Effect of Fermentation Time on Nutrient Content and Organoleptic Quality of Corn (*Zea mays L.*) Tapai as Superfood

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Abstract. The purpose of this study is to analyze the effects of the fermentation time of making corn tapai (Zea mays L.) on nutrient content and organoleptic quality. This research is expected to produce a new product: processed corn as a superfood. This study included numerous treatments at various stages of the fermentation process (around 5, 6, and 7 days). The researchers analyzed alcohol, glucose, total dietary fiber content, and the organoleptic quality of corn tapai, which includes taste, texture, color, and flavor. The results showed that corn tapai had the highest alcohol contents (5,133%), glucose (11,933%), total dietary fiber (11,953%), and organoleptic qualities of taste (4,00), color (3,86), texture (4,28), and flavor (3,80). The researchers concluded that the length of fermentation affected the alcohol content, glucose content, dietary fiber content, and organoleptic quality of corn tapai. The longer the fermentation, the higher the alcohol and glucose content, while the total fiber content decreases. The length of fermentation also affects the various textures and tastes. It can be concluded that the duration of fermentation has an effect on the nutrient content and organoleptic quality of corn tapai.

Keywords: fermentation time, corn tapai, superfood, total dietary fiber, organoleptic quality

1 Introduction

Corn is one of the grain crops in the grass family (Graminaceae), which is very popular throughout the world and has high economic value in Indonesia [1]. Corn has a higher carbohydrate content than cassava, with 63,60 grams per 100 grams, and the highest protein content when compared to white sticky rice, black sticky rice, and cassava, with 7,90 grams per 100 grams [2]. Corn contains dietary fiber needed by the body. Corn can be used as a staple food; this is supported by its high carbohydrate content [3]. Carbohydrates are raw materials that support the fermentation process, where the basic principle of fermentation is the degradation of starch components by enzymes [4].

One of the famous traditional fermented foods in Indonesia, Malaysia, the Philippines, and Vietnam is tapai [5]. The tapai fermentation process uses microorganisms such as molds, yeasts, and bacteria found in tapai yeast [6]. Tapai yeast consists of molds (Aspergillus, Amylomyces rouxii, Mucor sp, and Rhizopus sp.), yeasts (Saccharomycopsis fibuligera, Saccharomycopsis malanga, Pichia burtonii, Saccharomyces cerevisiae, and Candida

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utilis), and bacteria (Acetobacter, Pediococcus sp, and Bacillus sp. The content of 100 grams of yeast is 43 grams of protein, 3 grams of carbohydrates, 140 grams of calcium, 10 grams of water, and 136 kcal of calories. [7][8].

Tapai with a slightly sour sweet taste, a soft texture, and an alcohol scent has good organoleptic quality [9]. Biochemical changes in tapai fermentation are the hydrolysis of starch into glucose and maltose, which will give a sweet taste, and the change of sugar into alcohol and organic acids that cause a sour taste [10]. The fermentation process causes changes in the color or properties of the material due to the breakdown of the food content [11].

The effect of long fermentation times on the physical and chemical content of tapai is an important process in producing good tapai products. Fermentation of glutinous rice at a temperature of 30 °C for 2, 3, 5, and 7 days obtained sweet tapai with a high aroma on the 3rd day of fermentation [12]. The optimum incubation temperature for the growth of Saccharomyces cerevisiae is 25–30 °C [8]. Yeast, which is dominated by the yeast Saccharomyces cerevisiae, has the ability to convert carbohydrates (fructose and glucose) into alcohol and carbon dioxide so that it can produce tapai in the form of a semi-liquid that has a soft, sweet, and sour taste, contains alcohol, and has a sticky texture [8].

In order to increase the use of local raw materials and create processed foods that are rich in benefits from the content of chemical compounds in corn, including carbohydrates, protein, fiber, vitamin B complex, and polyphenolic compounds, which have high nutritional properties, it is hoped that the use of corn as tapai in making tapai will not only be focused on cassava and sticky rice [13]. The goal of this study is to ascertain how the length of fermentation affects the amount of dietary fiber, alcohol, glucose, and organoleptic quality in corn tapai.

2 Research Method

2.1 Research design

The research was experimental research. This study employed a completely random design (CRD) for the research. The treatments in this study were to ferment the corn tapai for 5, 6, and 7 days. Each treatment was administered twice. Table 2.1 presents the research design.

Table 1. Research design treatment

Reduplication (P)	Treatment		
	A_1	A_2	A_3
P_1	A_1P_1	A_2P_1	A_3P_1
P_2	A_1P_2	A_2P_2	A_3P_2

Annotation:
Factor: fermentation time (A)
1 : Corn tapai with 5 days of fermentation
2 : Corn tapai with 6 days of fermentation
3 : Corn tapai with 7 days of fermentation

Reduplication: treatment reduplication (P)
1 : First reduplication
2 : Second reduplication

2.2 Material and ingredients

The materials used in this study consisted of ingredients for making corn tapai and proximate analysis materials (alcohol, glucose, and total dietary fiber).

2.2.1 Materials and ingredients for corn tapai

The raw materials for making corn tapai include local corn rice, NKL brand tapai yeast, and water. The tools used include scale, bowls, measuring cup, spoons, stove, boiling pan, steamer, spatula, tray, and plastic cups.

2.2.2 Corn tapai proximate analysis

The materials and tools used for the proximate analysis of corn tapai can be seen in table 2 below:

Table 2. Materials and proximate analysis of corn tapai

No	Analysis type	Analysis method	Material
1.	Alcohol	Gas Chromatographic	Aquades
2.	Glucose	Refractometer brix	Aquades
3.	Total Dietary Fiber	Enzimatic	Buffer fosfat (pH 6,0 dan 0,1), termamyl, NaOH 0,275 N, protease, enzim solution, aseton

2.3 Preparation of corn tapai.

Figure 2 shows the flow diagram for corn tapai production. After washing, the corn was soaked for 2 hours to insert a certain amount of water content so that gelatinization occurs. The corn was boiled with 175 ml of water and then washed again to remove the starch attached to the corn. Corn maturation was followed by a steaming process for 30 minutes, then the corn was cooled at room temperature. The fermentation process with yeast (1 g/100 g sample) was incubated in closed plastic cups and analyzed after 5, 6, and 7 days of fermentation.

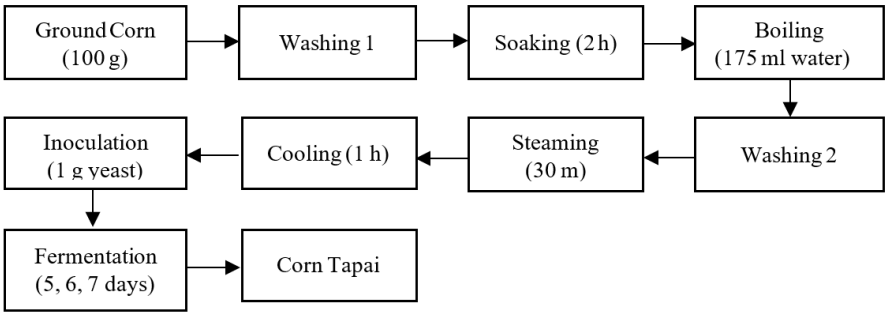

Figure 1. Corn tapai production

2.4 Data processing

Data processing on corn tapai was carried out by analyzing proximate levels and organoleptic quality. organoleptic test using semi-trained panelists with a total of 25 people. The results of proximate analysis and the organoleptic quality of corn tapai were statistically

analyzed using ANOVA. If the results of the ANOVA test are significant, then the DMRT test is continued with a significance level of 5%.

3. Results and Discussion

The results of statistical analysis of corn tapai nutrition can be seen in table 3.1

Table 3. Nutritional analysis data of corn tapai with different fermentation time.

Fermentation Time	Alcohol (%)	Glucose (%)	Total Dietary Fiber (%)
5 days	3,307a	9,808a	11,953a
6 days	4,586b	11,009b	11,698a
7 days	5,133c	11,933c	11,208b

3.1 Alcohol content of corn tapai

Alcohol is a compound fermented in tapai that gives the tapai a distinctive aroma and is a determinant of tapai maturity. The length of time of fermentation gives different results for the alcohol content of corn tapai. Based on the results of the analysis in Table 3.1, it shows that there is a significant difference, namely, the longer the fermentation, the higher the alcohol content. The duration of fermentation affects the alcohol content of cassava tapai [14]. The fermentation process converts corn rice starch into glucose and alcohol [15]. The increase in alcohol content is caused by yeast [16]. Saccharomyces, Candida, and Hansenula are yeasts that break down glucose into alcohol and various other organic substances [14]. Corn tapai gets its sweet flavor from the hydrolysis of starch into glucose and maltose by amylase and maltase enzymes. Glucose, which is hydrolyzed to alcohol and organic acids, gives tapai a sour taste because alcohol and some organic acids react to form esters [10].

3.1.1 Glucose content of corn tapai

The results of the study of corn tapai with 5, 6, and 7 days of fermentation had different glucose levels. The process of analyzing glucose levels using the Brix Refractometer method resulted in research data showing the highest glucose levels were found in corn tapai with a fermentation time of 7 days of 11,933% compared to the fermentation times of 5 days (9,808%) and 6 days (11,009%). This shows that the longer the fermentation time, the more the glucose levels increase.

In the fermentation process, starch (starch) is hydrolyzed into maltose by the enzyme amylase, and maltose, with the help of the enzyme maltase, becomes glucose [16]. In the tapai fermentation process, the role of Aspergillus is to produce the enzyme glukoamilase to break down starch into glucose units. Glucose will be converted into alcohol with the help of microbes in yeast and the enzyme zimase produced by Saccharomyces cereviseae. The growth and development of mold is increasing, causing higher glucose levels. The longer the fermentation time, the greater the opportunity for microbes to work longer so that they continue to produce glucose, which is a precursor for the formation of alcohol [17].

3.1.2 Total dietary fiber of corn tapai

Corn contains 12.8% of total dietary fiber [18], glutinous rice contains 5.4% [19], and cassava contains 20.5% [20]. A food can be categorized as high in fiber if it has a minimum dietary fiber content of 6% [21]. This shows that corn is a food item with a high fiber content.

Based on the results of the analysis in Table 1.1, it shows that the difference in fermentation time affects the dietary fiber content of corn tape. The results of the study of corn tape with 5, 6, and 7 days of fermentation time showed that corn tape had fiber contents of 11,953%, 11,917%, and 11,208%, respectively. Cassava tape has a fiber content of 7,53 [%] [22], and sticky rice tape has a fiber content of 5,9 [%] [23]. This suggests that corn tape has a higher fiber content than cassava and sticky rice tapai.

Dietary fiber consists of cellulose, hemicellulose, lignin, pectin, gum, and a wax coating [24]. The longer the fermentation time, the lower the fiber content of corn tape because the fermentation process can decompose cellulose into simple molecules [25]. In the fermentation process of making cassava tape, the fiber content decreased by 5.05% [26]. The results of the organoleptic quality analysis can be seen in Figure 2.

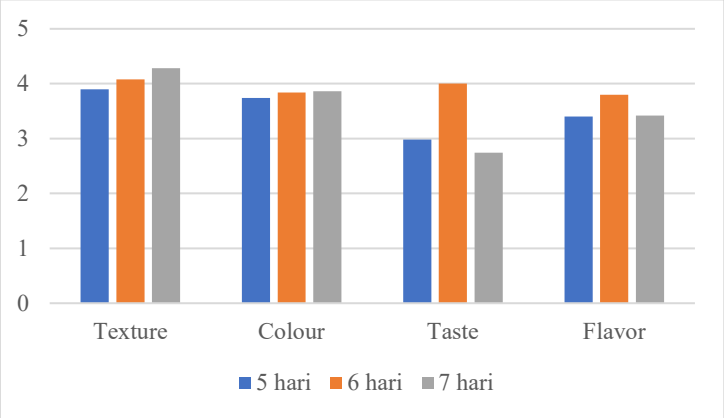

Figure 2. Data analysis of corn tapai organoleptic quality with different fermentation time

3.2 Texture organoleptic quality

Texture is an important sensory quality in processed food products and is related to the acceptance of a product by the human senses. The texture components of tapai are hardness and cohesiveness. In accordance with the analysis of the physical properties of the texture, the longer the fermentation time, the softer the texture of the corn tapai because it produces water [27]. The organoleptic quality of the texture with the highest value was corn tapai with a fermentation time of 7 days and a fairly soft and grainy texture. According to one study, the difference in the length of fermentation time has a significant effect on the texture of the results of a fermented product [28]. The texture of a material is strongly influenced by its water content [29]. If the water content in a material is high, then the texture tends to be softer. Conversely, if a material has a low water content, the texture will be harder.

3.2.1 Color organoleptic quality

Color, apart from being an indication of a food product, is also a factor that determines consumers' decisions when considering and choosing a food product before consuming it [30]. The data analysis revealed that there was no significant difference in the organoleptic quality of corn of the same color on days 5, 6, and 7 because it was the same as corn of a yellow color. The yellow color of the corn tape is due to the presence of carotenoids in the form of beta-carotene and xanthophylls [31].

3.2.2 Taste organoleptic quality

Taste is one of the factors that determines whether consumers will receive food and beverage products [32]. Tapai corn with a fermentation time of 6 days has a taste rating of 4, which indicates a sweet and slightly sour taste. The acidity, sweetness, and organoleptic levels of tapai can be caused by various things, one of which is the length of fermentation. The longer the fermentation process lasts, the more carbohydrates will be broken down into alcohol and acid [33]. This will affect consumer acceptance of the organoleptic quality of tapai. Excessive fermentation results in tapai, which has a high alcohol content and an overly sour taste, making it unpopular with the general public.

3.2.3 Flavor organoleptic quality

The length of fermentation in making tapai did not significantly affect the aroma of corn tapai. The whole corn tapai with fermentation times of 5, 6, and 7 days has a slightly sour flavor. The fragrance and acidity in tapai are caused by the alcohol content, which is the result of the breakdown of glucose into alcohol by microbes in tapai yeast, causing a fragrant, slightly sour, and not too pungent aroma due to excess alcohol [9]. The distinctive flavor of tapai is caused by microbial activity in yeasts, namely Hansenula, Endomycopsis, and Candida [34]. Alcohol and acid can be esterified by Hanensulla to produce a distinctive aroma on tapai [35].

4. Conclussions

According to the research result and discussion on "The Effect of Fermentation Time on the Nutritional Content and Organoleptic Quality of Corn Tapai (Zea mays L.) as a Superfood," it can be concluded that the fermentation time of 7 days has the highest chemical properties for the alcohol (5,133%) and glucose (11,933%). while the fiber content with the highest score in the 5-day fermentation was 11,953%. In the organoleptic quality test, the highest score for texture organoleptic quality was with 7 days of fermentation (4,28); the highest score for taste was with 6 days of fermentation (4,00); and there was no significant difference in the color and aroma of corn tape with 5, 6, and 7 days of fermentation.

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References

[1] Rahmawati DK, (2016). “Analisis Risiko Organisme Pengganggu Tumbuhan (Pest Risk Analysis) terhadap Pemasukan Benih Jagung (Zea mays L.) Impor dari Thailand,” *Digit. Repos. Univ. Jember*,

[2] Menkes (2018). *Tabel Komposisi Pangan Indonesia*. Jakarta: Kementrian Kesehatan RI,

[3] S. Rahman (2015). “Analisis Nilai Tambah Agroindustri Chips Jagung,” *J. Apl. Teknol. Pangan*, vol. 4, no. 3, hlm. 108–111

[4] T Rustringsih. (2007). “Pengaruh Penambahan Ammonium Sulfat Terhadap Produksi Etanol pada Fermentasi Beras Ketan Putih (Oryza sativa L. Var glutinosa) dengan Inokulum Saccharomyces cerevisiae,” *Univ. Muhammadiyah Surak.*

[5] I. S. Surono. (2016). Ethnic Fermented Foods and Beverages of Indonesia, *Ethnic Fermented Foods and Alcoholic Beverages of Asia*, Springer India, 341–382. doi: 10.1007/978-81-322-2800-4_14.
[6] Susanto dan Saneto. (1994). *Teknologi Pengolahan Hasil Pertanian*. Surabaya: Bina Ilmu.
[7] Dewi dan S. Aziz. (2011). *Isolasi Rhizopus Oligosporus pada Beberapa Inokulum Tempe di Kabupaten Banyumas*," *Molekul*, hlm. 93–104.
[8] R. Islami. (2018). Pembuatan Ragi Tape dan Tape (Making Yeast Tape and Tape), *J. Penelit. Dan Pengemb. Agrokomplek*, vol. 2, 56–63.
[9] K. Fatimah. (2011). *Uji Protein dan Karbohidrat tape Ketan dengan Penambahan Ragi NKL dan Tradisio*nal dengan Konsentrasi Berbeda untuk Pengembangan Materi Ajar Bioteknologi,.
[10] A. Santosa dan C. Prakosa (2010). Karakteristik Tape Buah Sukun Hasil Fermentasi Penggunaan Konsentrasi Ragi yang Berbeda, *Magistra*, no. 73,. 49–55.
[11] F. G. Winarno, S. Fardiaz, dan D. Fardiaz. (1980). *Pengantar Teknologi Pangan*. Jakarta: PT. Gramedia.
[12] R. Ohba, T. Koga, dan S. Ueda. (1989). *Liquefaction of Glutinous Rice and Aroma Formation in Tape Preparation by Ragi,.*
[13] M. E. Mashau, L. L. Maliwichi, dan A. I. O. Jideani. (2021). Non-alcoholic fermentation of maize (Zea mays) in sub-saharan africa, *Fermentation*, vol. 7, no. 3, doi: 10.3390/FERMENTATION7030158.
[14] H. Hasanah, A. Jannah, dan A. G. Fasya. (2012). Pengaruh Lama Fermentasi terhadap Kadar Alkohol Tape Singkong (Manihot utilissima Pohl).
[15] M. Astawan (2004). *Sehat Bersama Aneka Pangan Serat Alami*. Solo: Tiga Serangkai.
[16] Z. Berlian, F. Aini, dan R. Ulandari,. (2016). Uji Kadar Alkohol pada Tapai Ketan Putih dan Singkong Melalui Fermentasi dengan Dosis Ragi Yang Berbeda", *Jurnal Biota*, vol. 2, no. 1, 106–111.
[17] T. Aryana. (2018). Pengaruh Konsentrasi Ragi dan Lama Fermentasi terhadap Sifat Kimia dan Organoleptik Tape Jagung. 78.
[18] Bressani. (1990). Chemistry, technology and nutritive value of maize tortillas," vol. 6,. 225–264.
[19] C. Jeong, R. Hwa, K. Othani, dan L. On. (2001). *Non-Starch polysaccharydes of Cell Walls in Glutenous Rice, Rice and Black Rice.*.
[20] Rivera, Gerardi, Infante, Carrasco, dan Rodríguez. (1993). "Dietary Fiber Analysis of Cassava Using Gravimetric Methods," *Arch. Latinoam. Nutr.*, vol. 43, no. 1, hlm. 78–80,
[21] M. Foschia, D. Peressini, A. Sensidoni, dan C. S. Brennan. (2013). "The Effects of Dietary Fibre Addition on the Quality of Common Cereal Products," *J. Cereal Sci.*, vol. 58, no. 2, 216–227, doi: 10.1016/j.jcs.2013.05.010.
[22] F. Amanah. (2020). Jurusan Biologi Fakultas Sains dan Teknologi Universitas Islam Negeri Maulana Malik Ibrahim Malang, 117, 2020.
[23] D. R. N. Fauziyah. (2018). "Makanan Fungsional Tape Ketan Hitam Mencegah Sindroma Metabolik, 59.
[24] Herminingsih. (2010). *Manfaat Serat dalam Menu Makanan*. Jakarta: Universitas Mercu Buana.
[25] F. Amanah. (2020). Pengaruh Konsentrasi Bakteri Asam Laktat *Lactobacillus caseid* dan Lama Fermentasi terhadap Karakteristik Kimia Tepung Kulit Singkong (*Manihot esculenta*) Terfermentasi,117, 2020.

[26] Wulan dan Wikanastri. (2012). Kajian Kadar Protein, Serat, HCn, dan Sifat Organoleptik Prol Tape Singkong dengan Substitusi Tape Kulit Singkong, *J. Pangan Dan Gizi*, vol. 3, no. 06..
[27] Hafizah (2019). Uji Organoleptik dan Sifat Kimia Tape Ubi Jalar Ungu.
[28] D. Handayani)2017). Mutu Kimia dan Organoleptik Ubi Jalar Putih (*Ipomoea batatas*) yang Difermentasi dalam Waktu yang Berbeda, *J. Apl. Teknol. Pangan*, vol. 6, no. 1, doi: 10.17728/jatp.208.
[29] Winarno (1997). *Kimia Pangan dan Gizi*. Jakarta: PT Gramedia.
[30] A. Maulidiah, D. Hidayati, dan S. Hastuti. (2014). Analisa Karakteristik Manisan Kering Salak (*Salacca edulis*) dengan Lama Perendaman dan Konsentrasi Larutan Gula, vol.8, 9
[31] Anandika dan Mayasari. (2016). *View of The Effects of Corn Tempeh Fermentation on Protein and Carotenoid Level.*
[32] Winarno, *Kimia Pangan dan Gizi*. Jakarta: PT Gramedia Pustaka Utama, 2004.
[33] E. Nasution, V. R. Setiawati, dan I. Nairfana. (2021). The Effect of Fermentation Time on Organoleptic Quality, Acidity (pH) and Sweetness Level of Sorghum (*Sorghum bicolor L. Moench*) Tape.
[34] Saono, A. Hasono, A. Tomomatsu, K. Katoh, dan A. Matsuyama. (1982). "Ragi and Its Utilitation for the Manufacture of fermented Foods in Indonesia," *Nippon Shoukin Kogyo Gakkashi*, vol. 29, no. 11, hlm. 685–692.
[35] M. Asnawi, S. H. Sumarlan, dan M. B. Hermanto (2013). Karakteristik Tape Ubi Kayu (*Manihot utilissima*) Melalui Proses Pematangan Dengan Penggunaan Pengontrol Suhu," vol. 1, no. 2, 11.