Antioxidant capacity of bamboo shoots (Dendrocalamus asper) flour produced under fermentation process by lactic acid bacteria

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Abstract. Bamboo shoot is part of the shoots of bamboo plants that can be consumed. Bamboo shoots can be processed by fermentation. The treatment of fermentation has many advantages such as increasing the fiber content and antimicrobial activity. The aim of this study was to determine the effect of fermentation treatment on antioxidant activity, morphological structure of starch, elemental mineral content and spectrum of functional groups of bamboo shoot flour. The treatments carried out in this study were bamboo shoot flour treated with fermentation for 24 and 48 hours spontaneously and using lactic acid bacteria, viz., Lactobacillus bulgaricus and Lactobacillus casei. Antioxidant activity, total phenol, total flavonoids, SEM, and FTIR were analyzed. The results showed that the antioxidant activity of bamboo shoot flour which experienced 48 hours fermentation had lower antioxidant activity than 24 hours, this was in line with the results of analysis of total phenol and total flavonoids. The morphological form of starch which has been fermented for 48 hours has a smaller granule shape and size and more was broken than 24 hours of fermentation. The elements contained in fermented bamboo shoot flour include carbon, oxygen, potassium and calcium. FTIR results of fermented bamboo shoot flour showed the same spectrum pattern but different absorbance values.

1. Introduction
Bamboo is a family of grasses (Gramineae) which is still one family with rice, corn and wheat. The most consumed part of the bamboo plant is buds. Bamboo varieties that produce bamboo shoots with low HCN content and are safe for consumption include “betung” bamboo (Dendrocalamus asper), whoreled bamboo (Gigantochloa verticillata), “kuning” bamboo (Dendrocalamus litiforus) and giant timber bamboo (Bambusa aldhami). Betung bamboo and temen bamboo are local bamboo which is widely known by the people of Indonesia [1].

Fresh bamboo shoots have the main content of water which is equal to 85.63%. Bamboo shoots have the advantage of having low fat content, high fiber, potassium, carbohydrates, vitamins and minerals. In Indonesia bamboo shoots are usually consumed by cooking into various dishes such as soup, sayur lodeh, spring rolls, and pickles. Research conducted by Wahanani (2014) [2] showed that bamboo shoots can be used as an additional ingredient in making nuggets. In addition to being processed in the form of fresh, bamboo shoots can also be processed in the form of flour. As research conducted by Haryani et al. (2014) [3] about the application of bamboo shoot flour as a substitute for
making donuts. Bamboo shoots can be processed by fermentation. The treatment of fermentation in bamboo shoots can increase the fiber content and cellulose [4]. The treatment of bamboo shoots fermentation is also able to increase antimicrobial activity.

Lactic acid bacteria are found in fermented food and beverage products. Lactic acid bacteria are a group of bacteria that are able to convert carbohydrates (glucose) to lactic acid. *Lactobacillus* is the largest genus in the group of lactic acid bacteria with almost 80 different species. Based on the pattern of fermentation of lactic acid bacteria divided into 2 groups namely homofermentative and heterofermentative. The *Lactobacillus bulgaricus* bacteria have homofermentative properties, which means that these bacteria can produce more than 85% lactic acid during fermentation. *Lactobacillus casei* bacteria have heterofermentative properties, these bacteria will ferment monosaccharides (glucose) into compounds with a simpler structure that produces 50% lactic acid and a small amount of acetic acid, butyrate, propionate, CO₂, and several other end products [5].

The aim of this study was to determine the effect of fermentation treatment on antioxidant activity, morphological structure of starch, elemental mineral content and spectrum of functional groups found in bamboo shoot flour.

2. Materials and methods

2.1. Materials
The main material used in this study was bamboo shoots. Bamboo shoots used are a type of betung bamboo shoot (*Dendrocalamus asper*) obtained from Rawalele Village (6°32’11.4”S 107° 43’29.5E) and Dawuan Kaler Village (6°32’37.1”S 107° 41’34.0E), Dawuan District Subang-West Java, Indonesia, and was identified at Herbarium Bogoriense, Research Center for Biology, LIPI (No. 957/IPH.1.01/If.07/IV/2018). The bacteria used for the fermentation process are lactic acid bacteria whereas *Lactobacillus bulgaricus* FNCC 00041 and *Lactobacillus casei* FNCC 00090. Growing and inoculation of lactic acid bacteria was carried out in the Microbiology Laboratories of Research Center for Appropriate Technology, Indonesian Institute of Sciences.

2.2. Preparation of lactic acid bacteria
Bacterial culture methods (*Lactobacillus bulgaricus* and *Lactobacillus casei*) were carried out by culture of 1 ml of lactic acid bacteria were included in 50 ml of media A consisting of 5% skim and sterile water. Then lactic acid bacteria were incubated for 24 hours. After that, the culture originating from the A medium of 5ml inserted into B media consisting of 5% skim and 500 ml sterile water.

2.3. Preparation of bamboo shoots fermented flour
Making fermented bamboo shoots is done by fresh bamboo shoots peeled, washed, sliced, then soaked with lactic acid bacteria. Immersion was carried out by 1 kg of bamboo shoots soaked using water containing 10% lactic acid bacteria as much as 3 L. Soaking treatment was made 2 treatments, 24 hours and 48 hours. After immersion, the bamboo shoots are washed, dried at 45 °C, crushed, sifted using a size of 40 mesh. The research design can be seen in table 1.

| Treatment                     | Time   |                      |
|-------------------------------|--------|----------------------|
| Control                       |        | 24 hours             |
| *Lactobacillus bulgaricus*    |        | 48 hours             |
| *Lactobacillus casei*         |        |                      |

2.4. Analysis procedure
The chemical analysis was carried out, including moisture, ash, protein, fat and carbohydrate by difference. Determination of moisture and ash content was performed using approved method by
AOAC (1990). Meanwhile, protein content was determined by means of Dumas combustion method using DuMaster Buchi D-480, Switzerland. The fat content was analyzed using Soxhlet with hexane as a solvent. Antioxidant was analyzed using IC$_{50}$ method. Total phenolic content was determined by spectrophotometri method. Total flavonoid content was determined by spectrophotometri method. Morphology pati with SEM. Mineral compound with SEM-EDX. The changes of functional groups of polysaccharides of the flour were identified using Fourier Transform Infra-Red Spectrophotometry (FTIR). The type of spectrometer was Nicolet iS5 Spectrometer Fast Facts.

3. Results and discussions

3.1. Fermentation condition

The conditions during bamboo shoot fermentation were observed by calculating the growth of bacterial counts from 0 hours, 24 and 48 hours as shown in table 2, as well as changes in pH on bamboo shoot immersion media during fermentation from 0 hours, 24 and 48 hours as shown in table 3.

Table 2. Number of lactic acid bacteria based on types of treatment and time of fermentation

| Treatments     | Number lactic acid bacteria (log CFU/ml) |
|----------------|-----------------------------------------|
|                | 0 hours| 24 hours| 48 hours |
| Control        | 5.57±0.13$^{aA}$| 5.71±0.01$^{ab}$| 6.20±0.02$^{ac}$|
| L.bulgaricus   | 6.44±0.01$^{cA}$| 6.86±0.06$^{cB}$| 7.08±0.03$^{cC}$|
| L.casei        | 6.26±0.02$^{bA}$| 6.67±0.02$^{bB}$| 6.98±0.06$^{bC}$|

Note: the numbers followed by different letter codes indicate a significant difference at the 5% significance level. Uppercase letters apply to the same line. Lowercase letters apply to the same column.

Table 2 showed that there was a significant difference in the number of bacteria with 0, 24 and 48 hour fermentation treatments ($P<0.05$). This shows that the longer the fermentation time, the more lactic acid bacteria were produced. The presence of lactic acid bacteria in the control treatment showed that bamboo shoots contained naturally occurring lactic acid bacteria. The lactic acid bacteria fermentation process is influenced by several factors including salt, temperature, pH and the availability of carbohydrates as a food source. According to [6], probiotic bacteria in the Lactobacillus casei group can ferment various kinds of sugar to spur their growth. The growth of lactic acid bacteria requires complex nutrition, such as amino acids, peptides, nucleotide bases, vitamins, minerals, fatty acids and carbohydrates. Bacterial growth at 0 to 24 hours has a faster growth rate than the bacterial growth rate from the 24 to the 48 hours. The speed of bacterial growth is based on the presence of energy and nutrient sources and suitable environmental conditions. The appropriate environment and adequate availability of nutrients will increase bacterial productivity during fermentation time [7].

Table 3. Media pH of bamboo shoot fermentation

| Treatments     | pH  |
|----------------|-----|
|                | 0 hours| 24 hours| 48 hours |
| Control        | 6.31±0.01$^{cB}$| 5.45±0.01$^{cB}$| 4.66±0.01$^{cB}$|
| L.bulgaricus   | 5.54±0.01$^{cA}$| 4.52±0.01$^{cA}$| 3.73±0.04$^{cA}$|
| L.casei        | 5.61±0.01$^{cA}$| 4.62±0.01$^{cA}$| 3.61±0.01$^{cA}$|
Note: the numbers followed by different letter codes indicate a significant difference at the 5% significance level. Uppercase letters apply to the same column. Lowercase letters apply to the same line.

Table 3 showed that there was a significant difference in the degree of acidity both in the fermentation time \((P<0.05)\). The longer the fermentation time shows a significant decrease in pH. This is also related to the longer fermentation time, the higher the amount of lactic acid bacteria produced so that the pH of the media will become more acidic. Fermentation using lactic acid bacteria significantly resulted in a more acidic fermentation condition than the control. This is because the treatment of fermentation using lactic acid bacteria produces more bacteria than the control treatment, so the pH of the solution becomes more acidic [8].

3.2. Nutrient content

The results of the analysis of the nutrient content of bamboo shoots which include moisture, ash, protein, fat and carbohydrate can be seen in Table 4. In general, the highest content is found in fresh bamboo shoots, which is about 85.63% water [1]. The nutritional content of fresh bamboo shoots of the *D. asper* variety has been studied by [9], the results show that bamboo shoots have a protein content of 3.59 g / 100 g, a carbohydrate content of 4.90 g / 100g, and fat 0, 40 g / 100g. The water content in fermented bamboo shoots is very small in the range of 7.96-9.23%. This is because during the process of making bamboo shoot flour the drying process occurs. The moisture content of fermented bamboo shoots is in accordance with the quality requirements of SNI 01-2997-1992 cassava flour, which is a maximum of 12%. The ash content in a food indicates the mineral content contained in it. Bamboo shoots which were treated for 48 hours by *L. bulgaricus* significantly had the least ash content compared to the other treatments which were 1.88 ± 0.00%. Bamboo shoot flour which undergoes a 24-hour fermentation process by *L. casei* bacteria has a significantly higher ash content than the other treatments which is 2.74 ± 0.01%. This shows that the mineral content contained in it is significantly higher than the other treatments.

Table 4. Nutritional content of bamboo shoots (*Dendrocalamus asper*) with fermentation treatment by bacteria *L. bulgaricus* and *L. casei*

| Sample Code | Water (% db) | Ash (% db) | Protein (% db) | Fat (% db) | Carbohydrate (% db) |
|-------------|--------------|------------|----------------|------------|---------------------|
| KH1         | 9.23±0.12\textsuperscript{b} | 2.48±0.02\textsuperscript{e} | 28.40±1.16\textsuperscript{c} | 6.77±0.03\textsuperscript{a} | 62.34±1.21\textsuperscript{a} |
| KH2         | 7.96±0.05\textsuperscript{a} | 2.05±0.001\textsuperscript{e} | 23.98±0.34\textsuperscript{a} | 6.62±0.04\textsuperscript{a} | 67.35±0.29\textsuperscript{c} |
| LBH1        | 8.21±0.31\textsuperscript{a} | 1.96±0.01\textsuperscript{b} | 24.91±1.40\textsuperscript{ab} | 5.66±0.76\textsuperscript{c} | 67.46±2.17\textsuperscript{c} |
| LBH2        | 9.17±0.11\textsuperscript{b} | 1.88±0.0001\textsuperscript{a} | 26.29±1.09\textsuperscript{abc} | 6.32±0.87\textsuperscript{a} | 65.50±1.96\textsuperscript{ab} |
| LCH1        | 8.11±0.31\textsuperscript{a} | 2.74±0.01\textsuperscript{c} | 26.97±0.18\textsuperscript{bc} | 7.21±0.55\textsuperscript{a} | 63.08±0.38\textsuperscript{ab} |
| LCH2        | 8.27±0.17\textsuperscript{a} | 2.28±0.004\textsuperscript{d} | 25.26±1.12\textsuperscript{ab} | 5.82±0.68\textsuperscript{a} | 66.63±1.80\textsuperscript{bc} |

Means with different letters in the same column differ significantly at \(p \leq 0.05\).

The results of the analysis of fat content in fermented bamboo shoots showed that fermented bamboo shoot flour had a low fat content which is in the range of 5.66-7.21%. There was no significant difference in the fat content of bamboo shoots which were treated either spontaneously or fermented using *L. bulgaricus* and *L. casei* bacteria. This shows that there was no effect of treatment of spontaneous fermentation or fermentation using *L. bulgaricus* and *L. casei* bacteria on the fat content of bamboo shoot flour. The low fat content found in fermented bamboo shoots both spontaneously and fermented using *L. bulgaricus* and *L. casei* bacteria causes fermented bamboo shoot flour to be widely used and does not need to worry about the presence of fat in it. During the fermentation process the microbial oil will be formed. Oil produced in the form of single cell oil (SCO), which is an euphemism similar to single cell protein derived from single cell microorganisms [10]. When compared with the results of the analysis in this study, it can be seen that bamboo shoot
flour which has undergone a fermentation process has a higher protein, carbohydrate and fat content compared to fresh bamboo shoots. This is in accordance with the results of research from [9], stating that there was an increase in protein content in bamboo shoots treated with fermentation from 3.1% to 7.1% and 8.1% on day 3rd and 5th of fermentation. Based on research conducted by [10] also showed that mocaf flour modified from L. plantarum lactic acid bacteria produced protease enzyme. The enzyme will hydrolyze the protein into a simple peptide. Increased protein content in mocaf flour is obtained from the activity of protease enzymes produced by microbes during the fermentation process.

The analysis of carbohydrates of fermented bamboo shoots showed that the treatment of spontaneous fermentation for 24 was significantly smaller than the other treatments but not significantly different from bamboo shoot flour which received fermentation treatment by L. casei for 24 hours which was equal to 62.34 ± 1.21%. The carbohydrate content in fermented bamboo shoots is relatively high, which is in the range of 62.34 to 67.46%. The high carbohydrate content in bamboo shoot flour is because bamboo shoot flour has a high fiber content.

3.3. Antioxidant activity
The analysis of IC_{50} antioxidant activity, total phenol and total flavonoids from bamboo shoot flour (Dendrocalamus asper) with fermentation treatment by L. bulgaricus and L. casei bacteria can be seen in Table 5. The results showed that bamboo shoots fermentation treatment for 48 hours produced bamboo shoot flour which had antioxidant activity was lower than the 24-hour fermentation treatment. This was supported by the results of the analysis of total phenol and total flavonoids, the results showed the same pattern. Phenol and flavonoid are compounds that have antioxidant abilities. Decreasing the content of phenol compounds and flavonoids in the sample causes a decrease in antioxidant activity.

| Sample Code | IC_{50} (ppm) | mg gallic acid equivalent / g sampel | mg quercetin equivalent / g sampel |
|-------------|----------------|-------------------------------------|------------------------------------|
| KH1         | 14.61±0.02^a   | 9.50±0.12^a                         | 2.78±0.18^a                        |
| KH2         | 15.84±0.02^b   | 6.73±0.06^b                         | 1.58±0.09^b                        |
| LBH1        | 18.04±0.17^c   | 11.63±0.02^d                        | 6.05±0.06^e                        |
| LBH2        | 18.21±0.04^e   | 8.68±0.04^f                         | 3.46±0.12^f                        |
| LCH1        | 16.14±0.02^c   | 9.20±0.12^d                         | 4.18±0.27^d                        |
| LCH2        | 17.03±0.04^d   | 7.31±0.09^b                         | 2.43±0.04^b                        |

Note: the numbers followed by different letter codes indicate a significant difference at the 5% significance level.

The control treatment showed higher antioxidant activity compared to bamboo shoot flour which received fermentation treatment with lactic acid bacteria. This shows that bamboo shoot flour contains antioxidant compounds naturally. Even the IC_{50} antioxidant activity in the control sample which was fermented for 24 hours was significantly the highest compared to the other samples which was 14.61 ± 0.02 ppm. This means that with a sample concentration of 14.61 ± 0.02 ppm it can ward off DPPH free radicals by 50%. The treatment of bamboo shoot flour fermentation using L. casei bacteria significantly produced flour with higher antioxidant activity compared to flour produced from the treatment of bamboo shoots fermented by L. bulgaricus. This shows that the type of bacteria used for fermentation affects the antioxidant activity of the flour produced. This is in accordance with the results of [11] which showed that the results of measurement of antioxidant activity with the DPPH method depend on the type of isolates, types of media and different cultivation times resulted in different values of free radical inhibition. The crude extract of an ingredient is categorized as potentially antioxidant if it has an IC_{50} inhibitory value of 20 ppm [12]. Fermented bamboo shoots
have IC$_{50}$ inhibitory values in the range of 14-18 ppm. This means that fermented bamboo shoots have the potential to be antioxidants.

The results of the analysis of the total phenol content showed that bamboo shoot flour which was treated with fermentation by *L. bulgaricus* for 24 hours contained phenolic compounds which were significantly higher than the samples with other treatments which were $11.63 \pm 0.02$ mg equivalent gallic acid / g sample. The lowest total phenol content was owned by bamboo shoot flour samples which received spontaneous fermentation treatment for 48 hours which was $6.73 \pm 0.06$ mg equivalent gallic acid / g sample.

The results of the analysis of total flavonoid content in fermented bamboo shoot flour showed that bamboo shoot flour which was treated with fermentation by *L. bulgaricus* bacteria for 24 hours had the highest flavonoid content compared to other samples $6.05 \pm 0.06$ mg equivalent quercetin / g sample. The lowest total flavonoid content was owned by bamboo shoot flour samples which received spontaneous fermentation treatment for 48 hours which was equal to $1.58 \pm 0.09$ mg equivalent to quercetin / g samples.

The content of polyphenol compounds detected in the material depends on the treatment given to the material. In a material there are polyphenol oxidase and ascorbic oxidase enzymes. The enzyme in vegetables will be active when the vegetables are cut and then exposed to oxygen. Polyphenol oxidase and ascorbic acid enzymes will oxidize due to exposure to oxygen. Polyphenol oxidase enzymes play an important role in the process of decomposition of polyphenol compounds contained in the vegetables themselves. The oxidation of the enzyme polyphenol oxidase will cause a decrease in the content of phenol compounds so that antioxidant activity in which have the ability to capture free radicals from these materials will decrease [13].

### 3.4. Scanning electron microscopy

Scanning Electron Microscopy (SEM) is a tool commonly used to determine the morphology and topography of a sample. The results of the analysis of morphology starch bamboo shoots fermented flour can be seen in figure 1. It is known that fermented bamboo shoot starch has polymorphic or not homogeneous shape and size.

![SEM images of bamboo shoots fermented flour.](image)

**Figure 1.** SEM images of bamboo shoots fermented flour.
A = KH1, B = KH2, C = LBH1, D = LBH2, E = LCH1, F = LCH2
The surface morphology was rough, it looks a lot of grooves and fragments on the surface. This shows that starch has been degraded by lactic acid bacteria during fermentation. The form of starch fractions in the fermentation treatment for 48 hours was greater and smaller than the 24-hour fermentation process. The irregular shape of starch granules shows damage to the cell wall due to fermentation treatment. This is in accordance with the results of a study from [14] which states that the irregular shape of the granule is increasingly intensive as the fermentation time increases. Damage to the cell wall during the fermentation process is thought to be due to the activity of cellulolytic enzymes that damage the cell wall. According to [15] changes in starch granules are caused by the activity of cellulolytic enzymes that are intensive in degrading cellulose cell walls so that cell walls are damaged and starch granules are liberated. Starch granules which are liberated are then hydrolyzed by extracellular amylolytic enzyme activity which causes starch granules to become hollow and cause the starch polymer chain to be shorter. Liberation of starch results in changes in the chemical properties, viscosity and morphology of the starch produced. Starch granules that have a large size will be more resistant to the hydrolysis process, so that the enzyme will break down the smaller size granules first [16].

Testing using SEM-EDX (Energy dispersive x-ray spectroscopy) serves to determine the elements contained in the sample. EDX can be used to determine the distribution of mineral elements (mapping) in the sample. Minerals are needed by the human body for metabolic activities such as producing enzymes, helping the formation of antibody substances, channeling oxygen throughout the body and so on. The results of the analysis SEM EDX of bamboo shoots fermented flour can be seen in Table 6. Bamboo shoots are rich in important minerals such as potassium, phosphorus, sodium, calcium, magnesium, and iron [9]. The element that dominates fermented bamboo shoots is carbon, which is in the range 60.62-68.36%. The fermentation treatment using lactic acid bacteria increases the content of potassium and calcium by almost twice as much or more. The fermentation treatment using L. casei for 48 hours produced the least carbon and potassium elements compared to the other samples. The fermented bamboo shoots do not contain mineral elements such as potassium, phosphorus, sodium, magnesium, iron and zinc.

| Sample Code | Element (weight%) |
|-------------|-------------------|
|             | C     | O       | K     | Ca    |
| KH1         | 68.36 | 31.49   | 0.14  | ND    |
| KH2         | 61.60 | 38.90   | 0.16  | 0.14  |
| LBH1        | 62.83 | 36.44   | 0.32  | 0.30  |
| LBH2        | 62.68 | 36.84   | 0.26  | 0.22  |
| LCH1        | 63.72 | 35.58   | 0.37  | 0.34  |
| LCH2        | 60.62 | 38.89   | 0.12  | 0.37  |

Values are average (n=3)

3.5. FTIR
FTIR spectroscopy is a tool used for analysis qualitatively and quantitatively. This tool is widely used to identify natural compounds in the sample. The spectrum result of FTIR can be seen in figure 2. The spectrum results of fermented bamboo shoot flour showed almost the same pattern in each sample even though there were differences in the absorbance value. The pattern that is almost the same in the results of the FTIR spectrum in each sample shows the similarity of the content of secondary metabolites in each sample. Differences in the absorbance values at several peaks in each sample showed a difference in the amount of secondary metabolites. The greater the area under the peak, the higher the concentration of a compound. The functional groups of fermented bamboo shoot flour can be seen in table 7. The analysis results of fermented bamboo shoot flour show that there is an OH bond in the wave number around 3284.53-3294.10 cm⁻¹. there is a CH bond in the wave number around
2916.92-2918.23 cm\(^{-1}\), C = C aromatic ring bond at the peak of the wave 1632.58-1633.18 cm\(^{-1}\), there are aromatic groups at wavelengths of 1500-1600. In the results of the sample spectrum KH1 does not appear in the amine group at wave numbers around 1315-1316 cm\(^{-1}\) while all other samples are detected.

The main functional group area is in the absorption of wave numbers 4000-1500 cm\(^{-1}\). The fingerprint area is in the absorption of wave numbers from 500 to 1500 cm\(^{-1}\). At these wave numbers have a very diverse and specific absorption for each organic compound. The use of infrared spectra for identification can only be done if we have a spectrum of comparable compounds measured in the same conditions by comparing the fingerprint region. Identification of compounds detected in the spectrum with wave numbers from 1500-500 cm\(^{-1}\) is very difficult to do. This is because each compound provides a different pattern in this area [17].

![Figure 2. Spectrum FTIR of bamboo shoots fermented flour](image)

Note: A = KH1, B = KH2, C = LBH1, D = LBH2, E = LCH1, F = LCH2

| Wavelength number (cm\(^{-1}\)) | Functional group | Type of compound                        |
|---------------------------------|------------------|----------------------------------------|
| 3284.53-3294.10                 | -OH              | Alcohol, phenol (bond H), carboxylic acid |
| 2916.92-2918.24                 | C-H              | Alkanes                                |
| 1632.58-1633.18                 | C=C              | Aromatic (ring)                        |
| 1536.99-1537.59                 | C=C              | Aromatic (ring)                        |
| 1315.67-1316.47                 | C-N              | Amine                                  |
| 1236.51-1239.16                 | C-N ; C-O        | Amine, alcohol, ether, carboxylic acid, ester |
| 1034.40-1038.73                 | C-O              | Alcohol, ether, carboxylic acid, ester  |
4. Conclusion
Based on the results of the analysis showed that the antioxidant activity of bamboo shoot flour which experienced 48 hours fermentation had lower antioxidant activity than 24 hours. This was in line with the results of analysis of total phenol and total flavonoids. The morphological form of starch which has been fermented for 48 hours has a smaller granule shape and size and more is broken than 24 hours of fermentation. The elements contained in fermented bamboo shoot flour include carbon, oxygen, potassium and calcium. FTIR results of fermented bamboo shoot flour showed the same spectrum pattern but different absorbance values.

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