Abstract. Most people currently preserve bamboo shoots (Bambusa vulgaris) that have been harvested using alum which has an adverse effect on the human body. Alternative preservation of bamboo shoots can be done by making bamboo shoots using a solution of sugar and salt solution. This study aims to determine the effect of salt and sugar concentrations on the sensory and microbiological properties of pickled bamboo shoots. The design used was the factorial method in the basis of a completely randomized design (CRD) using two factors, namely salt solution and sugar solution. The formulation used were sugar concentration 1%; 2%; 3% and salt concentration 10%; 12.5%; 15% Sensory test results showed that the concentration of sugar and salt affected the hedonic test values of color, aroma, and texture. Whereas microbiological analysis showed that there is an increase in the total plate count by increasing fermentation time

Keywords: bamboo shoots, fermentation, pickled, salt, sugar.
1. Introduction

Bamboos are a unique group of giant arborescent grasses in which the woody culms arise from underground rhizomes [1]. Bamboo shoots (Bambusa vulgaris) have long been known by people as a food ingredient, especially for traditional cuisine, but the development of these food ingredients has not been so good. Bamboo shoots can be used as a single vegetable or can be mixed with other food ingredients [2]. Bamboo shoots have important benefits in society, such as in several Eastern Asian countries such as China, Taiwan, Korea and Japan, so that cultivation and processing technology has developed. At present bamboo shoots have become an international trade commodity and have been processed into canned food. Bamboo shoots contain carbohydrates that have the potential to be processed as fiber-rich bamboo shoots. Bamboo shoots that have been used are bamboo shoots that are around 1-5 months old because at that age shoots can be consumed which are thought to have the best age and for flour making. The shoots are usually harvested when they attain the height of 15-16 cm [3]. If the age is too young or too old, it will affect the yield of bamboo shoot flour.

Efforts to increase added value and to extend the shelf life of products, processing bamboo shoots into pickled can be used as an alternative in processing. Pickled is the result of processing fruit or vegetables using salt and preserved with acids, with or without the addition of sugar and spices as seasonings [4]. Pickling with salt is a familiar practice and it generates most shelf-stable and organoleptically sound foods [5]. Bamboo shoots has a harvest during the rainy season while in the dry season it cannot be harvested. Bamboo shoots are used as traditional food, such as in Semarang used as spring rolls. Most people preserve bamboo shoots that have been harvested using alum, which has adverse effects on the human body such as impaired liver and kidney function. In this research, pickling will be done by using a sugar solution and a salt solution. The purpose of this study was to determine the effect of salt and sugar concentrations on the sensory and microbiological characteristics of pickled bamboo shoots.

2. Material and Method

2.1. Material

The main material used in this study was fresh bamboo shoots (yellow ampel varieties) from Banyumeneng Village, Mranggen District, Demak, Central Java, Indonesia. Other materials used are salt, sugar, distilled water (technical), PCA (Plate Count Agar) (p.a Merck), alum, and 70% alcohol (technical). The equipment used in this study is a jar, knife, analytical balance (Shimadzu), oven (Memmer), test tube, erlenmeyer, measuring flask, autoclave, thermometer, micro pipette, magnetic stirrer (Ika C-Mag), plastic gloves, spatula or spoon, aluminum cup, petri dish, vortex (Ika), pipette volume, test tube, beaker, incubator (Memmer), digital scale, and laminar air flow (Fume Hood).

2.2. Method

Bamboo shoot fermentation begins with the preparation of sugar and salt solution. The bamboo shoots are peeled and washed and then weighed as much as 1 kg for each treatment. The main treatment procedures for making bamboo shoots are as follows: fresh sorted bamboo that is not deformed, washed and peeled. After the shoots are peeled, the shoots are made into cubes with a size (1x1x1 cm). Then, prepare the fermentation container including washing and sterilizing glass jars for 15 minutes by boiling in boiling water for 15 minutes. Then the bamboo shoots are put into a sterilized glass jar, then mixed with a salt solution with a concentration of 10%, 12.5%, and 15% in each treatment into a sterile glass jar containing bamboo shoots and 1%, 2%, 3% sugar solution with a ratio of bamboo shoots 200 grams and 250 ml solution. Then fermented in a sterile glass jar, covered and fermented to become bamboo shoots and analyze until the 7th and 14th day.

2.3. Research Design

The study was conducted using a factorial design on the basis of a completely randomized design (CRD) using two factors, namely the concentration of salt solution and sugar solution. There are two control used in this research, namely control 1 (sugar 0%, salt 0%) (K1) and control 2 (alum 3%) (K2). Data were analyzed using Diversity Analysis (ANOVA). If there are differences, the Duncan’s Multiple Range Test (DMRT) is continued with a 95% confidence level. Data analysis using SPSS version 21 computer software.

Table 1. Research Design

| Sugar Concentration (w/v) | Salt Concentration (w/v) |
|--------------------------|-------------------------|
| A (1%)                   | 1 (10%)                 |
| B (2%)                   | 2 (12.5%)               |
| C (3%)                   | 3 (15%)                 |
| A1                       | A2                      |
| B1                       | B2                      |
| C1                       | C2                      |
| A3                       | B3                      |

3. Results and Discussion

3.1. Sensory Properties

3.1.1. Color Hedonic Test
Table 2 showed the results of the highest color hedonic bamboo shoot test, namely 3.93 in bamboo shoots fermentation with 3% sugar solution and 10% salt solution. Panelists tended to prefer bamboo shoots with lower salt concentrations, this was due to the higher concentration of salt solution used in the color of bamboo shoots produced so the panelists less liked it. The change in color produced by the pickled bamboo shoots was influenced by the concentration of sugar and salt used, high salt concentrations will inhibit the fermentation process, causing the pickled color to turn yellow. Whereas the untreated bamboo shoots produced blackish brown color, this was due to the absence of treatment and cause spoilage of the bamboo shoots. Whereas the lowest hedonic shoot color test results were in control one which did not do any treatment, it happened because the shoots did not undergo fermentation, causing the bamboo shoots to store decay and brown color.

Table 2. Data on hedonic test of colored pickled bamboo shoot day 7

| Sugar (%) | Salt (%) | Hedonic Test |
|-----------|----------|--------------|
| 10        | 12,5     | 3,50±1,04abc | 3,13±1,25bc | 3,37±0,89bcd |
| 2         |          | 3,60±1,19ab  | 3,30±1,26bc | 3,23±1,25bc  |
| 3         |          | 3,93±1,13a   | 3,03±0,89bc | 2,97±1,21c   |
| Control 1 |          | 1,27±0,82d   |             |             |
| Control 2 |          | 3,40±0,93abc |             |             |

Note: 1 = Dislike; 2 = rather like; 3 = Neutral; 4 = Like; 5 = really like

Based on Table 2, it can be seen that the hedonic test or preference test on pickled shoots on day 0 showed results that are not significantly different. Panelist response to the color of bamboo shoots produced decreases with increasing fermentation time. Panelists prefer pickled bamboo shoots fermented with 3% sugar solution and 10% salt solution. This happens because the color change produced by pickled bamboo shoots is influenced by the concentration of sugar and salt used, high salt concentrations will inhibit the fermentation process, causing the color of the pickled to be more yellow. Discoloration occurs due to the addition of too much salt which can inhibit the growth of hetero fermentative lactic acid bacteria and cause normal fermentation to not take place [6]. The higher the concentration of salt solution, the optimum fermentation will occur which causes the color of pickled shoots to turn yellow.

3.1.2. Aroma Hedonic Test

The concentration of the sugar and salt solution used is not significantly different whereas the samples that were not treated were significantly different, some panelists tended to rather like the scent produced on pickled bamboo shoots while those on untreated bamboo shoots were not liked by panelists a foul aroma.
Based on the response given, it can be seen that the panelists do not have a particular preference for treatment in each group. However, it can be shown that the addition of salt affected the preference level of panelists on the aroma of pickled bamboo shoots produced. Lactic acid bacteria are known to produce various aroma component, bacteriocins and exopolysaccharides which contribute to the development of some characteristic properties such as taste, visual appearance, texture, shelf life and safety.

### Table 4. Data on hedonic test of aroma pickled bamboo shoot day 7

| Sugar (%) | Salt (%) |
|-----------|----------|
|           | 10       | 12.5  | 15     |
| 1         | 2,33±0,92ab | 2,07±1,14ab | 2,60±0,93a |
| 2         | 2,13±1,04ab | 2,20±1,32ab | 2,33±0,99ab |
| 3         | 2,30±0,98ab | 1,87±0,77bc | 2,63±1,03a |

Control 1 1,47±0,90c
Control 2 2,20±1,21bc

Note: 1 = Dislike; 2 = rather like; 3 = Neutral; 4 = Like; 5 = really like

### Table 5. Data on hedonic test of aroma pickled bamboo shoot day 14

| Sugar (%) | Salt (%) |
|-----------|----------|
|           | 10       | 12.5  | 15     |
| 1         | 2,03±1,18b | 1,93±1,14b | 2,03±1,09b |
| 2         | 2,47±1,13ab | 2,13±0,86b | 2,23±1,14ab |
| 3         | 2,67±1,12a | 1,90±1,06b | 2,47±1,13ab |

Control 1 1,13±0,34c
Control 2 2,33±1,21bc

Note: 1 = Dislike; 2 = rather like; 3 = Neutral; 4 = Like; 5 = really like

### 3.1.3. Texture Hedonic Test

Based on Table 6 it can be seen that the concentration of the sugar and salt solution used was not significantly different at the panelist preference level. The highest level of preference for texture was pickled bamboo shoots with 15% salt concentration and 2% sugar with the average hedonic panelist rating of pickled bamboo shoots ranging from 2.40-3.23, this can be occurred because the high concentration of salt solution will cause more and more nutrients to be attracted from the shoot through a semi-selective membrane selectively to a more concentrated solution and will produce a soft bamboo shoot texture [7].

### Table 6. Data on hedonic test of texture pickled bamboo shoot day 7

| Sugar (%) | Salt (%) |
|-----------|----------|
|           | 10       | 12.5  | 15     |
| 1         | 2,40±1,07ab | 2,53±0,97b | 3,00±1,20ab |
| 2         | 2,43±1,25bc | 2,60±1,03ab | 3,23±1,19a |
| 3         | 2,93±1,20ab | 2,53±0,90b | 2,67±1,06ab |

Control 1 1,87±1,33c
Control 2 2,67±1,12ab

Note: 1 = Dislike; 2 = rather like; 3 = Neutral; 4 = Like; 5 = really like

Based on Figure 2, it can be seen that the hedonic test or preference test on pickled shoots on day 0 showed results that are not significantly different, panelists tend to like the smell of bamboo shoots on day 0 which has not been treated. The panelists' preference scale for the highest aroma of pickled bamboo shoots on the 7th day was obtained on pickled bamboo shoots with high concentrations of sugar and salt solutions. Whereas on the 14th day the panelists' favorite scale of aroma was obtained in pickled shoots with a concentration of 10% salt solution and 3% sugar solution. Some panelists thought they liked the aroma in some pickled bamboo shoots. The smell of pickled bamboo shoots that is produced is rather aromatic and slightly aromatic. The results of the panelists' assessment of the aroma of pickled bamboo shoots showed that the addition of salt affected the preference level of panelists on the aroma of pickled bamboo shoots produced. Lactic acid bacteria are known to produce various aroma component, bacteriocins and exopolysaccharides which contribute to the development of some characteristic properties such as taste, visual appearance, texture, shelf life and safety.

![Fig. 2. Aroma hedonic test results of pickled bamboo shoots](image-url)
Table 7. Data on hedonic test of texture pickled bamboo shoot day 14

| Sugar (%) | Salt (%) |
|-----------|----------|
| 10        | 12,5     | 15      |
| 1         | 2,33±1,12ab | 3,00±1,25a | 2,67±1,09ab |
| 2         | 2,63±1,06ab | 2,37±0,99ab | 2,70±1,1ab  |
| 3         | 2,50±1,16ab | 2,23±1,07b  | 2,93±1,17a  |

Control 1 | 1,47±0,93a |
Control 2 | 2,47±1,27ab |

Note: 1 = Dislike; 2 = rather like; 3 = Neutral; 4 = Like; 5 = really like

Based on Table 7 it can be seen that the concentration of the sugar and salt solution used was not significantly different at the panelist preference level, but significantly different from control 1 that was not treated. The average hedonic panelist’s assessment of pickled bamboo shoots ranged from 2.23 to 3.00 (rather like to neutral). The highest level of preference in texture is pickled bamboo shoots with salt concentrations of 12.5% and 15%, the concentration of salt solution given affect the concentration of the sugar and salt solution used was not significantly different at the panelist preference level, but significantly different from control 1 that was not treated. The average hedonic panelist’s assessment of pickled bamboo shoots ranged from neutral to like. On the 7th day the highest preference scale was 3.10 in bamboo shoots with a concentration of 15% salt solution and 2% sugar which showed a neutral value.

3.2. Microbiological Properties

The total plate count on pickled bamboo shoots on the seventh day had significantly different results, the highest total plate count results are in control one or shoots that are not treated with the addition of salt and sugar solution that is equal to 8.425 cfu/ml so that the shoot will experiencing decay and microbes will grow a lot, the cause of microbial contamination in food can be caused by the initial number of microbes in food affecting the number of further microbes that will increase the number of microbial contamination in the product. Lactic acid bacteria are the dominant microorganisms in ethnic fermented vegetables and bamboo shoot products [8]. While the lowest total yield of pickled plate count bamboo shoots with 15% salt solution immersion is 6.992 cfu/ml, the results showed the higher the salt concentration, the lower the microbes produced. Salt concentrations that are too high will reduce acid production. Salt concentration caused lactic acid bacteria to be less able to convert sugar and cause yeast growth.

Table 8. Microbiological data of pickled bamboo shoot day 7

| Sugar (%) | Salt (%) |
|-----------|----------|
| 10        | 12,5     | 15      |
| 1         | 7,203±0,01c | 7,117±0,014d | 6,992±0,034e |
| 2         | 7,269±0,01bc | 7,228±0,020c | 6,992±0,046e |
| 3         | 7,308±0,02ab | 7,220±0,059bc | 7,079±0,033d |

Control 1 | 8,425±0,008a |
Control 2 | 8,360±0,034a |

Table 9. Microbiological data of pickled bamboo shoot day 14

| Sugar (%) | Salt (%) |
|-----------|----------|
| 10        | 12,5     | 15      |
| 1         | 8,214±0,01c | 8,178±0,016c | 8,155±0,008c |
| 2         | 8,278±0,01bc | 8,252±0,01e  | 8,203±0,003e |
| 3         | 8,306±0,01d  | 8,270±0,02a  | 8,360±0,034d |

Control 1 | 8,518±0,008a |
Control 2 | 8,425±0,034a |

Table 9 can be seen that the total plate count on pickled bamboo shoots on the seventh day has significantly different results, the highest total plate count results are in control one or shoot that is not...
treated with the addition of salt and sugar solution that is equal to 8.518cfu / ml, in the control one bamboo shoot has decayed because no preservation was done with a solution of salt and sugar. While the lowest total yield of pickled plate count shoots with 15% salt solution immersion and 1% sugar is 8,155cfu / ml.

Based on Figure 4, it can be seen that the microbiological analysis of total plate count on pickled shoots on day 0 shows results that are not significantly different, on day 0 or shoots that have not been treated, resulting in lower microbes that is 5.75 x 105 cfu/g. On the 7th day there was an increase in microbes in pickled shoots, due to fermentation by lactic acid bacteria. Salt with the resulting acid will inhibit unwanted microbes. At this stage lactic acid bacteria begin to play a role and will reach peak growth on the first day of fermentation. Changes in the amount of lactic acid produced each day are influenced by microbial activity that grows. Bacterial growth is generally characterized by four phases: an initial non-growth period called the adaptation phase (lag phase), followed by a period of rapid growth (logarithmic/exponential phase), then leveling off (static phase), and finally followed by a decline in population living cells (phase of death or decline).

4. Conclusions

The hedonic test results of color, aroma, and texture showed that the panelists on average gave a neutral value to the sample by fermentation treatment. Whereas in the sample without treatment, the average panelist gave the lowest value. The results of microbiological analysis showed significant differences in results on the 7th day. The results of the total plate count showed that the sample without treatment contained 8,425 cfu/ml microbes, more than the fermented bamboo shoot sample.

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