 ISBN: 978-623-92207-1-6

The Potential of Local Garlic (*Allium sativum L.*) to Become a Flavor Enhancer Through Lacto-Fermented Garlic

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***Abstract*— Garlic is an agricultural commodity that is often used as an additional ingredient in various food that serve as a flavor enhancer. According to data from the Central Statistics Agency and the Directorate General of Horticulture of the Republic of Indonesia, in 2019 Indonesia's garlic production reached 88,816 tons. However, this amount is still not able to meet the demand for garlic in Indonesia which reaches 600,000 tons per year. To solve this problem, the Government of the Republic of Indonesia imports garlic from other countries. The problem of trade competition between local and imported garlic then arises. People prefer imported garlic because of the cheaper price and larger size. This condition causes farmers to not be able to survive in the competition and suffer losses. However, local garlic can actually compete in terms of quality. Local garlic has a sharper aroma with a more savory taste which will make the dish more delicious. Therefore, more attention to local garlic is needed, such as making innovations that can increase the value of local garlic. Lacto-fermented garlic is a food innovation that utilizes lactic acid bacteria (LAB) in the fermentation process. The fermentation process helps garlic produce a stronger aroma and taste as the allicin content increases. The fermentation process of garlic is carried out using the anaerobic fermentation method which lasts for 14 days. Garlic is fermented in a salt solution with 4 different concentrations consisting of 0%, 5%, 8%, and 10%. During the fermentation process, the aroma, garlic color, and solution color were observed. In terms of the aroma and color test aspects at the four concentrations used, the sample with a concentration of 8% on day 14 was selected as the best sample. This is because the osmosis process that occurs during fermentation is not excessive so that many organosulfur compounds in onions are still contained.**

Keywords—Indonesian local garlic, flavor enhancer, lacto-fermented garlic, lactic acid bacteria.

I. INTRODUCTION

Garlic (*Allium sativum* L.) is an agricultural commodity that is often used as an additive for various dishes. The distinctive taste of garlic comes from the sulfur compound made from allicin. Processed garlic will soften the taste and bring out a natural sweet and savory taste, as well as a strong distinctive aroma of garlic. Garlic can be categorized as a natural flavoring in cooking, because of its function in cooking which is useful for enriching the taste.

In Indonesia, garlic plays an important role as a spice that is always present in almost every type of cuisine. According to data from the Central Statistics Agency and the Directorate General of Horticulture, in 2019 Indonesia's garlic production reached 88,816 tons. However, this amount is still not able to meet the demand for garlic in Indonesia which reaches 500,000 tons per year [4]. To solve this problem, the Government of the Republic of Indonesia imports garlic from other countries. The problem that then arises is the trade competition between local and imported garlic. People prefer imported garlic because of the cheaper price and larger size. This condition causes farmers to not be able to survive in the competition and suffer losses.

Local garlic can actually compete in terms of quality because it has a sharper aroma with a more savory taste which will make a dish more delicious [5]. Because of that, more attention to local garlic is needed to maximize its potential so that it can survive in the trade competition with imported garlic. Making refined food that can increase the added value of local garlic can be one solution to this problem.

Food innovation through fermentation process is now becoming popular. The fermentation process creates a new unique taste, aroma, and texture but is still rich in benefits such as lacto-fermented garlic. Lacto-fermented garlic is a food innovation that utilizes lactic acid bacteria (LAB) in the fermentation process. Fermentation by microorganism cultures will help garlic increase its antioxidant content [3]. In addition, the fermentation process also helps garlic produce a different and more delicious taste because of the increase in several organosulfur compounds. Thus, it is very suitable when used as a food enhancer.

Based on this explanation, it is known that efforts to increase the added value of local garlic can be done in various ways, one of which is processing it into lacto-fermented garlic. With the hope, this innovation can be a new alternative for people to get food enhancer with different flavors while at the same time supporting local garlic production so that they can compete in the midst of the abundance of imported garlic.

II. METHOD

This research is an experimental study which was conducted using a completely randomized design (CRD) 2 factors. The first factor is the difference in the concentration of the salt solution, namely 0% (P0), 5% (P1), 8% (P2), and

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10% (P3). The second factor is the time level difference factor, namely day 0 until day 14. The treatment combination of the two factors can be seen in Table 1.

TABLE 1. COMBINATION OF FACTOR 1 AND FACTOR 2

Day of Fermentation	Salt Solution			
	P0	P1	P2	P3
D0	P0D0	P1D0	P2D0	P3D0
D1	P0D1	P1D1	P2D1	P3D1
D2	P0D2	P1D2	P2D2	P3D2
D3	P0D3	P1D3	P2D3	P3D3
D4	P0D4	P1D4	P2D4	P3D4
D5	P0D5	P1D5	P2D5	P3D5
D6	P0D6	P1D6	P2D6	P3D6
D7	P0D7	P1D7	P2D7	P3D7
D8	P0D8	P1D8	P2D8	P3D8
D9	P0D9	P1D9	P2D9	P3D9
D10	P0D10	P1D10	P2D10	P3D10
D11	P0D11	P1D11	P2D11	P3D11
D12	P0D12	P1D12	P2D12	P3D12
D13	P0D13	P1D13	P2D13	P3D13
D14	P0D14	P1D14	P2D14	P3D14

The process of making lacto-fermented garlic begins by adding 50 grams of garlic to the four salt solutions. The salt solution was made using 75ml of water. The fermentation process lasts for 14 days in anaerobic conditions. Every day, fermentation was observed for changes in aroma, color of garlic and color of the solution.

A. Aroma

The aroma of garlic is tested using the sense of smell and is defined quantitatively and qualitatively. Quantitatively, the aroma of garlic is tested by smelling an increase in the distinctive aroma of garlic, then the assessment is carried out using a plus sign (+) where the more plus the higher the aroma of garlic is created. Qualitatively, the change in aroma (other than organosulfur aroma) was defined descriptively.

B. The Color of Garlic

The color of garlic is assessed using the sense of sight. The assessment is defined quantitatively by using a plus sign (+) where the more plus the darker the color of the garlic is created. The desired color change is a brownish discoloration.

C. *The Color of Solution*

The color of the fermentation solution was assessed using the sense of sight. The assessment is defined quantitatively by using a plus sign (+) where the more plus the darker the color of the solution is created. The desired color change is a brownish discoloration.

III. RESULT

P0D0	P1D0	P2D0	P3D0

P0D1	P1D1	P2D1	P3D1

P0D2	P1D2	P2D2	P3D2

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P0D3	P1D3	P2D3	P3D3

P0D4	P1D4	P2D4	P3D4

P0D5	P1D5	P2D5	P3D5

P0D6	P1D6	P2D6	P3D6

P0D7	P1D7	P2D7	P3D7

P0D8	P1D8	P2D8	P3D8

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Fig. 1. Lacto-fermented garlic for 14 days

A. *Aroma*

When the garlic is cut or crushed, a distinctive aroma of garlic will develop. This aroma is produced by allicin, which is the result of changes from allin by the alliinase enzyme. When garlic are fermented into lacto-fermented garlic, the aroma change that occurs is the aroma of an organosulfur, which is slightly different from the allicin compound. This shows that the allicin compound is still contained inside the garlic.

If the four samples were compared, the sample with a salt concentration of 0% experienced a significant change in the first 4 days and continued to experience a decrease in aroma until it was difficult to detect because it was covered in a foul smell due to the decay process that had started to occur. The salt content affects water activity of fermentation process, so

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that it controls the growth of unwanted microorganisms. Therefore, in samples with a salt concentration of 0% there is no inhibition process for the growth of unwanted bacterial and causes the decay of the material.

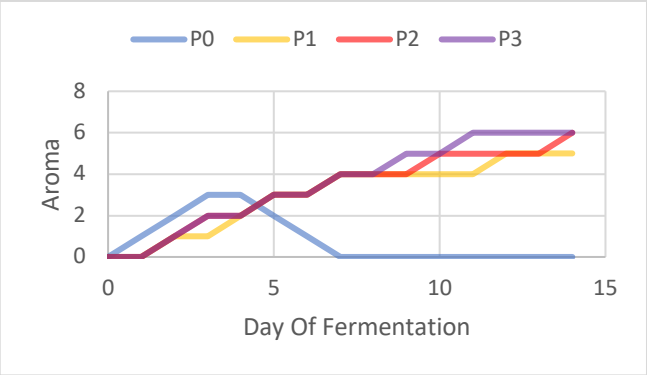

Fig. 2. Graph of lacto-fermented garlic aroma value

Descriptively, changes in aroma (other than the smell of organosulfur) occurred in two samples with a concentration of 0% and 5%. At a salt concentration of 0%, a very pungent odor appears on the fourth day. Meanwhile, at a salt concentration of 5%, foul odors began to appear on the 13th day, even though at a low level.

The soaking process with a salt solution causes several compounds in garlic to be pushed out due to the concentration of the solution in the material being lower than the concentration of the salt solution [6]. This is in line with the test results obtained. A higher salt concentration indicates a higher and faster change in the resulting aroma. Lacto-fermented garlic which is fermented with a solution concentration of 10% produces an aroma with the highest value, namely 6+ starting from day 11.

B. The Color of Garlic

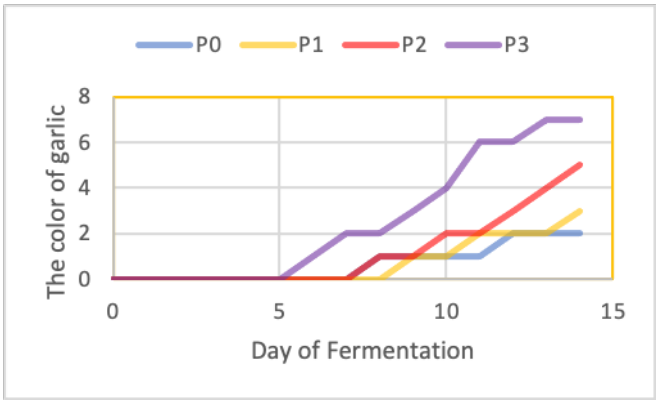

Fig. 3. Graph of garlic color value

The color change in the fermentation process is closely related to the texture change of a material. The texture of vegetables becomes softer because of the microbial activity in them which can produce pectinase enzymes and break down pectin. Pectin is a sturdy wall that gives a hard texture to the surface of raw vegetables [2]. So that when the fermentation process takes place, over time the material will experience a color change according to the characteristics of the constituent material. In this case, the garlic in lacto-fermented garlic experiences a darker color change towards browning.

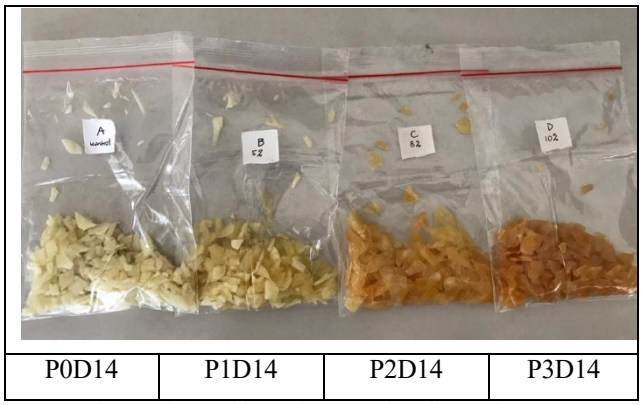

Fig. 4. Chopped lacto-fermented garlic on day14

The difference in the color of the four samples can be seen on the 14th day of fermentation. In addition to microbial activity, salt in the fermentation process causes the release of nutrient fluids from the cells of the material through the osmosis process [1]. The process of releasing these nutrients can trigger damage to cell membranes so that the garlic change color. This is indicated by the test results which show that lacto-fermented garlic with the highest salt concentration of 10% has a significant change in color to brown. This is contrast to garlic with 0% concentration which has the lowest value because the solution activity is very minimal. The greater the difference in concentration between the solution and garlic, the greater the osmotic activity that occurs.

C. The Color of Solution

The change in the color of the solution during the fermentation process is directly proportional to the color change in the material. These events are related to each other starting from the difference in concentration between the salt solution and the solution in the material. Salt in the fermentation process causes the nutrient discharge from the cells of the material through the osmosis process. The process of releasing these nutrients can trigger damage to cell membranes so that the garlic change color. The sugars contained in these nutrients will be used by lactic acid-producing microorganisms that occur naturally in vegetables to produce lactic acid anaerobically [1]. Therefore, the change in the color of the solution will coincide with the change in garlic color.

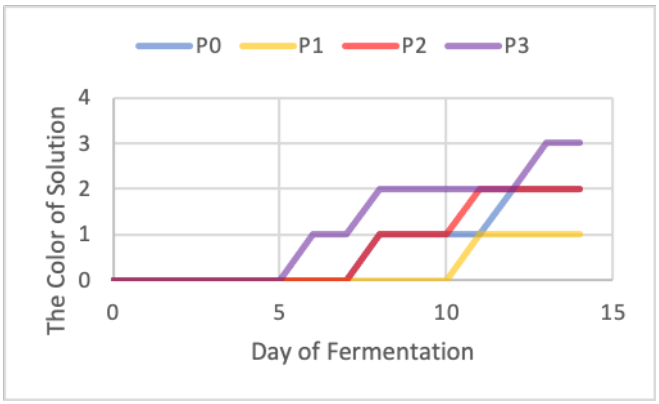

Fig. 5. Graph of solution color value

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The most visible color change was in samples with a concentration of 0% starting on day 8. The color change that occurred was not only brownish but also turbid. The turbidity of this solution is caused by the unwanted microbial activity of spoilage. This turbidity also makes it difficult to observe the color of the solution. In the other three samples, the color change that occurred was brownish without turbidity. And the brown color is most visible in samples with a concentration of 10% as the greatest osmosis event also occurs in this solution.

IV. CONCLUSION

Based on research on local garlic in lacto-fermented garlic, several conclusions were obtained:

1. The fermentation process causes the garlic to experience several changes in terms of aroma and color. These two aspects represent the microbial activity by lactic acid bacteria. The most significant change was seen in samples with a salt concentration of 10%. This is because the higher the salt concentration in the solution the higher the osmotic activity of the material. While salt concentrations that are too low will cause undesirable microbial activity, such as in samples with concentrations of 0% and 5%.
2. In terms of the aroma and color test aspects at the four concentrations used, the sample with a concentration of 8% on day 14 was selected as the best sample. This is because the osmosis process that occurs during fermentation is not excessive so that many organosulfur compounds in onions are still contained.
3. Local garlic has the potential to be a food enhancer because the fermentation process creates unique organosulfur aromas besides allicin. This aroma will give lacto-fermented garlic products a new taste when used in cooking.

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