JURNAL
BIOS LOGOS
Accredited by Ministry of Research, Technology and Higher Education No. 105/E/KPT/2022

Vol. 15 (No.3), Nov 2025, 324–335
DOI: https://doi.org/10.35799/jbl.v15i3.61693
E-ISSN: 2656-3282
P-ISSN: 2088-9569

The Effect of Addition Various Concentrations of Yeast (*Saccharomyces cerevisiae*) on the Quality of Porang Tubers (*Amorphophallus* sp.)

Irawati, Henny Helmi*, Rahmad Lingga
Program Studi Biologi, Jurusan Sains dan Ilmu Formal, Fakultas Sains dan Teknologi, Universitas Bangka Belitung
**Email korespondensi: henny-helmi@ubb.ac.id/hennyhelmi24@gmail.com*

(Article History: Received-May 16, 2025; Revised-Nov 20, 2025; Accepted-Nov 30, 2025)

Abstract

Porang tubers (*Amorphophallus* sp.) are a food commodity rich in glucomannan but also contain antinutritional compounds such as calcium oxalate. This study aimed to determine the effect of adding *Saccharomyces cerevisiae* yeast on improving the quality of porang flour and its ability to reduce calcium oxalate content. The research method used was fermentation with the addition of various concentrations of *S. cerevisiae*. The treatments applied were soaking with 10% *S. cerevisiae*, 20% *S. cerevisiae*, and a control treatment without yeast (0%). Parameters observed during the fermentation process included pH, total acidity, and total population in the porang soaking water. Meanwhile, yield, calcium oxalate, glucomannan, starch, moisture, ash, and color were analyzed to assess porang flour quality. The results showed that pH decreased and total acidity increased with the length of fermentation up to 72 hours. Yeast increased at 10% and 20% *S. cerevisiae* concentrations until 48 hours and decreased at 72 hours, whereas in the control treatment, population of yeast decreased up to 48 hours and increased at 72 hours. The study indicated that fermentation with *S. cerevisiae* effectively reduced calcium oxalate content and improved porang flour quality. The lowest calcium oxalate content was found in the 10% *S. cerevisiae* treatment, while the highest glucomannan content was observed in the 20% treatment. Porang flour treated with 20% S. cerevisiae showed lower moisture and ash content, while flour from the 10% treatment had higher starch content and a brighter color. Based on various test parameters, the porang flour produced in this study complied good quality standards.

Keywords: *Calcium Oxalate; Fermentation; Porang Flour; Saccharomyces cerevisiae*

INTRODUCTION

Porang is one of the plant species in Indonesia capable of growing in tropical and subtropical soil conditions. Porang belongs to the genus *Amorphophallus* and is classified under the Araceae (Sari, 2015). The production of porang does not require advanced technology. Porang cultivation carried out simple land preparation is sufficient for seedling development, planting, plant maintenance, and tuber harvesting (Alevalia & Arvianti, 2023). Porang can grow in various soil conditions, requires sunlight exposure while also being iyaable to thrive under the shade of teak, mahogany, sono, and durian trees (Hamdhan, 2021). Beneficial nutrients found in porang flour is glucomannan. Porang contains up to 65% glucomannan (Arifin, 2001). According to Hidayah et al. (2018), porang tubers have been widely utilized as a carbohydrate source and can serve as an alternative food ingredient due to their macronutrient content and potential as industrial raw material. Glucomannan can function as a gelling agent, stabilizer, thickener, and effective water absorber and it also provides health benefits such as reducing the risk of cancer, lowering body weight, and decreasing levels of harmful cholesterol (Hidayah, 2016).

One of the challenges in utilizing porang is the presence of antinutritional compounds, particularly calcium oxalate. The maximum standard for calcium oxalate content in porang chips is 50 mg/100 g (BSN, SNI 7939:2020). According to Febrianti and Wardani (2022), the calcium oxalate content in untreated porang tubers without soaking was 2.77%. The high calcium oxalate content in porang tubers contributes to an itchy

sensation when consumed. Several methods can be applied to reduce calcium oxalate levels, including soaking in acidic solutions. Based on the study by Wardani and Handrianto (2019), soaking porang flour in a 20% vinegar (acetic acid) solution reduced oxalate content by 90.27%. Calcium oxalate can also be reduced through fermentation methods. Certain bacteria are capable of producing organic acids, and some yeasts generate ethanol, which can subsequently be converted into acetic acid as the final product

The economic value of porang tubers can be increased by processing them into flour. According to the Indonesian National Standard (SNI), quality of porang flour was determined by its contents of calcium oxalate, glucomannan, protein, carbohydrates, fat, moisture, and ash. Fermentation method using the yeast *S. cerevisiae* has the potential to improve the quality of porang flour. An additional advantage of processing porang tubers through fermentation is the potential reduction in production costs, making the process more efficient. Reducing calcium oxalate levels in porang tubers is essential to minimize the antinutritional compounds present in the plant. The reduction of oxalate content through a maceration method using ethanol as a solvent has been shown to optimize glucomannan levels while decreasing calcium oxalate content (Faridah & Widjanarko, 2013). Research involving various concentrations of *S. cerevisiae* starter cultures in fermentation processes has not yet been conducted. This study is expected to reduce antinutritional compounds, particularly calcium oxalate, through the production of ethanol as the final fermentation product of *S. cerevisiae*.

METHODS

Preparation of starter

Saccharomyces cerevisiae was cultivated in potato dextrose broth (PDB) medium aseptically in a laminar air flow cabinet and incubated for 72 h at 30°C. After incubation, *S. cerevisiae* cells were centrifuged at 4,000 rpm for 15 min. The yeast pellet was separated from the supernatant and resuspended in sterile distilled water. The cell concentration was adjusted with distilled water until a turbidity equivalent to the 0.5 McFarland standard was obtained.

Preparation of fermented porang flour

Porang tubers were peeled and sliced into chips. The chips were then placed into containers at a weight of 500 g and soaked in 1 L of *Saccharomyces cerevisiae* starter at 10% and 20% consisted, with a control treatment without starter, for 72 h. Each treatment was conducted in triplicate. After fermentation, the porang chips were drained and dried using a food dehydrator at 60°C for 24 h. The dried, fermented chips were subsequently ground using a blender and sieved through a 100 mesh to obtain fermented porang flour.

pH and total acidity

The pH was determined using a pH meter over a 72-hour soaking period. Total acidity during fermentation was analyzed using an acid–base titration method following the procedure described by Wulandari (2018).

Total microorganism

Yeast population was determined using the total plate count (TPC) method at 24-hour intervals for up to 72 hours during fermentation. Samples were collected from the

fermentation soaking water. The analysis was performed using the spread plate method on potato dextrose agar (PDA). 100 µL of porang fermentation water from serial dilutions ranging from 10^{-1} to 10^{-6} was plated and incubated at 37 °C for 72 hours. Yeast colonies were enumerated using a colony counter after incubation, and the results were recorded and documented.

Yield

The yield of fermented porang flour was calculated by dividing the dry weight of the produced flour by the weight of the fresh porang tubers prior to peeling, and the result was expressed as a percentage (%)

Ca-Oksalat

Calcium oxalate content was determined using permanganometric titration. 1000 mg sample of fermented porang flour was dissolved in 190 mL of distilled water with 10 mL of 6 M HCl, heated at 100 °C for 60 minutes, diluted with 250 mL of distilled water, and filtered. The analysis, 50 mL of the filtrate was mixed with 10 mL of 4 M H_2SO_4, heated to 70 °C, and titrated with 0.05 M potassium permanganate until a pink endpoint was reached (Widjanarko & Megawati, 2015).

Glucomanan content

Glucomannan content was determined by measuring the absorbance of 0.8 mL each of glucomannan extract, glucomannan hydrolysate, and distilled water (blank) in 10 mL volumetric flasks. Then, 0.6 mL of 3,5-dinitrosalicylic acid (DNS) was added, and the mixtures were incubated in a water bath for 5 minutes, cooled to room temperature, and diluted to 10 mL with distilled water. Absorbance was measured at 540 nm, and glucose content was calculated using the linear regression equation of the glucose standard curve (Chua, 2011).

Starch content

Starch content in fermented porang flour was determined using the Luff–Schoorl method. For analysis, 25 mL of filtrate from the sample preparation was mixed with 25 mL of Luff–Schoorl solution. Then, 15 mL of 20% KI solution and 25 mL of 25% H_2SO_4 were added. The mixture was capped and kept in the dark for 30 minutes. The liberated iodine was titrated with 0.1 N $Na_2S_2O_3$ solution using 2–3 mL of starch indicator.

Moisture and ash content

Moisture and ash content were determined using gravimetric methods. Moisture content was analyzed by drying, based on sample weight measurement. Samples were heated in an oven at 105°C for 3 hours until a constant weight was achieved. Ash content was determined by ashing in a furnace at 600°C for 30–60 minutes, followed by cooling in a desiccator and weighing until a constant weight (W2) was obtained (Handayani et al., 2020).

Color analysis

Color analysis was performed following McLellan et al. (1994) using a CR-300 Minolta chromameter. The chromameter provided Hunter L values. Flour color was analyzed based on the L* value, which ranged from 0 (black) to 100 (white).

RESULTS AND DISCUSSION

The pH, total acidity, and total yeast population of the fermentation water from porang tuber chips are presented in **Table 1**. Fermentation was conducted anaerobically using Saccharomyces cerevisiae at concentrations of 10%, 20%, and without yeast addition (0%).

Table 1. pH, total acidity, and total microorganisms of fermented porang flour

pH	**0 h**	**24 h**	**48 h**	**72 h**
S. cerevisiae 0%	5,44±0,12^{b}	5,38±0,23	5,26±0,19	5,07±0,02^{b}
S. cerevisiae 10%	6,01±0,10^{a}	5,45±0,05	5,30±0,10	5,37±0,04^{a}
S. cerevisiae 20%	5,87±0,08^{a}	5,31±0,03	5,29±0,03	5,15±0,09^{b}
Total Acidity(%)	**0 h**	**24 h**	**48 h**	**72 h**
S. cerevisiae 0%	0,21±0,05	0,75±0,10^{a}	1,23±0,31	1,86±0,18^{a}
S. cerevisiae 10%	0,09±0,00	0,48±0,10^{b}	0,84±0,13	0,87±0,22^{b}
S. cerevisiae 20%	0,12±0,12	0,75±0,05^{a}	0,99±0,18	1,62±0,64^{ab}
TPC (log CFU/mL)	**0 h**	**24 h**	**48 h**	**72 h**
S. cerevisiae 0%	3,73±0,25	3,53±0,15^{b}	3,46±0,09^{b}	3,50±0,33
S. cerevisiae 10%	3,53±0,35	3,70±0,06^{b}	4,06±0,11^{a}	3,53±0,06
S. cerevisiae 20%	3,83±0,31	3,93±0,05^{a}	4,16±0,14^{a}	3,90±0,07

Noted: Means followed by the same letter within a column are not significantly different, whereas means followed by different letters indicate significant differences. Values not followed by letters indicate no significant effect of treatment.

A significantly lower pH was observed in the 0% *S. cerevisiae* treatment during fermentation compared with the other treatments, as indicated by Duncan's multiple range test ($p < 0,05$). Prolonged fermentation resulted in a further decrease in the pH of porang fermentation water, which is attributed to increased organic acid production (Ramadhan et al., 2012). A decrease in pH during fermentation could be caused by the degradation of glucose into organic acids such as lactic acid and acetic acid by certain microorganisms such as lactic acid bacteria (Helmi & Karsiningsih, 2024).

The pH values observed in this study were correlated with alcohol production by *Saccharomyces cerevisiae*. During fermentation, the 10% inoculum treatment consistently exhibited higher pH values than the 20% treatment. This observation is consistent with previous findings reporting higher ethanol production at lower inoculum levels (Wardani and Pertiwi, 2013). In contrast, the persistently lower pH observed in the 20% treatment may be attributed to the accumulation of toxic metabolic by-products associated with excessive inoculum density. Such conditions can limit yeast growth and metabolic activity by restricting nutrient availability and cell interactions (Mukhtar et al., 2010). The pH variations across treatments indicate active yeast metabolism during fermentation.

Total titratable acidity (TTA) at 0 and 48 h did not differ significantly among treatments, whereas significant differences were observed at 24 and 72 h (**Table 1**). The highest TTA value (1.86%) was recorded in the control treatment (0% Saccharomyces cerevisiae) after 72 h of fermentation. This increase may be attributed to the growth of organic acid–producing microorganisms other than yeast in the control treatment. Higher TTA values have been associated with the dominance of acid-producing microorganisms, particularly lactic acid bacteria (Röling, 1994; Pangestika et al., 2021). In addition,

fermentation time significantly influenced acidity, with longer fermentation periods resulting in increased total acid production (Firdaus, 2019).

The 10% concentration treatment showed lower total titratable acidity (TTA) compared to the 0% and 20% treatments throughout the fermentation process. This may be due to the fact that one of the end products of fermentation by *Saccharomyces cerevisiae* yeast is alcohol. According to Helmi et al. (2024), *S. cerevisiae* utilizes simple sugars and converts them into alcohol. Total acidity in the 20% treatment tended to increase daily during porang fermentation. Fermentation duration at 10% and 20% concentrations produced by-products such as alcohol and CO_2, which contributed to the increasing TTA.

The ethanol generated during porang fermentation can be converted by acetic acid bacteria into acetic acid, thereby increasing total acidity (Helmi & Karsiningsih, 2024). Ethanol concentration during porang fermentation peaked at 813.85 ppm at 48 hours, then decreased to 253.76 ppm at 72 hours (Helmi et al., 2024). This indicates that between 48 and 72 hours, acetic acid bacteria metabolized ethanol into acetic acid. According to Chapp et al. (2024), acetic acid is a short-chain bioactive fatty acid produced in large quantities from ethanol metabolism.

The population of *S. cerevisiae* at 0 and 72 hours showed no significant differences among treatments. In contrast, at 24 and 48 hours, significant differences were observed, as shown in **Table 1**. Duncan's test indicated that the *S. cerevisiae* population at 24 hours in the 0% and 10% treatments differed from the 20% yeast concentration (Table 1). Fermentation naturally occurred, allowing yeast growth even in the 0% treatment. According to Helmi et al. (2024), naturally occurring yeast during porang fermentation was dominated by the genus *Candida* at 0 and 24 hours, and by *Cyberlindnera* at 48 and 72 hours.

Yeast populations tended to decrease by 72 hours, which is related to the rapid growth phase of *S. cerevisiae*. Yeast cells consumed large amounts of sugar from 0 to 24 hours. After 24 hours, cell growth slowed as the number of cells increased until 48 hours and sugar consumption decreased by 72 hours (Buckee & Hagritt, 1978). Baronil et al. (2018) reported that the logarithmic phase is characterized by an increase in cell number and biomass, resulting in ethanol production as a primary metabolite. Ethanol is thus one of the main products generated during the exponential growth phase (Sari et al., 2008). The decline in yeast cell numbers at 72 hours is likely due to limited metabolic activity.

In the 10% and 20% yeast treatments, total cells increased continuously until 48 hours, followed by a decline at 72 hours. The decrease in total cells at 72 hours indicates entry into the death phase, likely due to the accumulation of toxic fermentation by-products, including alcohol and carbon dioxide. CO_2 produced during fermentation can inhibit *S. cerevisiae* growth (Azizah et al., 2012). The accumulation of ethanol during fermentation contributes to the inhibition of fungal growth (Pérez-Gallardo et al., 2013; Rodrigues et al., 2015; Varize et al., 2022). Anaerobic fermentation by *S. cerevisiae* beyond 72 hours is no longer effective, as the yeast has entered the death phase (Wahono et al., 2011). Yeast enzymatic activity increased during the first 48 hours of fermentation, reaching a high level that indicates fermentation can be terminated (Helmi et al., 2024).

Quality of porang flour

The quality of porang flour was evaluated based on yield, calcium oxalate content, glucomannan content, starch content, moisture content, ash content, and color, as these parameters reflect the characteristics of porang tubers fermented.

Table 2. The results of the analysis on porang flour included yield, calcium oxalate content, glucomannan content, and starch content.

Sample	Yield	Ca-Oksalat	Glukomanan	Starch content
S. cerevisiae 0%	4,85±0,17[ab]	7,35±0,54[a]	39,79±14,75	52,97[c]
S. cerevisiae 10%	4,98±0,24[a]	4,65±0,23[c]	40,72±9,74	60,24[a]
S. cerevisiae 20%	4,18±0,46[b]	5,40±0,49[b]	48,51±2,79	54,37[b]

Noted: Means followed by the same letter within a treatment column are not significantly different, whereas means followed by different letters indicate significant differences.

Porang flour showed the highest yield at the 10% *S. cerevisiae* treatment, whereas the lowest yield was observed at the 20% treatment (**Table 2**). The yield from the 0% treatment was lower than that of the 10% treatment, which may be attributed to the growth of diverse indigenous microorganisms that enhanced sugar degradation in porang tuber chips. The activity of these microorganisms was evidenced by a decrease in pH and an increase in total titratable acidity (TTA), indicating intensive degradation processes, despite the total plate count (TPC) being lower than those observed in the 10% and 20% treatments. According to Edam (2017), lactic acid bacteria in starchy foods are able to produce enzymes such as amylase and amyloglucosidase, which hydrolyze starch into glucose as a primary energy source. In addition, studies on modified cassava flour (mocaf) fermentation have demonstrated that prolonged fermentation duration tends to reduce yield (Wulandari et al., 2021)

The 10% *S. cerevisiae* treatment was identified as optimal, yielding 4.98% flour. This high yield was influenced by tuber carbohydrate content, yeast utilization efficiency, and effective fermentation conditions. In contrast, the 20% yeast concentration resulted in the lowest yield (4.18%), which can be attributed to intensified amylolytic activity, promoting starch depolymerization into soluble sugars and ultimately reducing flour recovery. Fungi, especially yeasts, are capable of producing amylase and ethanol during fermentation (Riesute et al., 2021). Amylase catalyzes the hydrolysis of starch into simpler soluble sugars, such as glucose, which can dissolve into the fermentation medium (Bhattacharjee et al., 2019; Parapouli et al., 2020; Chávez-Camarillo et al., 2022).

The calcium oxalate content based on Duncan's test showed significant differences among treatments, as presented in **Table 2**. The highest calcium oxalate content was observed in the 0% treatment, with a value of 7.35 mg/100 g. This indicates that calcium oxalate degradation was primarily caused by organic acids produced by lactic acid bacteria rather than by yeast. The mechanism of calcium oxalate reduction during fermentation involves hydrolysis by oxalate-degrading enzymes present in lactic acid bacteria (Ferdian et al., 2021). Treatments with 10% and 20% *Saccharomyces cerevisiae* resulted in lower calcium oxalate content compared to the 0% treatment after 72 hours of fermentation. *S. cerevisiae* fermentation appears capable of solubilizing calcium oxalate crystals in porang tubers via metabolites such as ethanol and acetic acid. According to Kurniawati and Widjanarko (2010), longer ethanol exposure during stepwise washing decreases calcium oxalate levels in porang flour.

A lower calcium oxalate content was observed in the 10% treatment compared with the 20% treatment, with values of 4.65 and 5.40 mg/100 g for the 10% and 20% treatments, respectively (**Table 2**). This difference may be attributed to the higher ethanol concentration in the 20% treatment, which inhibited the metabolic activity of

Saccharomyces cerevisiae. Consequently, glycolytic activity was disrupted, likely due to reduced carbon source utilization. According to Fiedurek et al. (2011), high ethanol concentrations (11%) can inhibit *S. cerevisiae* metabolism.

The highest glucomannan content was observed in the 20% treatment, reaching 48.51%, while the lowest was found in the 0% treatment at 39.79%. According to the Indonesian National Standard (SNI 7929:2020), glucomannan quality is classified into Grade I (>35%), Grade II (25–<35%), and Grade III (15–<25%). all samples in this study were classified as Grade I, with glucomannan content above 35%. Glucomannan, the major constituent of porang flour, is commonly used as an indicator of its quality. The 20% treatment showed the highest glucomannan content. However, differences among treatments were not statistically significant (Duncan's test in table 2). washing porang chips with 60% ethanol as a solvent resulted in a higher glucomannan content of 64.22% (Saputro *et al*. 2014).

The 10% treatment exhibited the highest starch content (60.24%), while the lowest was observed in the 0% treatment (52.97%) (**Table 2**). This may be due to the growth of endogenous amylolytic microbes during fermentation. Helmi et al. (2024) reported that porang fermentation is dominated by several yeast species, including Candida, which predominates during the 24 h and is capable of starch degradation (Pratama et al., 2021). At 10%, starch content was lower than at 20%, showing a negative correlation with both glucomannan content and yield (**Table 2**). This may be due to the lower total phenolic content (TPC) in the 10% treatment, resulting in less starch degradation. During fermentation, intracellular breakdown releases insoluble components such as starch, fats, and proteins, which are then hydrolyzed by microbial enzymes (Widhiastiti et al., 2022). Aryanti and Abidin (2015), as cited in Pasaribu et al. (2019), reported that extraction leads to losses of minerals, starch, fiber, and simple sugars. In both the 10% and 20% treatments, yeast degraded starch, producing ethanol through amylase activity. Starch serves as the primary carbon source for ethanol production in yeast fermentation (Riesute et al., 2021).

Table 3. Analysis of moisture, ash, and whiteness of porang flour.

Sample	Moisture content	Ash content	Lightness
S. cerevisiae 0%	8.16±1.75^{a}	7.55±1.69^{a}	79.32^{b}
S. cerevisiae 10%	6.75±1.08^{ab}	4.22±0.49^{b}	80.59^{a}
S. cerevisiae 20%	5.41±0.66^{b}	2.71±1.88^{c}	77.87^{c}

Noted: Values in the same column with the same letter are not significantly different; different letters indicate significant differences

The moisture content based on Duncan's test showed significant differences among treatments. The lowest moisture content was observed at the 20% concentration (5.41%), while the highest was found at the 0% concentration (8.16%) (**Table 3**). Low moisture content in flour can inhibit the growth of fungi and bacteria, thereby extending shelf life. According to Dwiyono et al. (2014), low moisture content reduces bacterial activity and enzymatic reactions, which contributes to improved material stability. During fermentation, water diffusion into the material remained relatively constant because the soaking water volume was maintained throughout the fermentation process (Mardani et al., 2013). This condition contributed to the maintenance of relatively stable moisture content throughout the fermentation process.

The results of Duncan's test on ash content showed significant differences among treatments. The ash content at the 0% treatment was 7.55% (**Table 3**), which did not comply with the applicable quality standard. The high ash content observed in this treatment indicates a high mineral content in porang flour. High mineral content, particularly calcium, may affect the digestive process, as food materials with elevated mineral levels are more difficult to digest. According to Ambarsari et al. (2009), a high ash content in food products reflects a high mineral concentration. At the 10% treatment, the ash content decreased to 4.22% (Table 3), complying with the quality standard for Category II. The 20% treatment was the most effective, producing the lowest ash content of 2.71% (**Table 3**), which complied with the Category I quality standard (<4%). The reduction in ash content is consistent with Kartika et al. (2021), who reported that lower ash content is directly associated with decreased mineral levels during soybean fermentation. Ethanol produced during fermentation by *Saccharomyces cerevisiae* is presumed to dissolve inorganic compounds such as calcium oxalate and other mineral components. This finding is in accordance with Wardani and Hardianto (2019), who reported that ethanol can dissolve calcium oxalate and other inorganic mineral compounds present in porang flour.

The lightness (L) of porang flour was analyzed based on vertical coordinates, where 0 represents black and 100 represents white (Zarubica et al., 2005). After 72 hours of fermentation, the highest lightness value was observed in the 10% yeast concentration treatment at 80.59%, whereas the 20% treatment showed the lowest value at 77% (Table 13). This difference may be influenced by the starch content in porang flour. Fermentation combined with soaking affects pigment degradation in food materials (Chavez, 2006). Soaking induces pigment degradation, which is presumed to remove some color compounds. As fermentation progresses, additional pigments are lost, resulting in a whiter appearance (Aisah et al., 2021).

CONCLUSIONS

Fermentation using *Saccharomyces cerevisiae* as a starter was effective in reducing calcium oxalate content in porang flour. The lowest calcium oxalate level was observed in the 10% yeast treatment, measuring 4.65 mg/100 g. The glucomannan content of porang flour was enhanced by fermentation with *Saccharomyces cerevisiae*, which produces ethanol as its main metabolite, reaching the highest level of 48.51% in the 20% yeast concentration treatment. The best quality of porang flour for the 10% yeast concentration treatment was observed in terms of yield (4.98%), starch content (60.24%), and color (lightness, 80.59%), whereas the optimal moisture and ash contents were obtained in the 20% treatment, with values of 5.41% and 2.71%, respectively. The quality of porang flour complied with the Indonesian National Standard (SNI No. 7939:2013), indicating that it is a high-quality product.

REFERENCES

Aisah, A., Harini, N., & Damat, D. (2021). Pengaruh waktu dan suhu pengeringan menggunakan pengering kabinet dalam pembuatan MOCAF (modified cassava flour) dengan fermentasi ragi tape. *Food Technology and Halal Science Journal*, *4*(2), 172-191.

Alevalia, A., & Arvianti, E. Y. (2023). Analisis Usahatani Porang Sebagai Upaya Diversifikasi Pangan Di Masa Mendatang. *Jurnal Ekonomi Pertanian Dan Agribisnis*, *7*(2), 615-622.

Ambarsari, I., Sarjana, & A. Choliq. (2009). Rekomendasi Dalam Penetapan Standar Mutu Tepung Ubi Jalar. Ungaran.

Arifin, M.A. (2001). Pengeringan Keripik Umbi Ilesiles secara Mekanik untuk Meningkatkan Mutu Keripik Iles. [Tesis]. Bogor : Teknologi Pasca Panen PPS IPB.

Azizah, N., Al-Barrii, A. N., & Mulyani, S. (2012). Pengaruh lama fermentasi terhadap kadar alkohol, pH, dan produksi gas pada proses fermentasi bioetanol dari whey dengan substitusi kulit nanas. *Jurnal Aplikasi Teknologi Pangan*, *1*(3).

Baronil M.D., S. Colombo & E. Martegani. (2018). Antagonism between salicylate and the cAMP signal controls yeast cell survival and growth recovery from quiescence. Dipartimento di Biologia, Università di Padova, Italy. Microbial Cell Vol. 5 No. 7 pp: 344-356.

Bhattacharjee I, Mazumdar D, Saha SP. (2019). *Microbial amylases and their potential application in industries*: A review. Structure 8: 162- 170.

Buckee, G. K., dan Hargitt, R. (1978). *Measurement of carbohydrates in wort and beer, a review*. Journal of Institution of Brewing Research. 84(1): 13-21.

BSN. (2020). *Serpih Porang*. SNI No. 7939:2020. Jakarta: Badan Standarisasi Nasional.

Chapp, A.D.; Shan, Z.; Chen, Q.-H. (2024). *Acetic Acid: An Underestimated Metabolite in Ethanol-Induced Changes in Regulating Cardiovascular Function. Antioxidants* 2024, 13, 139. https://doi.org/10.3390/ antiox13020139

Chua, M. (2011). *An investigation of the biology and chemistry of the chinese medical plant Amorphophallus konjac*. Disertasi. University of wolverhampton.

Chavez, A. L. Sanchez, T. Ceballos, H. Rodrigues-Amaya, D.B. Nestel, P. Tohme, J. Ishitani, M. (2006). *Retention of Carotenoids in Cassava Roots Submitted to Different Processing Methods.* Colombia: John Wiley & Sons, Inc.

Cha´vez-Camarillo GM, Vianey P, Jime RA, Aranda-garcı E, CristianiUrbina E. (2022). *Production of extracellular α -amylase by singlestage steady-state continuous cultures of Candida wangnamkhiaoensis in an airlift bioreactor*. Plos one 17 (3): e0264734. DOI: 10.1371/journal.pone.0264734.

Dwiyono, K., Sunarti, T. C., Suparno, O., & Haditjaroko, L. (2014). Penanganan Pascapanen Umbi Iles-Iles (*Amorphophallus muelleri* Blume) Studi Kasus di Madiun Jawa Timur. *Jurnal Teknologi Industri Pertanian*, 24(3):179-188.

Edam, M. (2017). Aplikasi bakteri asam laktat untuk memodifikasi tepung singkong secara fermentasi. *Jurnal Penelitian Teknologi Industri Vol*, *9*(1), 1-8.

Faridah, A. and Widjanarko, S.B., (2013). *Optimization of Multilevel Ethanol Leaching Process of Porang Flour (Amorphophallus muelleri) Response Surface Using Methodology*. *International Journal on Advanced Science and Engineering Information Technology*, 3(2).

Febrianti, E. P., & Wardani, R. K. (2022). Reduksi Kadar Oksalat dalam Umbi Porang Menggunakan Variasi Konsentrasi, Suhu dan Lama Perendaman dalam Larutan NaCl dan Akuades. *Rekayasa*, *15*(3), 362-367.

Firdaus, R. Z. (2019). Pengaruh penambahan Garam NaCl dan Campuran Mikroorganisme *Acetobacter aceti* dan *Saccharomyces cerevisiae* Terhadap Perubahan Kadar Oksalat dan Asam Total pada Fermentasi Kubis (*Brassica oleraceae*). [SKRIPSI]. Malang: FMIPA . Universitas Brawijaya

Ferdian, M. A., & Perdana, R. G. (2021). Teknologi Pembuatan Tepung Porang Termodifikasi Dengan Variasi Metode Penggilingan Dan Lama Fermentasi. *Jurnal Agroindustri*, *11*(1), 23-31.

Hamdhan, R. Al. (2021). Dampak Usahatani Komoditas Porang Terhadap Kesejahteraan Masyarakat Di Desa Klangon, Kecamatan Saradan, Kabupaten Madiun. Agricore: Jurnal Agribisnis Dan Sosial Ekonomi https://doi.org/10.24198/agricore.v5i2.30614

Handayani, T., Aziz., Y. T., Herlinasari, Depit. (2020). Pembuatan dan Uji Mutu Tepung Umbi Porang (*Amorphopallus Oncophyllus Prain*) di Kecamatan Ngrayun. Jurnal Medfarm: Farmasi dan kesehatan. 9: 13-21.

Helmi, H., & Eni, K. (2024). The Physical, Chemical, Microbiological, Antibacterial and Prebiotic Characteristics of Fermented Porang Flour with Addition of Bacteria and Yeast. *Biosaintifika: Journal of Biology & Biology Education*, *15*(1).

Helmi, H., Kusmiadi, R., Mahardika, R. G., & Karsiningsih, E. (2024). Diversity of fungi and dynamics of ethanol concentration during fermentation of porang (Amorphophallus oncophyllus). *Biodiversitas Journal of Biological Diversity*, *25*(2).

Hidayah, R. (2016). Budidaya umbi porang secara intensif. Universitas gajah mada.

Hidayah, N., Suhartanto, MR and Santosa, E. (2018) 'Pertumbuhan dan Produksi Iles-iles (*Amorphophallus muelleri* Blume) dari Berbagai Teknik Budidaya,Bul. Agrohorti, 6(3), hlm. 405–411. doi: 10.1017/CBO9781107415324.004.

J. Fiedurek, M. Skowronek, A. Gromada. (2011*) Selection and adaptation of S. cerevisiae to increased ethanol tolerance and production*, Pol. J. Microbiol. 60. 51–58.

Kurniawati, A. D., & Widjanarko, S. B. (2010). Pengaruh Tingkat Pencucian dan Lama Kontak Dengan Etanol Terhadap Sifat Fisik Dan Kimia Tepung Porang (*Amorphophallus Oncophyllus*). *Malang: Universitas Brawijaya*.

McLellan MR, Lind LR, Kime RW. (1994). *Hue angle determinations and statistical analysis for multiquadrant hunter L, a, b data*. J Food Quality 18: 235–240. DOI: 10.1111/j.1745-4557.1995.tb00377. x.

Mardani, A., J. Sumarmono., & T. Setyawardani. (2013). Total Bakteri Asam Laktat Kadar Air, dan Protein Keju Peram Susu Kambing yang Mengandung Probiotik *Lactobacillus casei* dan *Bifidobacterium longum. Jurnal Imliah Peternakan,* 1(1):244-253.

Mukhtar, K., Asgher, M., Afghan, S., Hussain, K. dan Zia ul-Hussnain, S. (2010). *Comparative study on two commercial strains of S. cerevisiae for optimum ethanol production on industrial scale*. Journal of Biomedicine and Biotechnology 2010: 1-5.

Parapouli M, Vasileiadis A, Afendra AS, Hatziloukas E. (2020). S. cerevisiae and its industrial applications. AIMS Microbiol 6: 1-31. DOI: 10.3934/microbiol.2020001.

Pasaribu, G., Hastuti, N., Efiyanti, L., Waluyo, T. K., dan Pari, G., (2019). Optimasi Teknik Pemurnian Glukomanan pada Tepung Porang (*Amorphophallus muelleri* Blume). Jurnal Penelitian Hasil Hutan. 37(3): 201-208

Pangestika, L. M. W., Lioe, H. N., Adawiyah, D. R., Suliantari, S., Melzer, G., & Weinreich, B. (2021). Penggunaan ekstrak khamir sebagai nutrisi tambahan pada fermentasi moromi kecap kedelaI. *Jurnal Teknologi Pertanian*, *22*(1), 1-12.

Pérez-Gallardo R V, Briones LS, Díaz-Pérez AL, Gutiérrez S, RodríguezZavala JS, Campos-García J. (2013). *Reactive oxygen species production induced by ethanol in S. cerevisiae increases because of a dysfunctional mitochondrial iron-sulfur cluster assembly system*. FEMS Yeast Res 13: 804-819. DOI: 10.1111/1567- 1364.12090.

Pratama, A., Balia, R. L., & Suryaningsih, L. (2021). Pengaruh Penambahan Yeast (Candida apicola) Pada Sosis Fermentasi Daging Domba Terhadap Kualitas Fisik, Kimia dan Akseptabilitas. *Agrointek: Jurnal Teknologi Industri Pertanian*, *15*(2), 574-582.

Ramadhan, F. S., Rahim, H., & Wardhani, D. H. (2012). Kajian pertumbuhan Lactobacillus casei pada substrat porang (Amorphopallus oncophillus). *Jurnal Teknologi Kimia Dan Industri*, *1*(1), 237-244.

Rodrigues B, Peinado JM, Raposo S, Constantino A, Quintas C, LimaCosta ME. (2015). *Kinetic and energetic parameters of carob wastes fermentation by S. cerevisiae: Crabtree effect, ethanol toxicity, and invertase repression*. J Microbiol Biotechnol 25: 837- 844. DOI: 10.4014/jmb.1408.08015.

Riesute R, Salomskiene J, Moreno DS, Gustiene S. (2021). *Effect of yeasts on food quality and safety and possibilities of their inhibition*. Trends Food Sci Technol 108: 1-10. DOI: 10.1016/j.tifs.2020.11.022.

Röling, W, F, -M., Timotius, K, -H., Prasetyo, A, -B., Stouthamer, A, -H., Van Verseveld, H, -W. (1994). *Changes in microflora and biochemical composition during the Baceman stage of traditional indonesian kecap (soy sauce) production.* Journal of Fermentation and Bioengineering. 77, 62–70. https://doi. org/10.1016/0922-338X(94)90210-0

Sari. I.M., Noverita dan Yulneriwarni. (2008). Pemanfaatan jerami padi dan alang-alang dalam fermentasi etanol menggunakan kapang Trichoderma viride dan khamir S.s cerevisiae. Vis Vitalis.5(2):55-62.

Standar Nasional Indonesia (SNI). (2013). Serpih porang (SNI 7939-2013). Badan Standardisasi Nasional, Jakarta.

Varize CS, Bücker A, Lopes LD, Christofoleti-Furlan RM, Raposo MS, Basso LC, Stambuk BU. (2022*). Increasing ethanol tolerance and ethanol production in an industrial fuel ethanol S. cerevisiae strain. Fermentation* 8: 1-14. DOI: 10.3390/fermentation8100470.

Wahono, S.K., Damayanti, E., Rosyida, V.T. dan Sadyatu, E.I. (2011). Laju Pertumbuhan *S. cerevisiae* pada Proses Fermentasi Pembentukan Bioetanol dari Biji Sorgum (Sorghum bicolor L.) Conference: Proceedings of National Seminar on Chemical Engineering and Processes - Diponegoro University, Semarang, Indonesia, ISSN: 1411- 4216

Wardani, A. K., & Pertiwi, F. N. E. (2013). Produksi etanol dari tetes tebu *oleh S. Cerevisiae* pembentuk flok (Nrrl–Y 265). *Agritech*, *33*(2).

Wardani, R. K., & Handrianto, P. (2019). Pengaruh Perendaman Umbi dan Tepung Porang Dalam Sari Buah Belimbing Wuluh Terhadap Sifat Fisik dan Kadar Kalsium Oksalat. *Journal of Pharmacy and Science*, *4*(2).

Widhiastiti, N. P. U., Darmayanti, L. P. T., & Pratiwi, I. D. P. K. (2022). Pengaruh Lama Fermentasi dengan Lactobacillus plantarum terhadap Karakteristik Fisikokimia dan Fungsional Tepung Biji Durian (Durio zibethinus Murr). *Jurnal Ilmu dan Teknologi Pangan (ITEPA)*, *11*(1), 100-111.

Widjanarko, S.B., Megawari, J. (2015). Analisis Metode Kolorimetri dan Gravitasi Pengukuran Kadar Glukomanan Pada Konjak (*Amorphopallus konjac*). Jurnal Pangan dan Agroindustri. Vol 3:1

Widjanarko, S. B., & Mawarni R. (2015). Penggilingan Metode Ball Mill dengan Pemurnian Kimia Terhadap Penurunan Oksalat Tepung Porang. *Jurnal Pangan dan Agroindustri,* 3(2):571-581.

Wulandari, F., Nazaruddin, N., & Amaro, M. (2021). Pengaruh jenis bakteri asam laktat dan lama fermentasi terhadap mutu fisik, kimia, organoleptik dan mikrobiologi tepung mocaf. *Prosiding SAINTEK*, *3*, 169-181.

Wulandari, A. (2018). Pengaruh Lama Waktu Fermentasi Kombucha Teh Hijau Daun Jati (*Tectona grandis*) Terhadap Kadar Tanin Total dan Asam Total Tertitrasi (TAT). Program Studi Pendidikan Biologi Jurusan Pendidikan Matematika Dan Ilmu Pengetahuan Alam Fakultas Keguruan Dan Ilmu Pendidikan Universitas Sanata Dharma Yogyakarta 2018, 202.

Zarubica, A.R., Miljkovic, M. N., Purenovic, M. M., & Tomic, V. B. (2005).Color Parameters, Whiteness Indices and Physical Features Of Making Paints For Horizontal Signalization. Facta Universitatis (Physics, Chemistry, and Technology), Serbia, Montenegro. 3:205-216.