Evaluation of Nutrient, Microbial and Economy Values of Bamboo Shoots (*Dendrocalamus Asper*) Kimchi

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Abstract: Betung bamboo shoots are a type of vegetable in the form of young shoots that grow from the roots of the betung bamboo tree. To extend the shelf life of betung bamboo shoots is by processing bamboo shoots into kimchi. The aim of this study is to evaluate the nutrient, microbiological values and the feasibility of bamboo shoot kimchi product. The research conducted: (1) the physical and cyanide content of fresh and processed bamboo shoots, (2) making bamboo shoots kimchi, (3) nutrition and total microbial analyzed and feasibility of bamboo shoots kimchi products. The results showed cyanide content of fresh-cut bamboo shoots content of 266.21 µg/mL, meanwhile bamboo shoots after boiling and soaking contained 46.73 µg/mL. The nutrition content of bamboo shoots kimchi showed a moisture content of around 89 - 90%, ash (11-14% dwt), fat (4-12% dwt), protein (12-18% dwt), carbohydrates (50-73% dwt), crude fiber (9-25% dwt), total bacteria (TPC) and total lactic acid bacteria (LAB) in bamboo shoots ranging from 7.67 to 8.69 Log cells/mL, and 7.60–8.05 Log cells/mL, respectively. The analysis of techno-economics of bamboo shoots kimchi is financially feasible to run.

1 INTRODUCTION

Indonesia is an agricultural country that has abundant natural resources. Various types of plants can grow well and have functional properties that are beneficial to human health. The Director of Business Development and Investment of the Directorate General of Agriculture Product Processing and Marketing (PPHP) of the Ministry of Agriculture stated that currently, national fruit and vegetable consumption is approximately 40kg /capita/year. The consumption level is still below the standard of adequate food for fruits and vegetables set by FAO, which is 65.75 kg /capita/year (Badan Pusat Statistik, 2012).

One of the typical vegetables consumed by Indonesian people is bamboo shoots. Bamboo shoots are a typical plant of the Asian continent (Handoko, 2003). Bamboo shoots are young shoots from bamboo trees that grow from the roots of bamboo trees (Rachmadi, 2011). Bamboo shoots are one type of vegetable that has been known and consumed by humans in various parts of the world. Bamboo shoots have a crunchy, sweet texture and have a distinctive smell of bamboo shoots (Rizkiyani *et al*, 2016).

The ingredients contained in fresh bamboo shoots are water, protein, carbohydrates, fiber, fat, vitamin A, thiamin, riboflavin and vitamin C and some minerals including calcium, phosphorus, iron and potassium. The content of protein, fat and carbohydrates in bamboo shoots is not much different compared to other vegetables. The dietary fiber content in bamboo shoots is quite high, which is around 2.56%, 10% higher than other tropical vegetable species such as 1.27% soybean sprouts, 0.61% cucumber and mustard 1.01% (Handoko, 2003).

Vegetables, especially those with green leaves, are one good food because they contain vitamins and minerals, including vitamin C, provitamin A, iron, and calcium. Vegetables can grow in a variety of different environmental and temperature conditions,

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so they vary in variety. One of the properties of vegetables is that they quickly wither and rot due to inadequate handling of off-harvest. To extend the shelf life can be done by various processing, for example made kimchi, pickles, sauerkraut, salted vegetables, crackers, and others.

The processing of vegetables that is currently starting to attract the public is Kimchi. Kimchi is a kind of pickled vegetable fermented with hot spices. Vegetables salted for several hours are then washed and given spices made from a mixture of krill shrimp, fish sauce, garlic, ginger, and red chili powder. In addition, kimchi is also believed to be beneficial for the health of the human body because it contains high levels of dietary fiber and has a low-calorie content (Park *et al* 2014).

The lactic acid fermentation process occurs perfect if the factors that affect the growth of lactic acid bacteria can adequately control. At the beginning of the general fermentation of lactic acid bacteria that grow is *Leuconostoc mesenteroides*. Factors that influence the growth of lactic acid bacteria include fermentation temperature, salt levels added, and the presence of nutrients (Azka *et al*, 2014).

According to Pradani and Hariastuti (2009), the fermentation process in vegetables influenced by the level of salt solution used. The level of salt solution that is too low (less than 2.5%) results in the growth of decomposing bacteria and proteolytic bacteria (bacteria that break down proteins), while high salt concentrations exceeding 10% do not recommend because they can cause the growth of halophilic bacteria or even inhibit the ongoing fermentation process (Pradani and Hariastuti, 2009). The level of salt that is too high will reduce acid production. The concentration of salt causes lactic acid bacteria to be less able to convert sugar and create yeast growth (Sadek *et al*, 2009). According to Ali (2014), the addition of salt in the fermentation process can help reduce oxygen solubility in water and can inhibit the activity of proteolytic bacteria.

There have been many studies on fermentation of vegetables and fruits, such as Wulan's (2004) research on carrot particles, Saskia *et al.* (2017) regarding bamboo shoots, Fathonah (2009) regarding salted mustard, and Lestari's research (2017) regarding turnip kimchi. Research on bamboo shoot kimchi is still scared, especially the evaluation of the value of nutritional content, microbes, and techno-economic analysis. The aim of this study is to evaluate the nutrient, microbiological values and the feasibility of bamboo shoot kimchi product.

2 MATERIALS AND METHODS

2.1 Materials

The material used in making bamboo shoots, which are 25 kg of betung (*Deandrocalamus asper*) bamboo shoots, was obtained in the area of Dawuan Kidul Village - Subang, West Java-Indonesia (6º32'37.1 "S 107º 41'34.0E). Botanical identification has been carried out at Herbarium Bogoriense, Biology Research Center - LIPI (No. 957 /IPH.1.01/if.07/IV/ 2018). Salt, chili, garlic, onion, ginger, soy sauce, sugar, and rice flour obtained from the Traditional Market in Subang, West Java-Indonesia. The material used for analysis in the chemical analysis was 25% HCl, n-hexane, 1N NaOH, 1% phenoftalin, chloroform, 3N HCl, sodium carbonate, picric acid, KCN, and distilled water.

The tools used in making bamboo shoots are plastic basins, plastic gloves, spoons, knives, cutting boards, filters, knives, and jars. The tools used for analysis are erlenmeyer, beaker, analytical scales, test tubes, funnels, flasks, soxhlet, condensers, saucers, glass bottles, volumetric flasks, furnaces, oven, desiccators, spectrophotometers, Du-Master, and pippet 10mL.

2.2 Methods

The research is divided into four stages which include: (1) physical and cyanide analysis of fresh and processed bamboo shoots (Fig 1); (2) making bamboo shoot kimchi; (3) analysis of nutrient content and total microbial kimchi shoots and (4) calculation of bamboo shoot kimchi techno-economy.

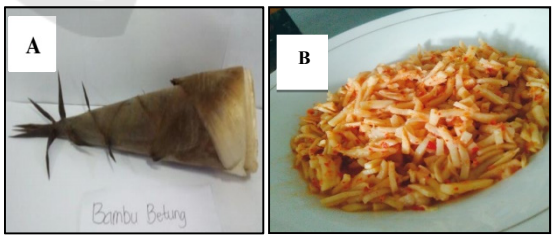

Figure 1: Fresh Bamboo shoots (**A**) and processed bamboo shoots kimchi (**B**) (Picture: P2 TTG-LIPI collection).

2.3 Sample Preparation

Fresh betung bamboo shoots are sorted and trimmed to separate the skin and bamboo shoots. Bamboo shoots are washed three times with running water, then drained and cut with a uniform size of ± 2-3 mm thick. Cut bamboo shoots are boiled with 1% salt

solution soaked, then drained. Bamboo shoots are then soaked in salt solution with a concentration of 3% (KR.1), 5% (KR.2) and 7% (KR.3) for 5 hours, drained, washed again. The ingredients are then mixed into bamboo shoots, packaged in glass jars, and fermented for 6 days. Bamboo shoot Kimchi is ready to be analyzed.

2.4 Procedure Analysis

The value of nutrient content observed, namely: water content (AOAC, 2007), ash content (AOAC, 1999), fat content and protein content (Lestari, 2017), carbohydrate levels (Yenrina, 215), crude fiber content (AOAC, 1995), energy is calculated using Atwater factors (1g fat = 9 kcal; 1 g protein = 4 kcal; and 1 g carbohydrate = 4 kcal), and total microbes, ie total lactic acid bacteria and total plate count (Fardiaz, 1992). Calculation of techno-economic analysis to determine the feasibility of making bamboo shoot kimchi.

2.5 Data Analysis

Data presented in mean ± standard deviation (SD). Analysis of variance (ANOVA) was conducted to see the differences between treatments using the Microsoft Excel 2013 program. Techno-economic calculations were carried out by determining investment costs, production costs, and business feasibility tests. The feasibility test has seen from the results of the break event point calculation, payback period, benefit-cost ratio, and return of investment of the entire process of bamboo shoot kimchi.

3 RESULTS AND DISCUSSION

3.1 Physical and Cyanide Content of Raw Materials

Bamboo shoots contain cyanide compounds, taxiphylin, which is poisonous for human consumption, so it needs further processing and processing to consume it (Singhal *et al*, 2017). The results of physical analysis and levels of cyanide in fresh betung shoots (Table 1) showed that the raw material of fresh bamboo shoots contained cyanide content of 266.21 µg/mL. Further processing, boiling for 20 minutes is done to reduce cyanide content. Cyanide content in bamboo shoots after boiling and soaking is 46.73 µg/mL. These results meet the safe limits of cyanide (HCN) content for consumption (<50 mg/L) (FAO, 2011).

Table 1: Result of physical analysis and levels of cyanide of bamboo shoots.

Sample	pH	Titrated acid (%)	Cyanide (µg/mL)
Fresh bamboo shoots	6.49	0.01	266.21
Bamboo shoots resulting from boiling and soaking	6.21	0.02	46.73

*Data is an average (n=3).

3.2 Nutrition Content of Bamboo Shoots Kimchi

Bamboo shoots are a food ingredient that often found in Indonesian cuisine. Diversification of bamboo shoot products into kimchi provides the added value of bamboo shoots both economically and their utilization. One of the uses for bamboo shoots can see from the substances contained in bamboo shoots.

The nutrition value of betung bamboo shoots (*D. asper*) (Table 2) shows that most bamboo shoot kimchi has a water content of about 89 - 90%. This result is in line with the research of Rachmadi (2011), who reported that the water content in bamboo shoots was 90%[3]. Bamboo shoot kimchi contains nutrients, namely: ash (11-14% dwt), fat (4-12% dwt), protein (12-18% dwt), carbohydrates (50-73% dwt) and crude fiber (9-25% dwt). These results indicate that bamboo kimchi has a high content of ash, carbohydrates, and crude fiber. According to Kencana *et al.* (2012), fresh bamboo shoots have high protein and crude fiber content. Fresh bamboo shoots have a crude fiber value of around 23-27% BC (Patty *et al*, 2012). Besides, the energy of bamboo shoots kimchi is around 283-475 kcal/100 grams (Table 2).

Table 2: Nutrient content of bamboo shoots kimchi (100g).

Parameter	Total*
Water (%)	89.24 – 90.42
Abu (%bk)	11.06 – 14.51
Fat (%bk)	4.00 – 12.21
Protein (%bk)	11.52 – 17.85
Carbohydrates (%bk)	50.28 – 73.49
Crude fiber (%bk)	9.48 – 24.95
Energy (kcal)	283.18 – 475.26

*Data is an average (n=0)

The ash content is quite high in kimchi bamboo shoots, indicating that bamboo shoots have high mineral content as well. According to Iqbal *et al.* (2012), the high ash content in a plant shows a high mineral content. Iwansyah *et al.* (2018), reported that betung bamboo shoot flour has high potassium, zinc, and iron minerals.

3.3 Microbial

Bamboo shoot Kimchi is a fermented product from betung bamboo shoots (*Dendrocalamus asper*), but gradually, the fermentation of Kimchi is dominated by lactic acid bacteria. The microbiological parameters of bamboo shoot kimchi carried out include: total bacterial total plate count (TPC) method and total lactic acid bacteria.

Table 3: Average total lactic acid bacteria (LAB) and *total plate count* of bamboo shoots kimchi.

Sample	Total Mikrobes*	
	Total LAB (Log sel /mL)	*Total Plate Count* (Log sel/mL)
K.Rebung 1	7.60[b]	8.69[a]
K. Rebung 2	7.87[b]	7.67[b]
K. Rebung 3	8.05[a]	7.92[b]

*Data is average (n=9); a>b, different letters in each column state significantly (P<0.05).

The total microbial results of bamboo shoot kimchi (Table 3) showed that the total bacteria (TPC) and total lactic acid bacteria (LAB) in bamboo shoots ranged from 7.67-8.69 Log cells/mL, and 7.60-8 respectively. , 05 Log cells/mL. The results of the analysis of variance showed that the salt concentration had a significant effect on the average value of total bacteria (TPC) and total lactic acid bacteria. Duncan's further test, total bacteria (TPC) in bamboo shoot kimchi with a 3% (KR.1) salt solution soaking had the highest total bacterial count (8.69 cell log/mL) followed by KR.2 and KR.3. Similarly, for lactic acid bacteria, bamboo shoots with a 7% (KR.3) saline immersion treatment had the highest total lactic acid bacteria (8.05 cell log/mL) followed by KR.1 and KR.2 (Table 3). This result is in line with the research of Chae and Ta Huang. (2009) which states that the kimchi fermentation rate influenced by salt concentration and temperature.hi carried out include: total bacterial total plate count (TPC) method and total lactic acid bacteria.

According to Chae and Ta Huang. (2009), optimum kimchi is consumed if it contains 0.6-0.8% acid titration (pH 4.2), 3% NaCl, and its organic acid content is quite high. Some LABs have certain antimicrobial activities that are useful in preserving Kimchi. Kimchi's fermentation process is divided into three stages, namely: (1) a number of Leuconostoc mesenteroides and lactic acid bacteria produce metabolites in the form of lactic acid, acetic acid, ethanol, mannitol, carbon dioxide, and organic acids, and inhibit the propagation of aerobic bacteria; (2) reduced number of Leuconostoc mesenteroides (stunted growth) and Lactobacillus plantarum, homofermentative lactic acid bacteria, actively polymerizes and produces lactic acid and creates a sour taste in kimchi; and (3) Lactobacillus plantarum and Lactobacillus brevis active during the final stages of fermentation affect the maturation of Kimchi (Chae and Ta Huang, 2009).

3.4 Technoeconomic Analysis

Economic aspects are important enough to know the feasibility of a business. In this section, the business prospect of making bamboo kimchi viewed from a financial issue. The purpose of this analysis is to determine whether or not the kimchi bamboo shoots are feasible to develop. The assumptions taken in the cost analysis in the business of bamboo shoots are as follows:

1. Production capacity of 10 kg of Kimchi bamboo shoots/day, with the need for bamboo shoots of 10 kg
2. Calculated 25 working days in a month
3. Prices are based on 2019
4. Selling price per 200 grams = Rp. 10.500

The costs incurred to run a business consist of investment costs and production costs. Investment costs are fixed costs whose magnitude is not affected by the number of products produced (Kusuma and Mayasti, 2015). The techno-economic analysis is calculated based on details of investment costs in bamboo shoot kimchi businesses (Table 4) as well as production costs, which are costs during the production process (Table 5).

The results of economic analysis (Table 6) show that the business of making bamboo shoots is financially feasible. The level of business feasibility can see from the calculation value of the Benefit-Cost Ratio. Benefit-Cost Ratio is a method to find out whether a business is profitable or not profitable, if the BCR value is> 1 then a feasible business is continued but if BCR <1 then the business is not feasible or loses. BCR value (Table 6) shows more than one that is 1.21, meaning that from each unit of capital issued will be obtained results (income) of 1.21 times. For example, for every Rp. One thousand issued will get Rp.1210-.

Break Event Point (BEP) is the state of a business when it does not earn a profit and does not suffer losses (Fuad, 2006). BEP shows a value where the sale of production equals the cost of production, so expenditure equals income. The BEP value can be used to make decisions relating to the reduction or addition of selling prices, costs, and profits. The BEP value (Table 6) in this bamboo shoot kimchi business

Table 4: Investment costs.

No	Description	Total	Price (Rp)	Total (Rp)
1	Gas stove	1 pieces	350.000	350.000
2	Gas cylinders	1 pieces	800.000	800.000
3	Big pan	2 pieces	500.000	1.000.000
4	Knife	2 pieces	15.000	30.000
5	Cutting board	2 pieces	20.000	40.000
6	Scales	1 pieces	140.000	140.000
7	Large basin	4 pieces	20.000	80.000
8	Filter	2 pieces	15.000	30.000
9	Small basinl	4 pieces	10.000	40.000
10	Seasoning grinder	1 pieces	80.000	80.000
11	Tablespoon	1 dozen	8.000	8.000
12	Refrigerator	1 pieces	2.000.000	2.000.000
13	Rent a building	1 year	5.000.000	5.000.000
14	Administrative support	1 set	150.000	150.000
Amount of invesment cocts				9.748.000
Tool shrinkage (10%)				974.800
Capital interest: 11% x Rp. 9.748.000				1.072.280
Buildinh maintenance 3% x Rp. 5.000.000				150.000
Total fixed costs				2.197.080
Total fixed costs/day (FC)				87.883

Table 5: Production/Operational Costs.

No	Description	Total	Unit	Price/unit (Rp)	Total (Rp)
1	Rebung Betung	7.3	kg	15.000	109.500
2	Fresh chili	0.2	kg	20.000	4.000
3	Chili powder	0.2	kg	45.000	9.000
4	Onion	0.3	kg	13.900	4.170
5	Garlic	0.1	kg	16.500	1.650
6	Ginger	0.2	kg	50.000	10.000
7	Salt	0.6	kg	10.000	6.000
8	Sugar	0.2	kg	18.000	3.600
9	Glutinous rice flour	0.3	kg	20.000	6.000
10	Salty soy sauce	0.2	kg	15.000	3.000
11	Plastic packaging	100	Pcs	1.000	100.000
12	Employee wages	2	Person	25.000	50.000
13	Water use	-	-	-	5.000
14	Gas usage	3	Kg	6.600	19.800
15	Use of electricity	10	Kwh	1.500	15.000
Total production / operation					346.720,00
Fixed cost / day					438.811,20
Variable Cost					346.720,00
Total Cost					785.531,20

Table 6: Business feasibility criteria.

Fixed Cost/day	Rp. 87.883,20
Variable Cost	Rp. 346.720,00
Cost of goods sold	Rp. 8.692,06 / package 200 gram
Sales results/day	Rp. 525.000,-
Benefits/day	Rp. 90.396,80
Break Event Point	51 package (200 g) / day
Pay Back Period	5 year
Benefit-Cost Ratio	1.21
Return of Investment	21%

will break even (meaning no profit and no loss) if you can sell 51 packs of the product (200 g) per day with a selling price of Rp. 10.500 per package. One of the goals that achieved in carrying out a business is the return of funds issued as a business investment. Payback Period (PBP) is one method that can be used to find out how long cash inflows can cover the cash outflows that are used as an initial investment (Fuad, 2006). The results of PBP calculations (Table 6) for bamboo shoot kimchi is five years. It shows that in about five years, the business capital of making bamboo shoot kimchi will return. The results of the calculation of Return on Investment (ROI) show that from every Rp.100 financing issued, a profit of Rp. 2100 -.

CONFLICT OF INTEREST

There is no conflict interest in this paper.

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