary for the purposes of sorting fresh tilapia based on size and weight.

Tilapia has a flat body shape in a vertical direction (compress) and the position of the mouth is located at the tip of the nose (terminal). Characteristics of tilapia are dark vertical lines on the tail fin of six. This line is also found in the dorsal and anal fins. Generally, tilapia consumption size ranges from 200-500 grams and total length is around 30 cm. Tilapia has dorsal fins with 16-17 sharp spines and 11-15 soft fingers, and anal fins with 3 thorns and 8-11 fingers. The tail has a vertical stripe of 7-12 pieces (Suyanto, 1999).

Yield

The recovery is the percentage comparison between the weight of the part of the material that can be utilized with the total weight of the material. Yield value is an important parameter for knowing the economic value and effectiveness of a product. The tilapia yield calculated in this lab includes parts of bone, meat, skin, and innards. The yield of tilapia can be seen in Figure 2.

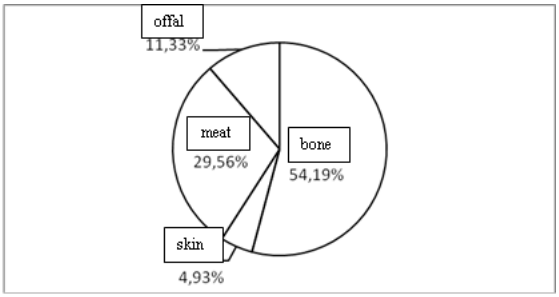

Figure 2. The yield of tilapia (*O. niloticus*)

The highest yield value was found in bone (including head parts), which was 54.19%, followed by parts of meat, innards, and skin respectively at 29.56%, 11.33% and 4.93%. Calculation of yield on fresh fish is very important. this is because it is related to the aspects of the parts that can be used. The separation of the parts of tilapia, both bones, offal and skin, shows that the part of the meat used is very small, below 30 percent. Almost all of the tilapia fish proportion is dominated by bones Bone which is the largest part of

tilapia can be used as an ingredient in making fish bone flour. Tilapia meat has also been used in the form of fillets to become an export commodity (Gustiano and Arifin, 2010).

Freshness Observation

Eye

The eye is one part of the body of the fish which is used as a parameter for the level of fish's fitness. Based on the results of organoleptic assessment on the eyes of tilapia (*O.niloticus*) can be presented in Figure 3.

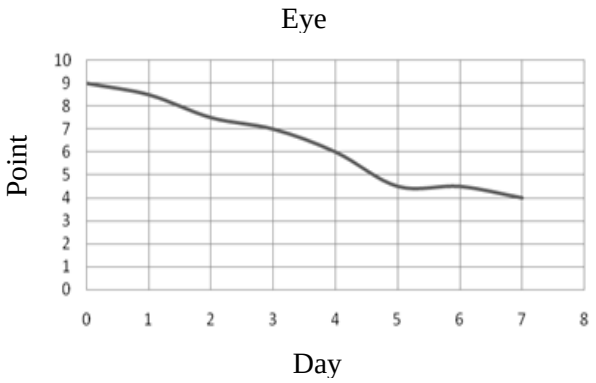

Figure 3. Organoleptic results of tilapia eye (*O. niloticus*)

Based on these data, it can be seen that the average organoleptic value at 0 days is 9, day 1 is 8.5, day 2 is 7.5 and day 3 is 7 at chilling (-1 to 5ºC). This shows that the length of storage for 0 days to 3 days of fish is still in the fresh category, because based on the organoleptic assessment of the eyeball which still stands bright, pupul is somewhat grayish and the cornea looks clear indicating that the freshness of the fish is still quite high. Whereas for 4 - 7 days of storage from existing data that the fish has undergone a process of decay, organoleptic results show a rather concave eye, pupil color becomes cloudy, and the cornea becomes cloudy. This shows that the storage time has undergone a process of quality deterioration.

Irawan (1995) explained that freshness would be achieved if the handling of fish went well. Fresh fish means that it has not experienced biochemical, microbiological, or physical changes that can cause severe damage to fish meat (Hidayat 2016). To maintain the quality of fresh fish, raw materials must be processed as soon as possible. If forced to wait for further processing, the fish must be stored with ice or cold water (0ºC to 5ºC), sanitary and hygienic (SNI 01-2729.1-2006).

Gill

Gills are one of the places where bacteria live which can cause damage to fish meat (Munandar *et al*, 2009). Gills can be used as a parameter to determine the freshness of the fish. Fresh fish have brilliant red gills without mucus while rotten fish have brown gills with thick mucus (Irawan 1995). Changes in the organoleptic mean value of tilapia gills during storage of chilling temperatures can be seen in Figure 4.

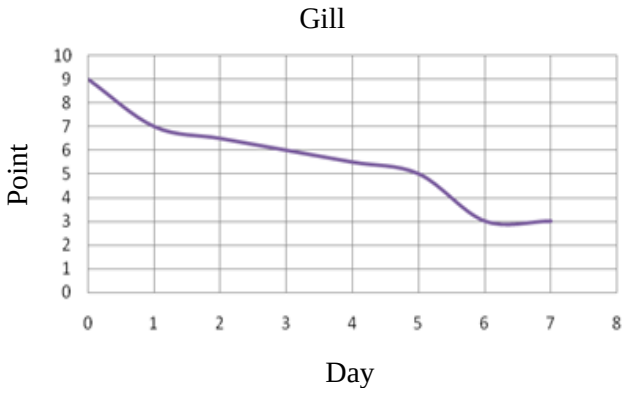

Figure 4. Organoleptic results on tilapia gill (*O. niloticus*)

Based on the picture above, the deterioration of the quality of fish when viewed from the gills shows that there is a significant change in the observation of the second day with a value of 6.5 and observation of the 6th day with a value of 3. This occurs because the fish orlep test is not directly inserted into the cooler after being turned off so that there is an increase in microbial activity and if it lasts long the quality deterioration will occur quickly.

Body Surface Mucus

Mucus has a protective ability for animals, among others, coating the surface of the body so as to facilitate movement when swimming, forming a protective layer of infection with pathogenic agents, containing antimicrobial compounds and playing a role in the osmoregulation process (Irianto, 2005). The organoleptic value of the body mucus surface of tilapia (*O. niloticus*) decreases along with the length of storage time. At the 0th to 2nd day storage the average organoleptic value of body mucus surface ranged from 7-9. At storage of the 3rd to 7th day the average organoleptic value ranges from 5-6. Based on SNI 01-2346-2006, fresh fish has an organoleptic value of 7-9. Fresh fish has clear, transparent and shiny bright mucus, while rotten fish have thick mucus that clumps and has a yellow-brownish color (BSN, 2006). The organoleptic value of the mucous surface of tilapia (*Oreochromis niloticus*) on the storage of chilling temperature is presented in Figure 5.

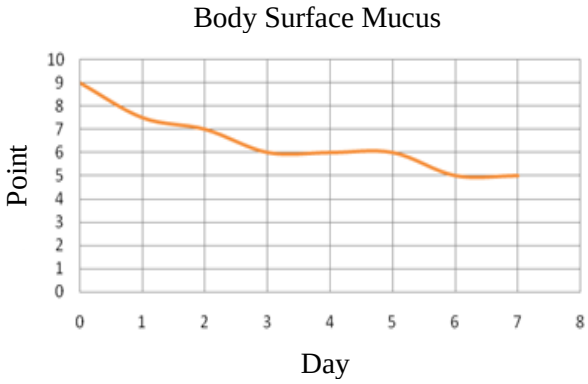

Figure 4. Organoleptic results on body surface mucus of tilapia

Odor

Organoleptic testing is a subjective test with the help of the five human senses as a benchmark for the acceptance of a material. The organoleptic testing of tilapia includes appearance (eyes, gills, body mucus, flesh, odor, and texture with organoleptic observational limits of 1-9. Observations were made based on the quality deterioration phase namely phase rigormortis, initial post rigor and final post rigor. Odor is an easy-to-use parameter determining fish freshness. Fresh fish has a fresh, specific type of smell. Rotten fish smells of ammonia, acid and rotten (BSN, 2006). The results of the organoleptic test for the smell of tilapia can be seen in Figure 6. The organoleptic odor of tilapia ranged from 1 to 9, the value of 9 showed that the odor parameters were very fresh, the specific odor of fish and the value of 1 showed clear foul odor parameters according to SNI 01-2729-1-2006. The results of observations of the organoleptic average value of the smell of tilapia can be seen in Table 1.

Table.1 The average organoleptic value of the smell of tilapia

Days	Odor
0	8,5
1	7,5
2	5
3	5
4	5
5	4
6	3
7	3

From the table above it can be seen the highest value of the organoleptic odor of tilapia on day 0 is 8.5 and the lowest value on the organoleptic odor of tilapia on the 7th day is 3. Based on the results of the organoleptic test of the smell of tilapia with treatment without weeding on day 0 to day 7 has an organoleptic mean value ranging from 8.5 - 3. On day 0 the organoleptic value of smelly tilapia is 8.5 (very fresh, specific smell) type), day 1 the organoleptic value of odor of tilapia is 7.5 (fresh, specific type), day 2 to day 4 the average organoleptic value of tilapia is 5 (the smell of ammonia starts to smell, a little sour smell), the fifth day the organoleptic value of the smell of tilapia was

4, the 6th to 7th day the organoleptic value of the smell of tilapia was 3 (strong ammonia odor, H_2S smell, clear smell and rotten acid).

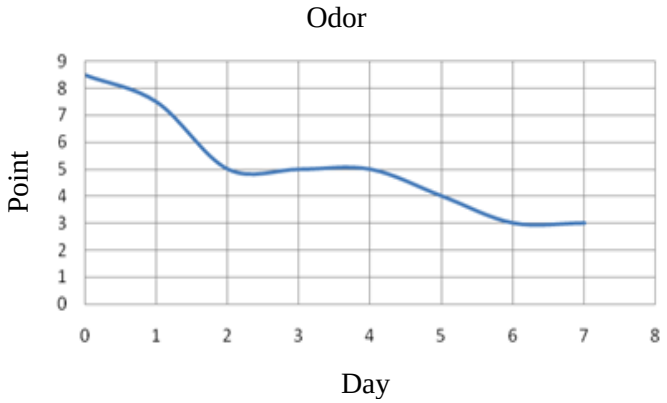

Figure 6. Organoleptic results on odor of tilapia fish (*O. niloticus*)

The difference in the average value of the organoleptic results of the odor of tilapia by treatment without weeding was seen on day 0 to day 1, the smell of fish with treatment without weeding had an organoleptic average value ranging from 8.5 to 7.5, according SNI 01-2729-1-2006 the condition of the fish is still in a fresh state while the average value of the odor of organoleptic test for tilapia by treatment without weeding on days 2 to 7, the smell of fish with no weed treatment has an average value Organoleptic average ranges from 3-5, according to SNI 01-2729-1-2006 the condition of fish not classified as fresh anymore is characterized by the smell of ammonia, sour smell, H2S odor, foul odor. The average organoleptic value of the smell of tilapia (*Oreochromis niloticus*) can be seen in Figure 6.

Texture

Another important parameter in determining the level of freshness of fish is the texture of fish because the change in texture is very clearly seen when there are changes in the stages of decline in the quality of fish. Fresh fish has a dense and elastic meat texture. Very soft texture of fish meat will be found in rotten fish (BSN 2006). The organoleptic test results for the texture of tilapia can be seen in Figure 7.

Through the organoleptic texture test we did, it can be concluded that at the beginning of storage the fish texture is worth 9 meaning the texture of the fish is still dense, elastic when pressed with a finger, and difficult to tear the meat from the spine, while on the first to the third day of meat the fish has begun to deteriorate, which is a rather dense texture, still elastic when pressed with a finger and still difficult to tear the meat from the spine and on the 4th and 5th day the flesh starts to soften, less elastic when pressed with a finger and easy to tear meat from the backbone.

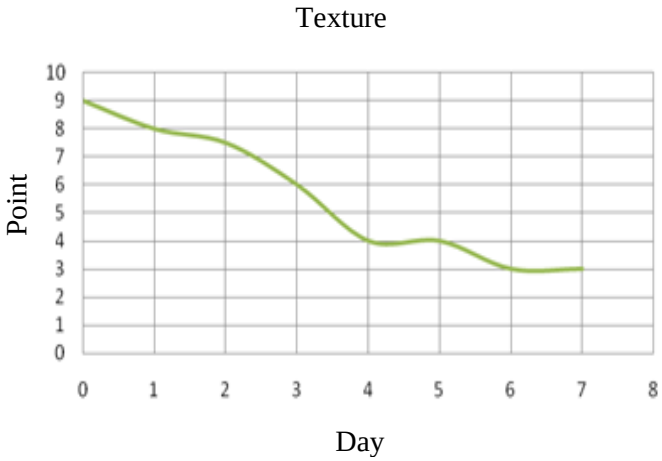

Figure 7. Organoleptic results on texture of tilapia fish (*O. niloticus*)

On the 6th and 7th day which is the last day of observation of the organoleptic test of tilapia, the results show that the texture of the meat is soft, the finger marks are seen when pressed, and it is easy to tear the meat from the spine so that it can be assumed that to the organoleptic value of fish texture.

Meat

The main parameter to determine the freshness of the fish is meat and contents stomach. Fresh fish meat, the incision is still brilliant, while the rotten fish is dull.

Enzymatic reactions such as kaptesin in meat play a role in the acceleration of the decay process (Bramstedt and Aurbach, 1961). Besides being caused by enzymatic reactions, microbial activity in the digestive tract is also able to decompose proteins that play an important role in the process of decreasing the quality of tilapia (Moeljanto, 1992). Figure 8 showed the average organoleptic value of tilapia meat.

Figure 8. Organoleptic results of tilapia (*O. niloticus*) meat

From the picture above it can be seen that on day 0-2 the meat is still said to be fresh because it has an organoleptic value above 7. On day 3-5, tilapia has begun to experience a phase of deterioration in quality with a range of organoleptic values characterized by changes in the meat incision. begin to soften, milking along the spine and soft abdominal wall. On the 5-7th day the fish is said to be no longer fresh with organoleptic values below 4. This result is also in accordance with the study of Munandar *et al.* (2009) indicating that tilapia without weeding begins to enter a period of not fresh after day 4. Change phase Tilapia meat occurs immediately after the fish die with different levels of change in various phases from pre rigor mortis - post rigor (Junianto, 2003).

CONCLUSION

The process of quality deterioration of tilapia at the storage of chilling temperature (0-5^{o}C) with treatment without weeding gives the results of the phase of deterioration of quality which lasts more quickly. This phase of quality deterioration is faster due to the process of microbial and enzymatic activity which increases with increasing days which causes a process of quality deterioration which increases with the characteristics of physical, chemical and organoleptic changes of tilapia.

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CAROTENOIDS AS NATURAL COLORANT : A REVIEW

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ABSTRACT

Color is quality attribute that is usually used by consumer as first assessment to choose the food product. However, food processing is one of process which can degrade the food's color, so the colorant is usually added. On this era, consumer tend to choose food products that have functional benefit. One of natural colorant which has it is carotenoids. Carotenoids gives red, orange, and yellowish. Carotenoids are divided into two groups, carotene and xanthophyll. Carotene consists of α-carotene, β-carotene, γ-carotene, and lycopene. Meanwhile, xanthophyll consists of β-cryptoxanthin, lutein, zeaxanthin, astaxanthin, fucoxanthin, and peridinin. This pigment is lipophilic so it can dissolve in oils and organics solvents and is quite resistant to heating, however it can be very easily degraded in acidic, light, and oxygen condition. Beside act as colorant, this pigment can act as antioxidant and provitamin A. The source of carotenoids is widely spread in flowers, fruits, tubers, leaves, and fruit peels. Extraction of this pigment can be done in three ways, there are maceration extraction, supercritical fluid extraction, and enzymatic extraction.

Keywords: Antioxidant, extraction, carotenoids, food colorant

INTRODUCTION

Color is one of the most important quality attributes in food, because generally consumers get the impression that they like or dislike a food product based on its color (Andarwulan *et. al*., 2011). The process often decreases the color quality of food, therefore producers usually add synthetic colorant to improve the quality of the food (Wijaya & Mulyono, 2010).

Synthetic colorant tent to be chosen by manufacturers because of their high stability. However, the excessive use of synthetic colorant will have a harmful impact on health. With the development of the times, public awareness of health is increasing which makes the demand for natural food colorant as an alternative to synthetic colorant even higher.

One of the natural colorants commonly used in food comes from carotenoid compounds. Carotenoid compounds give food a yellow, orange to red color. Apart from being a dye, carotenoids have a role as a source of antioxidants and provitamin A which are beneficial to health (Amaya, 2016).

STRUCTURE AND STABILITY OF CAROTENOID COMPOUNDS

Carotenoids are terpenoid compounds with color effects that range from red, orange, and yellow (Amaya, 2016). Violaxanthin, a xanthophyll, is a carotenoid member found in chloroplast membranes that causes a yellowish color. β-carotene and lutein from xanthophils are carotenoids found in the thylakoids of most plants (Janik *et. al*., 2008).

Carotenoids are tetraterpenoids (C40), which are a group of widely dispersed and fat-soluble pigments found in almost all plant species, from simple bacteria to yellow-flowered compositae. In plants, carotenoids consumed carotenoids, such as α-carotene and β-cryptoxanthin, also have provitamin A activity. Carotenoids are found in fruits and vegetables about 30-100% of human vitamin A requirements (Gross, 1991).

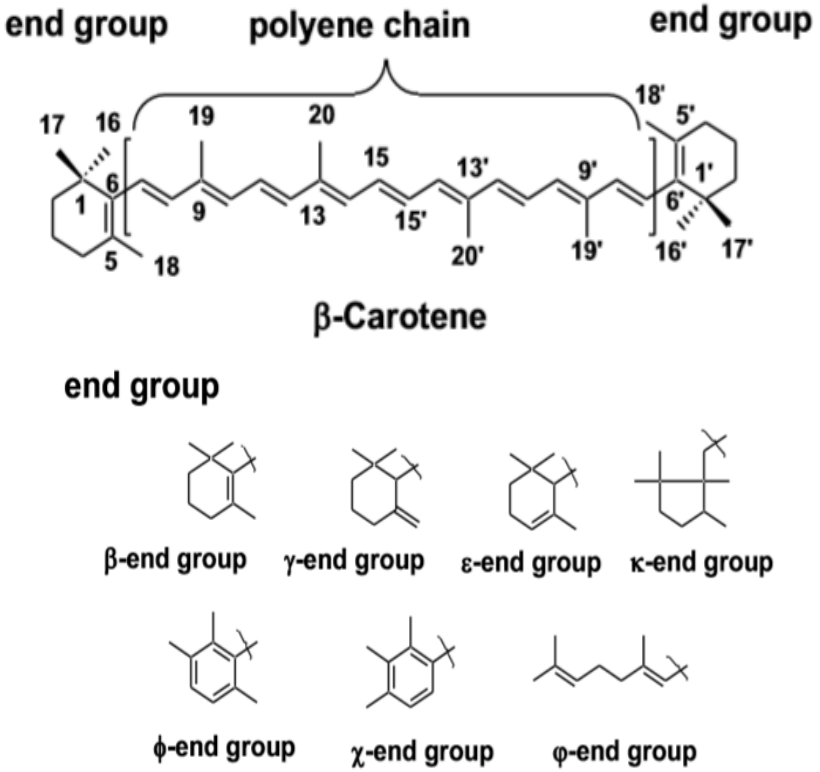

Figure 1. Basic structure of carotenoids and end groups (Britton *et. al*., 2004)

have two functions, namely as auxiliary pigments in photosynthesis and as colorant in flowers and fruits (Harborne, 1996).

Carotenoids are the most widespread pigments in nature. In higher plants, carotenoids in chloroplasts are often covered by the predominant chlorophyll pigment. In autumn when chloroplasts rot during plant aging, the yellow-orange color of carotenoids becomes clear (Fennema, 1996).

The role of carotenoid pigments is their ability as a precursor to vitamin A. Although β-carotene carotenoids have the greatest provitamin A activity due to their two β-ionone rings, other commonly

Most carotenoids consist of eight isoprene units with 40 carbon chains. The general structure of carotenoids generally consists of a polyene chain with nine conjugated double bonds and a final group at both ends of the polyene chain (Britton *et. al*., 2004). The chain structure of the polyene and the carotenoid end group is shown in Figure 1.

Carotenoids are divided into two groups, namely carotene and xanthophyll. Carotenes such as α-carotene, β-carotene, γ-carotene, and lycopene are hydrocarbons. Meanwhile, xanthophylls such as β-cryptosantin, lutein, zeasantin, astasantin, fukosantin, and peridinin, are carotenes containing oxygen atoms as hydroxy,

carbonyl, aldehyde, carboxylate, epoxide, and furanoxide groups in molecules (Maoka, 2009). The typical carotene and xanthophyll structures are shown in Figure 2.

stored in crystalline solid form and contain hydrocarbon solvents such as petroleum, hexane or benzene to minimize the risk of contamination with water before further analysis (Pinem, 2010).

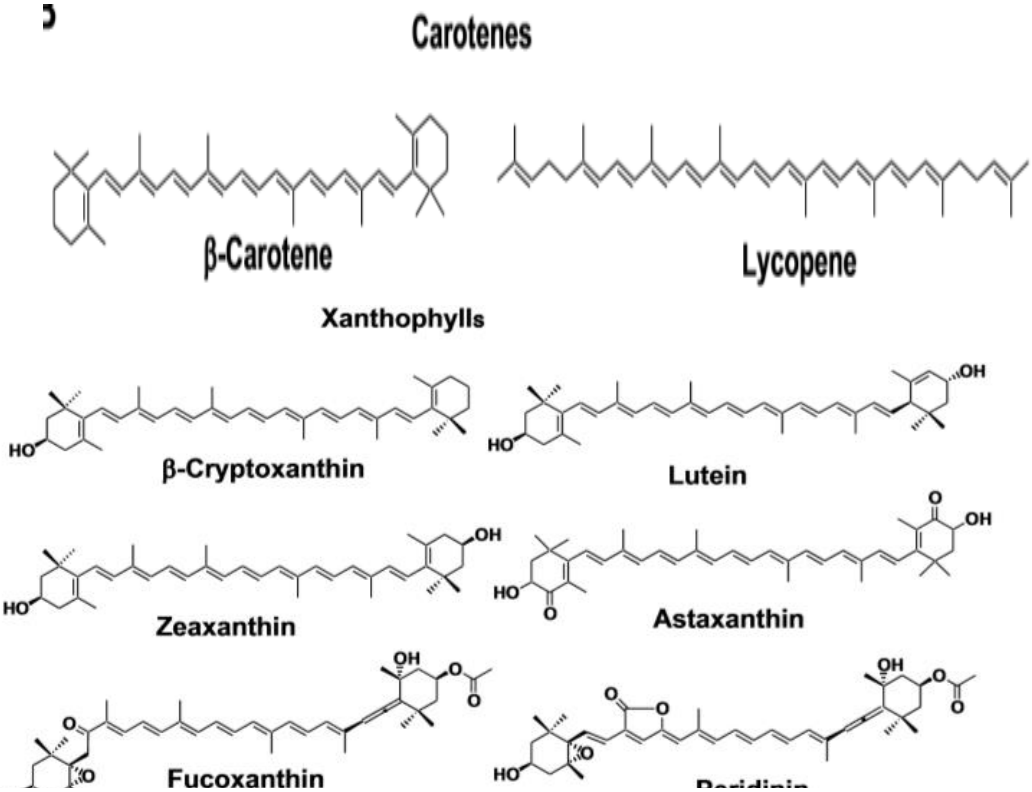

Figure 2. Structure of carotene and xanthophyll groups (Maoka, 2009)

The carotenoid most commonly found in plant tissue is β-carotene. These carotenoids are also used as food coloring. Several carotenoids found in plants, for example, are α-carotene found in carrots and capsanthin found in red peppers (Delgado-Vargas *et. al*., 2000).

All carotenoids are lipophilic compounds, thus carotenoids dissolve in oil and organic solvents, such as alcohol, chloroform, and acetone. Carotenoids are quite heat stable and their color can be lost due to the oxidation process (Thane & Reddy, 1997). In addition, carotenoids are very sensitive to acids, light, and oxygen (Friedrich, 1988), so they should always be stored in a dark room and in a vacuum, at a temperature of -200C. Carotenoids are best

Carotenoids are easily oxidized because of the many double bonds that are conjugated. In addition, the storage of carotenoid pigments in organic solvents will accelerate decomposition. This is due to the highly conjugated and unsaturated structure of carotenoids, so that the products of their degradation are very complex (Pinem, 2010).

During oxidation, epoxide and carbonyl compounds are initially formed. Further oxidation results in the formation of mono and oxygenated short chain compounds including epoxy-β-ionones. For provitamin A carotenoids, the formation of epoxides in the ring results in loss of provitamin activity. Extensive autoxidation will result in carotenoid pigment bleaching and loss of color. The oxidative breakdown

of β-carotene is intensified in the presence of sulfate and metal ions (Peisser & Yang, 1979).

Enzymatic activity, especially lipoxygenase will accelerate the oxidative degradation of carotenoid pigments. This process occurs through an indirect mechanism. Lipoxygenase will catalyze the oxidation of unsaturated or polyunsaturated fatty acids to produce peroxides, this is what causes lipoxygenase to react easily with carotenoid pigments (Ben *et. al*., 1971).

Carotenoids are relatively stable during storage and handling of most fruits and vegetables. The freezing process causes slight changes in carotene. However, the blanching process is known to affect carotenoid levels. Often the blanched plant products show a marked increase in the carotenoid content relative to the raw tissue. This is due to inactivation of lipoxygenase, which is known to indirectly catalyze oxidative decomposition of carotenoids, loss of water-soluble constituents or due to mild heat treatment which is usually used during the blanching process to increase the efficiency of pigment extraction (Francis, 1999). Although carotene is considered quite stable during heating, it is known that heat sterilization can induce a cis or trans isomerization reaction. To reduce excessive isomerization, this thermal process should be minimized whenever possible (Amaya, 2016).

Based on research conducted by Aryayustama *et. al*. (2018), showed that high storage temperatures could lead to a greater decrease in the total carotenoids of pandan fruit extract. In addition to storage temperature, the influence of the presence of oxygen can affect the structure of carotenoid compounds, this results in oxidation and isomerization of β-carotene pigments.

The color caused by carotenoids is from yellow to red so that the detection wavelength for monitoring carotenoids is usually in the range of 400-500 nm (Britton, 1995 in Susilowati, 2008). Hujaya (2008) reported that the maximum wavelength values of xanthophyll (444 nm) and carotene (450 nm) were not much different, but it was confirmed that the two compounds were different.

CAROTENOIDS AS ANTIOXIDANT

Carotenoids are a group of pigments that can reduce free radicals, so they can act as antioxidants (Gross, 1991; Rodrigues-Amaya, 2003; Stahl & Sies, 2003). Therefore, carotenoids are able to protect cells and organisms from oxidative damage caused by free radicals. The buildup of free radicals will cause various health problems such as cancer, inflammation, Alzheimer's, cataracts, the aging process on the skin, and a decrease in the immune system. Free radical inhibition by carotenoids is mainly carried out by β-carotene (Limantara & Rahayu, 2012).

The role of carotenoids as antioxidants is as a reducer of singlet oxygen (1O2) and radical peroxides (Palozza and Krinsky, 1992; in Redriguez-Amaya, 2001; Miranda *et. al*., 1998). The way carotenoids work in reducing singlet oxygen is based on the transfer of electrons between the two molecules. Energy from singlet oxygen transfers to carotenoids, and then the oxygen ground state phase and triplet carotenoid excitation are obtained so that singlet oxygen reactivity can be reduced (Stahl & Sies, 2003).

The factor that really supports the function of carotenoids as antioxidants is their structure. The structure of carotenoids greatly affects their bioactivity, such as the presence of double bonds, open chains, and the least amount of oxygen substituents which will increase the antioxidant activity of carotenoids (Di Mascio *et. al*., 1989 in Lila, 2004; Dutta *et. al*., 2005; Tahamatsu *et. al*.,

2003). Following free radical stabilization by beta carotene can be seen in Figure 3.

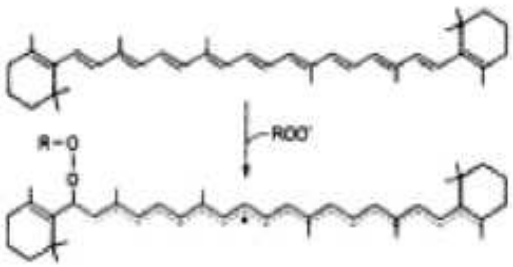

Figure 3. Free radical stabilization by beta-carotene (Belitz *et. al.*, 2004 in Nururrahmah *et. al*., 2013)

SOURCES AND EXTRACTION METHODS OF CAROTENOIDS

The sources of carotenoids are very scattered in nature. The source can come from flowers, fruit, tubers, leaves, and so on. The following sources of carotenoids can be seen in Table 1.

Members of carotenoid compounds such as beta carotene, lycopene, and xanthophylls are also very scattered sources in nature. Following are the levels of beta carotene, lycopene, and xanthophylls can be seen in Table 2.

Table 1. Carotenoid contents from various sources

Sources	Carotenoid Contents
Kabocha Pumpkin	254.77 mg/100g
Yellow Pumpkin	24.62 mg/100g
Seaweed (*Caulerpa* sp)	12,532 mg/g
Cassava Leaves (*Manihot esculenta*, Crantz.)	8,07 ± 45 µg/g wet basis
Rubber Cassava (*Manihot glaziovii*)	767 ± 71 µg/g Wet basis
Pandanus Fruit Extract	19,17%.
Yellow Ambon Banana Skin (*M. paradisiaca sapientum* L.)	6,203 ± 0,004 µg/
Sweet Potatoes with Yellow-Orange Tuber	0,205-0,254 µg/100 g
Sweet Potatoes with White Tuber	0,007-0,024 µg/100 g
Cilembu Sweet Potato	1,363 ± 0,113 mg/g
Marigold Flower	680 mg/kg

Source: Manasika *et. al*. (2015); Kim *et. al*. (2005); Darmawati *et. al*. (2016); Magdalena *et. al.* (2007); Made *et. al*. (2018); Suparmi *et. al.* (2012); Qurniati *et. al*. (2013); Setyawati (2015); Yolanda (2012).

Carotenoids can be obtained by an extraction process using non-polar solvents or organic solvents. This is because carotenoids are intracellular and highly hydrophobic. The extraction methods that can be used to obtain carotenoids include the maceration extraction method, the supercritical fluid extraction method, and the enzymatic extraction method (Maleta *et. al*., 2018).

This maceration extraction method uses a solvent which diffuses into the cell of the material wherein the carotenoid compounds will come out as a result of osmotic pressure, besides that the maceration process is usually carried out by stirring and heating to speed up the extraction process. Solvents that are often used are acetone and ethanol (Maleta *et. al*., 2018).

Table 2. Beta Carotene, Lycopene, and Xanthophyll Content from Various Sources

Type	Source	Content
Beta Caroten	Outer Dragon Fruit Skin	181,6 ppm
	Inner Dragon Fruit Skin	224,2 ppm
	Curly Red Chili (*Capsicum annuum* L Var. *Longum sendt*)	5,57±0,13 mg/100g
	Cayenne pepper (*Capsicum frutescens* L.)	0,36±0,01 mg/100g
	Big Red chilli (*Capsicum annuum* L. Var. *abreviatum Fingerhuth*)	10,54±0,07 mg/100g
	Carrot Powder	20550 µg/100 g
	Lompa Fish	0,22 µg/g
	Purple Sweet Potato (*Ipomoea batatas*)	75,91 ± 1,92 ppm
	Cantaloupe Fruit Extract	3,171±0,150%
	Carrot	34,94 ± 7,810 %
	Melon	57,133 µg/g
Lycopene	Cilembu Sweet Potato	0,038 mg/g
	Tomato	3041 µg/110 gram
	Watermelon	23,0 – 72,0 g/g
	Red Guava	54 g/g
	Papaya	20,0 – 53,0 gr/gr
	Red Grape	33,6 gr/g
	Bali Orange	1,38014±0,03007 mg/kg
	Forest Arben	9 mg/100 g
Xanthophyll	Marigold Flower	156,32 mg/kg
	Brown Seaweed (*Padina australis*)	13,15 mg/10 g wet basis

Source: Nururrahmah *et. al.* (2013); Octaviani *et. al.* (2014); Marliyati *et. al.* (2012); Mainassy *et. al*. (2011); Fauziah *et. al*. (2015); Kusbandari *et. al*. (2017); Agustina *et. al*. (2019); Idris (2011); Setyawati (2015); USDA National Nutrient Data Base (2020); Bramley (2000); Prihantini (2009); Tristiyanti *et. al.* (2013); Yolanda (2012) ; Nursid and Dedi (2017).

Things that must be considered in the extraction process using the maceration method are the extraction temperature and the stirring speed. The higher the temperature and the high stirring speed can accelerate the solvent to penetrate into the material and contact the material, but too high a temperature can also damage the bioactive components of the material (carotenoids) (Maleta *et. al*., 2018).

The supercritical fluid extraction method uses supercritical fluids which have the characteristics of low viscosity and relatively high diffusivity. One of the solvents often used in this method is liquid carbon dioxide because it has a critical temperature of 31.3 ℃ and a pressure of 72.9 atm. The main parameters that can affect the extraction with the supercritical liquid method are the ratio of the solvent to the material, the particle size of the material, the extraction temperature, the pressure, the extraction time, and the CO2 flow rate (Herero *et. al*., 2006).

The enzymatic extraction method uses the help of enzymes to extract the carotenoid compounds present in the material. The enzymes commonly used are

cellulase, pectinase, and hemicellulase enzymes. These enzymes will damage the cell walls of the material, so that carotenoid compounds can get out of the material. The factors that influence this method are pH and extraction temperature. The pH and temperature used are adjusted to the optimum conditions for the enzymes used (Lindahl *et. al*., 2013).

CONCLUSION

Carotenoids are pigments that can be used as natural colorant in food. This pigment provides red, yellow, and orange colors. Carotenoids can act as antioxidants and provitamin A. Functions as antioxidants are caused by the carotenoid structure, which has double bonds, open chains, and the least amount of bound oxygen substituents. In addition, carotenoids are lipophilic compounds so they can dissolve in oil and organic solvents. Carotenoid pigments are quite resistant to heating, but they can be very easily degraded in acidic, light, and oxygen environments. The process of carotenoid pigment extraction can be done in three ways, namely maceration extraction, supercritical fluid extraction, and enzymatic extraction.

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GOOD MANUFACTURING PRACTICES (GMP) IN SMALL ENTERPRISE OF MILKFISH SATAY

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ABSTRACT

Milkfish satay is indigenous food product from Banten Province. Quality assurance in the milkfish satay production need tobe improved, especially in the sanitation and food safety. Basic eligibility Program in the fish industry is needed to ensure food safety, namely sanitation standard operating procedures (Sanitation Standard Operating Procedures/SSOP) and the good food production (Good Manufacturing Practices / GMP). Good manufacturing practices (GMP) is a guideline for the food industry to produce food and beverages that are safe, have a high quality, and feasible for consumption. The purpose of this study was to examine the implementation of GMP on milkfish satay production. This study is conducted by doing interview with owner followed by observation and documentation of all activities related to the production process in order to examine the GMP applied. The result showed that the production activity of Milkfish Satay used traditional method. The small enterprise has to improve the GMP practices in the criteria of building and facilities, equipment, hygiene and sanitation facilities, activities, health and workers hygiene, label, process control, recording and documentation.

Keywords: Good Manufacturing Practices, Milkfish Satay, Banten

INTRODUCTION

Milkfish is one of Indonesia's export commodities. This fish is also a source of animal protein that is most favored compared to other types of animal protein. Banten Province is one of the centers for milkfish production with a yield of 3,553.59 tons in 2018 from the total production of cultivated fish in this province (DKP Provinsi Banten, 2019). Milkfish are generally sold directly to consumers in the fresh form to meet local consumption needs. The high production of milkfish is also due to the fact that Banten is the center for the production of milkfish satay which uses milkfish as raw material. Milkfish satay mostly produce by small enterprise in the Banten Province, especially in Serang City.

As an indigenous food product from Banten Province, the milkfish satay has a great opportunity to be developed and be appointed as a regional superior product. Therefore, it was still need to develop the product competitiveness especially in the aspects of quality and consumers safety. So that, the milkfish satay's enterprise is necessary to increase the awareness of the importance of hygienic food production process and responsible for consumer safety. The problem faced by milkfish satay's enterprise such as short of shelf life and food safety caused the product can only be marketed locally. Meanwhile, milkfish satay

intended to improve food safety by inhibiting the growth of microorganisms. Program eligibility base in the small enterprise is needed to ensure food safety, namely sanitation standard operating procedures (Sanitation Standard Operating Procedures / SSOP) and the good food production (Good Manufacturing Practices / GMP). Good Manufacturing Practices (GMP) are the basic requirements that should be met by an enterprise that wants to produce quality and safe food. These requirements based on Ministry Industry RI Rule No. 75/M-IND/PER171/2010 include the location, building, sanitation facilities, machine and equipment, materials, process control, product, laboratory facilities, employee, packaging, labelling, warehousing, sanitation program, transportation, documentation and training. The small enterprise that met the GMP requirement will get a certificate that valid for a period of 3 (three) years (National Food and Drug Agency, 2014).

The aim of this research was to mapping production process of Milkfish satay, to analyze the implementation of GMP in the milkfish production, and to give recommendation of the best practice of GMP in the small enterprise of milkfish satay. Several aspects of GMP are analyzed include industrial location, building, product, productions equipment, raw materials, personal hygiene, processing control, sanitation facilities, label dan packaging, storage, maintenance facilities, laboratory and transportation according to the Rule of Indonesia Ministry of Health and Rule of Indonesia Ministry of Industry. Through the application of proper sanitation procedures and GMP during the processing, small enterprise increases consumer confidence by ensuring quality and food safety.

METHODS

This research conducted in the production house of milkfish satay located in the Serang City, Banten Province. The research method used in this study is descriptive qualitative and quantitative. This research used survey methods in data collection through observation, interviews with the owner, and documentation of production processing. Location study was one of small enterprise in the Serang City, Banten Province. This enterprise still keeps traditional method to produce milkfish satay. This research also measured the quality of milkfish satay and water in the laboratory. The quality of milkfish was already analyzed for chemical hazard (Pb and Cd) and biological hazard (TPC, *E coli*, *Salmonella* sp, *Vibrio c.*, *Vibrio p.*) (Anggraeni et al. 2021). Quality of water was analyzed for *E. coli.*

RESULTS AND DISCUSSION

Processing of Milkfish Satay

The processing of milkfish satay in the small enterprise is sorting raw material. It followed by fish washing and scale cleaning. It continued by removing the gill and innards and separating fish meat from fish bone and fish skin/fish head. These three parts of fish was process differently. The fish skin and fish bone still used as skin milkfish satay, the fish meat mixed with coconut milk and seasoning, and the fish bone was thrown away. The batter that consists mixed of meat, coconut milk and seasoning then fill into the fish skin. This product was clamped using wooden clamp. The process followed by roasting clamped milkfish and packaging. The process flow diagram of milkfish processing can be seen in the Figure 1. Based on the Figure 1, every activity prone to cause cross contamination either from the environment or other foreign objects.

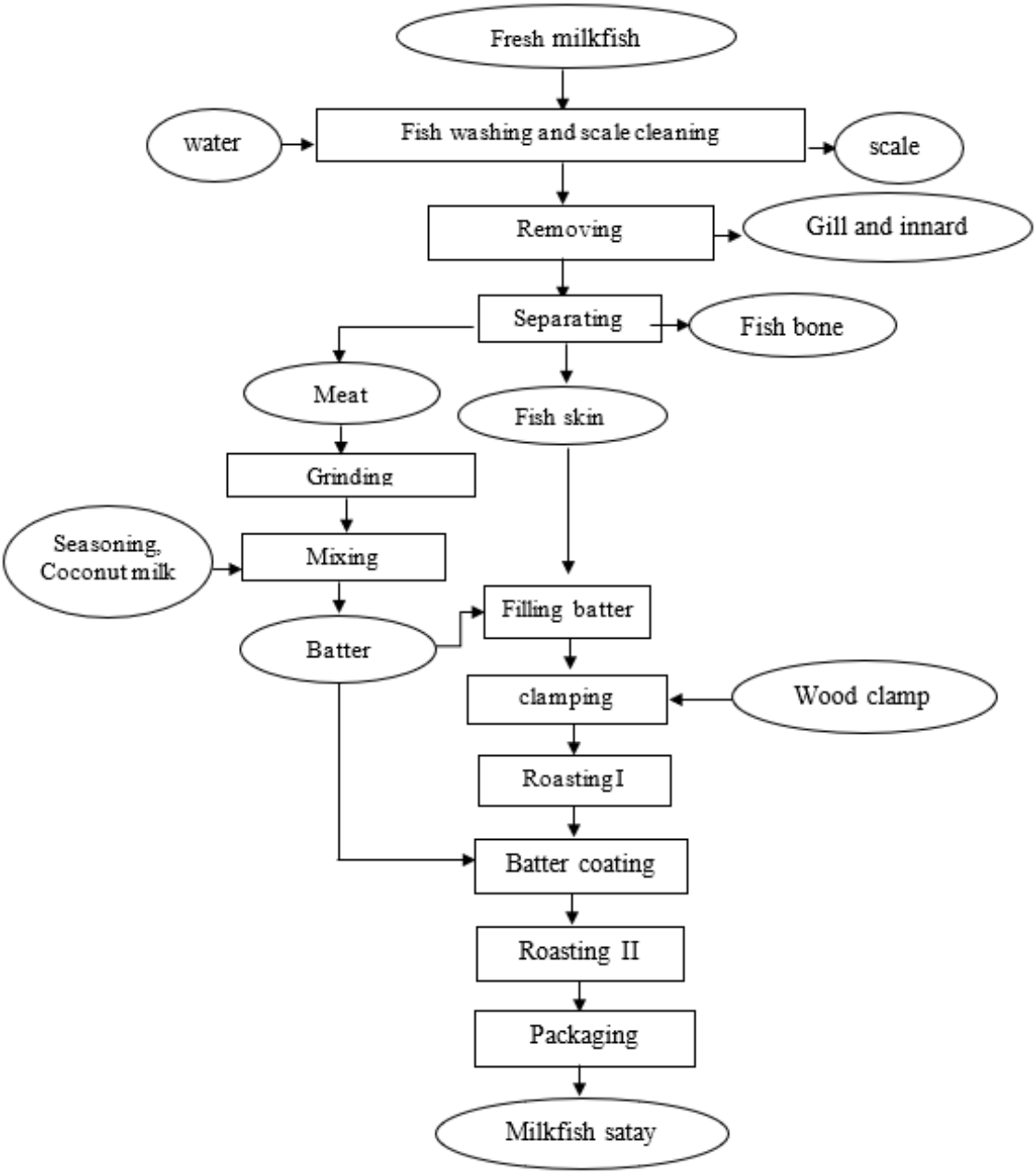

Figure 1. Process Flow Diagram of Milkfish

Evaluation of GMP Implementation in the Milkfish Satay Enterprise

Food safety is one basic requirement that must be fulfilled by every food producer in order to protect consumers. Efforts to increase food safety can be carried out by implementing a basic eligibility program. Basic eligibility program are Good Manufacturing Practice (GMP) and Sanitation Standard Operating Procedures (SSOP). This status of GMP application was assessed based on Permenperin RI No.75 /M-Ind / Per / 7/2010.

a. Production location

Based on the survey, location enterprise is far from polluted environment, landfill area, and waste area, flooded area. It is located in densely populated residential

area, but the outside of the building, such as the street, parking lot and yard are well managed so that buyer easily access the location.

Figure 2. Documentation of Production

b. Building and facilities

Yusra (2016) state that the unit building and its surroundings should be designed and arranged and have clear boundaries. It means that the area of each roomand equipment space must be sufficient, not crammed and sorted according to the activities. Based on the survey, the requirement of building and facilities was not implemented improperly such as:

• Design and construction

Design and construction of building must allow workers to clean the surface of the floor, ceiling, and wall easily. There are 4 rooms in the small enterprise that are washing and cleaning, mixing, roasting and storaging. In fact, the dirt and grime in the wall and floor are difficult to clean, beside the wall is in the shape of a dead corner so it allows microbial growth. The floor of cleaning room is already coated with ceramics, but the wall still uncoated ceramics. Layout of the production house are not in accordance with GMP and it may cross contamination because no proper separation for clean and dirty of material flow. Doors and windows are made of not from stainless, and non waterproof material. Mixing and filling room doesn't have enough lighting and the wall in this room isn't painted with light colour. The roasting process was done in the open area so that the product can contaminate with dust. Based on survey, it is still found water spills (muddy) in the mixing and filling room even tough this room must be dry.

• Facilities

According to the GMP Guidelines 75 / M-IND / PER / 7/2010 several aspects of sanitation facilities include water supply facilities, toilet facilities, waste disposal facilities and worker's hygiene. Facilities in the production house already meets GMP requirements such as the bathroom is located far from production house, the sewerage and drainage of liquid are sufficient so that the liquid waste flow smoothly, and equipment cleaning is done everyday. The water used is available in sufficient quality and quantities for production activities. The water was taken from groundwater. The water in the SME was analyzed for E coli and the result showed < 3 APM/g of E coli. It showed that water quality meets the requirement for food industry. Based on previous study, water used in this enterprise meets the requirement for sanitation hygiene standard in the Permenkes No. 32 Tahun 2017. But it is still found that the production house doens't equipped with a sink, hand soap, and dryers for workers to keep clean. These facilities must be available in the entrance and exit of the production room. Besides, there must be tube water in the entrance door of production room. There are facilities equipment made of wood and plastic which is prone of contamination.

c. Equipment

Equipment for production milkfish satay are baskets, knifes, trays, pans. These equipment are made from plastics, wood or stainlessteel. Before and aft using the equipment, an employee will wash them with soap and then dry them. Such actions may reduce contamination into the product. But, its better to replace the woods equipment with stainlessteel equipment, because wooden equipment prove of contamination.

d. Hygiene and Sanitation Facilities and Activities

In this enterprise, the cleanliness and sanitation programs are not applied. The practice of worker hygiene, clothing and hand washing is in bad condition.

e. Health and Workers Hygiene

Worker's hygiene and health will guarantee that workers who have direct or indirect contact with the food processed will not contaminate the product (Ministry of Industrial, 2010). Requirements of workers higiene and health are competence in food safety processing, health, wear working uniform, wash their hand before doing work and not to eat, drink, smoke, spit, or perform other actions which can contaminate didn't applied worker's hygiene and health standard. Workers don't wear production uniform, so that they worked without uniform, a head top, boots and without using gloves. We also found some male workers smoke during production. There must be PIC of checking the worker's health and hygiene periodically and of monitoring food safety process.

f. Product Label

The label print to the package. The label must show of product name, materials, net weight, name and address of company and expiration date according to PP 69/1999 about food label and advertisement. Based on the survey, the label product was written the product name, P-IRT number, name and address of the enterprise. However, the label has not included, materials, expiration date, and net weight. Author opinion, these items and nutritional facts must be included in the label to assure food safety product and increase competitiveness of product.

g. Process Control

Every industry should have controled their process so that the quality of food products met the final requirement. Process control aims to produce quality food products and provide benefits for consumers (Latif et al., 2017). Minimal monitoring was done in the small enterprise such as formulation of raw material standard, product composition, and processing. The monitoring control was done by feeling by PIC. However, it wasn't written in the document (SOP). This enterprise is supposed to document the operationalization of the eligibility base program and their activity such as SOP rejection product, SOP raw material acceptance, SOP process production, and SOP sanitation process, etc.

h. Storage

The small enterprise didn't store the raw material because when it purchased, it would be processed immediately. Storaging wasn't done toward product also because it sold. Shelf life of milkfish satay is about 3-4 day. The small enterprise provides storaging room with the clean condition. The packaging is stored separately from the final product, in a clean room.

i. Product withdrawal

A company can withdraw its product from selling if there is found any problem with the product. One reason for the withdrawal of food products is safety problem such as perhaps the product will cause illness or poisoned to consumers if they consume the product (Latif et al., 2017). This small enterprise has no withdraw procedure.

j. Recording and Documentation

This activity is very helpful to owners to record what problem faced with regard to product quality. It also important to record

production process, materials used, expiration date, and distribution system (Latif et al., 2017). Documentation activity was still minimal. Documentations in the small enterprise were the amount and date of production, the amount of raw material and product, financial book. The recording and documentation are done by owner.

Table 1. Recommendation for the next stage to GMP implementation

No	Parameter	Recommendation
1	Building and facilities	- Walls in the 4 rooms should be covered with a waterproff material that makes it easy to clean with a height of at least 2 m. - Provide lighting facilities and repaint the walls to make them lighter. Lighting condition was suggested in 220 lux for working area, 540 lux for inspection area, 110 lux for other rooms (Winarno, 2011). - close the roasting room so that dust contamination can be prohibited - provide tube water, sink, hand soap, and dryers for workers to keep clean. Minimun number of sinks 1 to 10 workers (Winarno 2011). - change the door, windows, ventilation using stainlessstell, waterproff and easy to clean materials. - manage program sanitation procedure regularly
2	Equipment	- replace wooden equipment with stainless steel equipment - using machine for process to minimize contamination and get high quality.
3	Hygiene and Sanitation Facilities and Activities	- arrange sanitation program example periodic cleaning - provide production uniforms that comply with GMP guideline - pest control by cleaning production room, closing the sewerage, using insect killer, using mouse trap, preventing pest get in from the from vents / windows / doors. The pest control activity could follow Kurniasih *et al* (2020).
4	Health and Workers Hygiene	- Create SOP for the production process which includes activities during production in order to avoid contamination
5	Product label	- The label included product name, materials, net weight, name and address of company and expiration date.
6	Process Control	- Control of raw material, additional material, and product must be done and documented. It must meet the quality and free from hazard (phisics, chemicals, microbiology). - Arrange SOP of production process
7	Recording and documentation	- Appoint a PIC whose task of recording and documentation which includes raw material, product quality, product code, sanitation facilities and equipment, and toilet cleaning (The record was reported to the head of QC/owner and was documented (Bimantara AP & Triastuti, 2018)

GMP RECOMMENDATION

This study of the recommendation of GMP implementation in processing milkfish satay is very important in order to produce good quality of satay products, guaranteed safety and fulfilled consumer expectations.

Based on the survey, it can be seen that milkfish enterprise was not implemented GMP properly and correctly. Table 1 shown that recommendations for improving the application of GMP in order to avoid contamination of the product.

CONCLUSION

Milkfish satay is an indigenous food product from Serang, Banten Province. The processing of milkfish satay in the small enterprise is sorting raw material, removing the gill and innards, separating fish meat from fish bone and fish skin/fish head, mixing fish meat with coconut milk and seasoning, filling the batter into fish skin, clamping, and roasting. The implementation of GMP is carried out by assessing several aspects including production location, building and facilities, equipment, hygiene and sanitation facilities and activities, health and workers hygiene, product label, process control, storage, product withdrawal, and recording and documentation. Some recommendation has been made for small enterprise to take corrective action to improve safety product.

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