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Analysis of vitamin C content, water content, and organoleptic test of lemon segment wall dodol

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ABSTRACT

Waste will become a problem if not managed properly. One way to do this is to recycle lemon waste into other products with economic value, such as making dodol from lemon segment wall. This study was conducted to determine the effect of the addition of lemon segment wall in making dodol and to determine the best treatment for making dodol. This study used a complete randomized design (CRD) with 4 treatments. The treatments used were control (without the addition of lemon segment wall), and the addition of different lemon segment walls, namely F1 (5%), F2 (10%), and F3 (15%), with each treatment repeated 3 times. Testing parameters in this study include water content, vitamin C, yield, and organoleptic test. Data from the study results were analyzed for variability to determine the effect of treatment on the test parameters. If there was a significant effect, the Duncan test was continued to determine the real difference between treatments. The results showed that making dodol with treatment F4 (addition of 15% lemon segment wall) is a treatment that has high values in each test parameter, including water content (36.52%), vitamin C (379.93%), and yield content (80.21%). Meanwhile, making dodol with treatment F0 (without the addition of lemon segment wall) is a treatment that has the lowest value in each test parameter, including water content (26.87%), vitamin C (247.94%), and yield content (79.41%) in laboratory testing and the best treatment as measured by the organoleptic test which is most liked by the panelists, namely treatment F0 (without the addition of lemon segment wall).

Keywords:
Dodol, Lemon segment wall, Moisture content, Organoleptic test, Vitamin C

1. Introduction

One of the major problems in the industrialization era is the management of industrial waste products. Because waste comes from the production process and survival. Waste management must be carried out from the beginning of the production process to minimize damage [1].

Food waste is often defined as wasted food due to intentional or unintentional elements from the production stage to consumption. The definition also concludes that food waste does not count to zero because food is composed of edible and non-edible elements (skin, spine, bone, and other components) [2].

Waste utilization is very important in maintaining environmental sustainability. Industrial waste treatment involves various methods to minimize environmental impact. One way of utilizing waste is to re-utilize industrial waste into valuable products. The main problem is the lack of public awareness and understanding of the need for efficient waste treatment, which results in waste often being dumped in landfills, which can cause soil and water pollution.

In daily life, fruits are an important necessity for humans. People use fruit flesh as juice, jam, salad, and syrup. The utilization of fruit peels is very rare and only discarded as waste. Citrus peel waste is the most common waste in the citrus

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processing industry. The citrus peel contains many benefits, including vitamin C, minerals, and fiber [3].

Lemon fruit is a large shrub or herbaceous plant with a height of about 2-15 meters. The lemon tree has a trunk and branches equipped with long thorns, but the thorns are not dense. The fruit has a distinctive sour flavor and aroma. Lemon fruit is a plant that has benefits as a natural antioxidant because it contains vitamin C, citric acid, essential oils, bioflavonoids, polyphenols, curamines, flavonoids, and volatile oils in its skin [4].

Lemon fruit contains about 85 mg of vitamin C [5]. Vitamin C is an organic substance needed by the human body in small amounts to maintain metabolic functions, and it also acts as an antioxidant for the body [6]. Vitamin C is also an important food antioxidant and significantly reduces the side effects of reactive species, such as reactive oxygen, that cause damage to oxidation reactions in macromolecules [7].

Lemon fruit (Citrus lemon) has fruit flesh that consists of several segments called segment walls. Each segment is bounded by a thin membrane that forms the pulp separating one segment from another. These walls provide a solid structure while protecting the juicy pulp inside. These segments contain tiny vesicles full of lemon juice, which contains various nutrients, including vitamin C, citric acid, and antioxidants.

The segment wall of the lemon also plays an important role in maintaining its freshness and quality. The membrane that borders each segment helps to retain moisture in the pulp so that lemons stay fresh longer after harvest. This segment wall is important not only for the structure and texture of the lemon but also for maintaining its nutritional content and flavor [8].

The vitamin C content in lemons is spread throughout the fruit's flesh, including in the vesicles in the segment wall. Generally, one medium-sized lemon contains about 30-40 mg of vitamin C, equivalent to 40-50% of the recommended daily requirement for adults. There is no specific difference in the percentage of vitamin C content found only in the segment wall compared to other parts. Vitamin C is evenly distributed throughout the fruit flesh. Therefore, each segment wall is assumed to contain a proportionate share of the total vitamin C in the lemon fruit [9].

According to SNI dodol 01-2986 of 1992, dodol is a food made from glutinous rice flour, coconut milk, and sugar or without the addition of other permitted food ingredients. Dodol is one of the most popular traditional foods. There are many types of dodol, depending on the diversity of additional mixtures and also how it is made [10].

The shelf life of dodol is influenced by its constituent components, microbial activity, processing technology and sanitation, the packaging system, and the use of preservatives. Usually, the making of dodol uses preservatives so that the shelf life of dodol is longer. The preservatives used must be appropriate and have a special license for food preservatives [11]. Glutinous rice flour is the main component in making dodol. When cooking in the presence of enough water, the starch contained in the flour absorbs water and forms a thick paste, and when cold, the starch will form a chewy, bouncy, and clayey mass [12].

The quality of dodol is influenced by several factors, such as the weighing of ingredients, the quality and use of ingredients, and the temperature and duration of cooking [13]. During storage, food products experience a decrease in quality caused by temperature, which is the main factor affecting food quality. The higher the storage temperature, the faster the reaction of various chemical compounds [14]. This study aims to determine the effect of adding a lemon segment wall and the best treatment for adding a segment wall in the manufacture of dodol.

2. Methods

2.1. Procedure for Making Lemon Segment Wall Dodol

Making lemon segment wall dodol starts with preparing the main ingredients, namely lemon segment wall, sugar, coconut milk, sticky rice flour, and water. Dodol will be made with four treatments of lemon segment wall concentration (0%, 5%, 10%, and 15% of the total ingredients). The first step is to separate the segment wall from the lemon fruit. Then, all the ingredients are mixed in a large pot and stirred slowly until evenly distributed. The cooking process is carried out over low heat at about 70–80 °C for approximately 2–3 hours. Stir constantly to avoid burning on the bottom. The dough is considered ready when the texture is thickened and sticky. After cooking, the dough is cooled at room temperature for 3-4 hours to harden. After that, the dodol is cut into desired pieces, tightly wrapped, and stored in an airtight container. Storage can be done at room temperature for 2 weeks or in the refrigerator to extend the shelf life to 1 month. Table 1 provides the concentrations used in making dodol lemon segment walls.

Table 1. Concentration for making dodol with lemon segment wall inclusion

Treatments*	Lemon segment wall concentration (%)	Sugar (g)	Coconut Milk (ml)	Glutinous rice flour (g)	Water (ml)
F1	0%	500	300	200	200
F2	5%	500	300	200	200
F3	10%	500	300	200	200
F4	15%	500	300	200	200

Source: Primary Data Research Lemon Segment Wall Dodol

*F1: Without the Addition of the Lemon Segment Wall

F2: Addition of 5% Lemon Segment Wall

F3: Addition of 10% Lemon Segment Wall

F4: Addition of 15% Lemon Segment Wall

Each treatment differs in the addition of lemon peel which is calculated from the total ingredients, so it is expected that this concentration variation can affect the taste, aroma, and final texture of the dodol. The data analysis used is analysis of variance (Anova) with an experimental design that is a complete randomized design and there are 4 treatments and 3 repetitions.

2.2. Procedure for Making Lemon Segment Wall Dodol

To determine the vitamin C content of a food ingredient, it is necessary to do both modern analysis and conventional analysis. Here is how to analyze vitamin C levels conventionally, namely first reparating the sample, then the sample is prepared and put in an Erlenmeyer as much as 1 gram and added 0.1 mL of iodine solution and Amylum solution and then titrated on the sample until it changes color. The following is the formula for determining vitamin C:

$$\text{Vitamin C Levels} = \frac{\text{mg Vitamin C}}{\text{Initial Sample Weight}} \times 100\% \quad (1)$$

2.3. Moisture Content Analysis

First, the material is mashed or refined, and the sample is weighed as much as 1 gram, put into a cup that has previously been cleaned, put into the desiccator, and then weighed. Next, the material was dried for 8 hours in the oven at 105^{o}C. After that, the material was cooled for 30 minutes in a desiccator before being weighed [15]. Moisture content was calculated using the following formula:

$$\text{Water Contents} = \frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Wet Weight}} \times 100\% \quad (2)$$

2.4. Organoleptic Test

Organoleptic test parameters include color, taste, texture, and aroma attributes of dodol products made with the addition of a lemon segment wall. Product acceptance scores by the panelists were determined on a numerical scale with 5 (very like), 4 (like), 3 (neutral), 2 (dislike) and 1 (very dislike) [16]. The testers' criteria were the testers' sensitivity, training, health, and concentration. The number of reviewers was 25 untrained reviewers. The type of sensory analysis is a hedonic test. The pre-test preparation of samples was uniformity, randomization, neutralization, temperature control, and masking.

3. Results and Discussion

3.1. Vitamin C

The test results of Vitamin C content obtained from this study can be seen in Figure 1. It shows that vitamin C content increased along with the addition of lemon peel segments where F1 (247.94 mg), F2 (312.81 mg) F3 (315.37 mg) and F4 (379.93 mg). It can be seen that treatment f1 has the lowest vitamin C content of 247.94 mg and F4 has the largest vitamin C content of 379.93 mg. The F3 treatment contains a lot of vitamin C due to the large amount of segment wall and most of the added lemon pulp that affects the analysis of vitamin C content. Vitamin C content in dodol varies depending on the ingredients used in its manufacture.

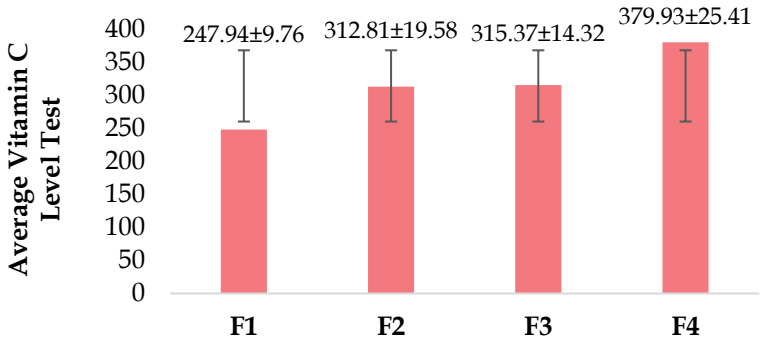


Figure 1. Vitamin C content in the dodol with different concentration of lemon segment wall

In this study, vitamin C dodol was very high, so it is not recommended to consume too much. A normal dose of vitamin C is between 60 and 90 mg per day, with one lemon containing 83 mg of vitamin C. Although vitamins are essential nutrients, consuming excessive amounts daily can have side effects. Vitamin C from nature can be found in fruits or vegetables. Local fruits known to be rich in vitamin C are local lemons [17]. Statistical tests using Anova showed a significant difference in vitamin C in each treatment (Fcal >5%). For this reason, a follow-up test was carried out by Duncan, which showed that the F0 treatment was very different from the F1, F2 and F3 treatments. This is suspected because the concentration of vitamin C in each treatment is dissolved in the dodol and spreads so that the concentration of vitamin C content is very different. The solubility of vitamin C in water occurs by diffusion and diffusion until it becomes homogeneous.

3.2. Moisture Content

The results of the Water content test obtained from this study can be seen in Figure 2. It shows that the water content increased for each treatment, namely F1 (26.87%), F2 (31.28%), F3 (34.22%) and F4 (36.52%). It can be seen that the highest water content is 36.52% in treatment F4 (addition of 15% lemon segment wall). In comparison, the lowest water content was 26.87% in the F1 treatment (without the addition of segment lemon wall). The moisture content of dodol generally ranges from 20-25%, depending on the ingredients and the manufacturing process [18]. If lemon segment wall is added to the dodol dough, the water content can increase because lemon has a fairly high water content, around 85-90%.

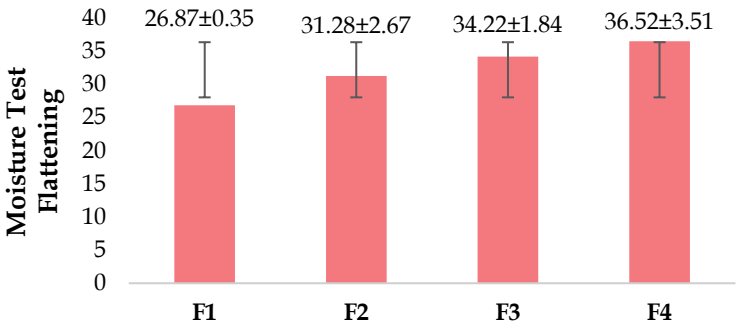


Figure 2. Moisture content in the dodol with different concentration of lemon segment wall

The addition of lemon segment wall can increase the water content of the dodol, so the final result may have a higher water content than without the addition of lemon. The moisture content needs to be controlled by adjusting the amount of lemon segment wall added and the cooking process. Usually, the addition of lemon segment wall should be balanced with longer cooking to evaporate some of the additional water so that the water content in the dodol remains in the optimal range [19]. Statistical tests using Anova showed a very significant difference in moisture content in each treatment (Fcal >5%). For this reason, a follow-up test was carried out by Duncan, which showed that the F0 treatment was very different from the F1, F2 and F3 treatments. This is thought to be because the water in food is physically and chemically bound to other food components.

3.3. Organoleptic test

3.3.1. Color

Figure 3 shows the color organoleptic test results obtained from this study. One important component that makes food look attractive is its color. Pigments, the effect of heat on sugar (caramel), the reaction between sugar and amino acids, and a mixture of other ingredients can make food colorful [20].

Based on the diagram above, it can be seen that the level of preference for the colour of lemon segment wall dodol is highest in treatment F0, which is 4.16 (without the addition of the lemonsegment wall). The color of dodol is usually darker than palm sugar. The Maillard reaction causes a non-enzymatic browning reaction involving amino acids and carbonyl groups, especially reducing sugars due to the heating process [21]. The colour will be slightly brighter while dodol made with the addition of lemon segment wall. The color obtained in this study is yellowish brown due to the use of fresh palm sugar or brownish yellow. The statistical test using Anova showed no effect on the color organoleptic test in each treatment (Fcal <5%), so the Duncan test was not carried out.

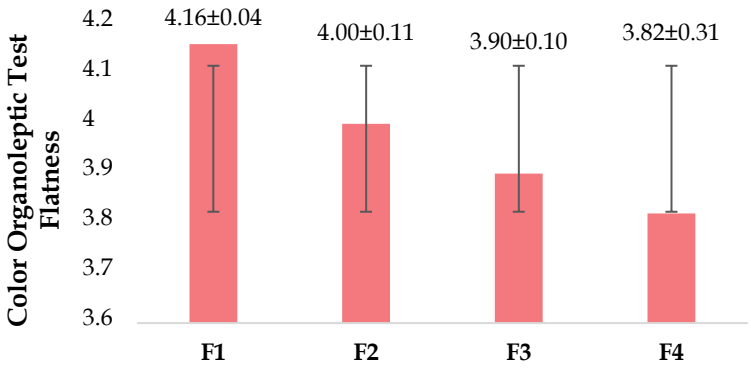


Figure 3. Effect of colour on lemon segment wall dodol

3.3.2. Aroma

Figure 4 shows the results of the aroma organoleptic test obtained from this study. Aroma is an important component that influences whether consumers accept or reject food products. High-quality dodol emits a distinctive odor from the ingredients used

in processing [22]. This tool is made with lemon segment wall, sticky rice flour, coconut milk, and palm sugar.

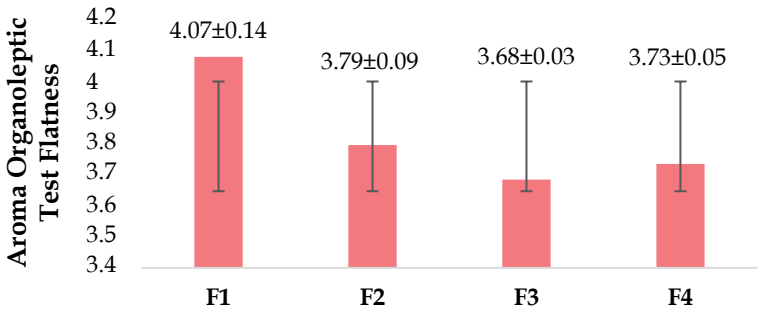


Figure 4. Effect of aroma on lemon segment wall dodol

Based on the diagram above, it can be seen that the level of liking for the aroma of lemon segment wall dodol is highest in treatment F0, which is 4.07 (without the addition of lemon segment wall). Dodol with the addition of lemon segment wall has a fresh aroma and must be typical of lemon. Aroma is a difficult parameter to measure so it usually causes different opinions in assessing aroma quality. This is because each person has differences in smell even though they can distinguish it and each person has a different preference level [23]. The statistical tests using Anova showed that it had a very real effect on the organoleptic aroma test in each treatment (Fcal >5%) so the Duncan test was carried out which showed a very real difference in each treatment.

3.3.3. Texture

Figure 5 shows the results of the texture organoleptic test obtained from this study. Texture can be seen, felt, or observed when biting, chewing, swallowing, or touching with fingers. Glutinous rice flour and coconut milk are the main ingredients of dodol. When coconut milk is used as a liquid during the heating process, the starch contained in the flour is absorbed by it, forming a thick paste. Once cooled, a chewy, bouncy, and clayey mass is formed.

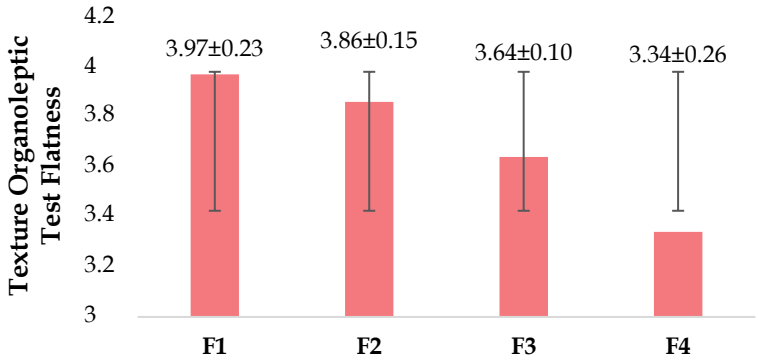


Figure 5. Effect of texture on lemon segment wall dodol

Based on the diagram above, it can be seen that the level of preference for the texture of lemon segment wall dodol is in treatment F0, which is 3.97 (without the addition of lemon segment wall). This study's texture is soft and slightly chewy due to several factors, including incorrect water content, non-optimal cooking process, and uneven mixing. The right addition of glutinous rice flour makes the dodol more elastic or chewy, but excessive addition makes it no longer elastic. The water in food can affect its texture: the more water in the food, the softer it will be. The gelatinization of glutinous rice starch is the cause of this dodol texture [24]. Sugar, in addition to glutinous rice starch, affects the formation of dodol, making it more clayey and bouncy [25]. The results of statistical tests using Anova showed that it had a very real effect on the texture organoleptic test in each treatment (Fcal >5%), so a Duncan test was carried out, which showed a very real difference in each treatment.

3.3.4. Flavor

Figure 6 shows the results of the texture organoleptic test obtained from this study. Flavor is a major factor in determining whether customers accept or reject food. It is also an important component in food quality control to determine customer acceptance. Oral stimuli, taste, and smell form the flavor of food. Granulated sugar gives dodol its sweet flavor.

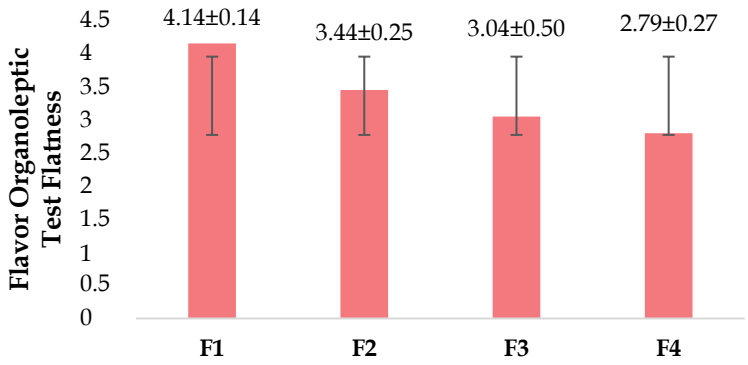


Figure 6. Flavor effect of lemon segment wall dodol

Based on the diagram above, it can be seen that the level of preference for the taste of lemon segment wall dodol is in the F0 treatment, which is 4.15 (without the addition of lemon segment wall). The level of dislike for the taste of dodol in treatment F3 is 2.79. This is due to adding a lot of lemon segment wall, which makes the dodol taste bitter. Citric acid contained in lemons makes food taste bitter because it contains limonin. Limonin, a bitter compound in most citrus, increases when left to stand for too long. Limonin has a complex molecular structure consisting of hydrophilic (water-loving) and hydrophobic (water-averse) groups [26]. The statistical tests using Anova showed that it had a very real effect on the taste organoleptic test in each treatment (Fcal >5%), so a Duncan test was carried out, which showed a very real difference in each treatment.

4. Conclusion

Dodol, with the addition of segment wall lemon, has a very significant effect on treatment F3 (15% segment wall addition), which is the highest result in vitamin C

testing parameters (379.93%) and water content test (36.52%). The best treatment in organoleptic testing was highest in treatment F0 (without the addition of segment wall lemon), which was most favored by the panelists.

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