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Characteristics of Edible Bowls Made from Papaya Skin as an Effort to Tackle Plastic Waste in Indonesia

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Abstract

Synthetic plastic made from the synthetic polymer polypropylene (PP) is generally used as food packaging, which over time causes environmental problems, so innovation in food packaging in the form of edible bowls is needed. Edible bowls are made from papaya skin pectin, wheat flour, gelatin flour, vegetable oil and water which are baked using oven technology. Based on tests, edible bowls have a water absorption capacity of 3% to 23%, can last for 18 minutes at a high temperature of 90°C and 31 minutes at a temperature of -10°C, and can decompose within 2 to 3 months. This edible bowl made from papaya skin is an alternative substitute for plastic packaging, thus tackling the problem of plastic waste in Indonesia.

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INTRODUCTION

Waste is a big problem faced in various countries, one of which is Indonesia. Every human activity produces waste, including plastic waste, which has the potential to damage the environment (Mahyudin, 2017). Plastic is a polymer that is strong, elastic, durable and cheap, so it is often used by humans to fulfill their daily needs. Plastic production continues to increase from year to year in line with the increase in world population (Aulia, et al., 2021). According to the World Bank report in 2020, Indonesia was ranked fifth as the largest waste producing country in the world with a total of 150 million tons of plastic waste (Wahyudi, et al., 2023). Even from a total of 192 coastal countries, several countries such as China, Indonesia, the Philippines, Vietnam and Thailand have the fastest level of productivity in producing waste in the world which exceeds half of the total plastic waste in the ocean (Khoiriyah, 2021). This makes Indonesia ranked second in the largest contributor of plastic waste in the ocean. Currently, plastic is used in various areas of life, such as in the industrial sector as product packaging because it is light and durable (Nagong, 2021). However, the increase in plastic production is increasingly worrying because throughout 2022 there will be 69 million tonnes of waste produced by society, of which 12.5 million tonnes is plastic waste (Exposto, et al., 2015). If not controlled, production levels are expected to double over the next few decades.

Responding to the problem of high production of plastic waste, the Indonesian government established Presidential Regulation of the Republic of Indonesia Number 97 of 2017 concerning National Policy and Strategy (Jaktranas) for the Management of Household Waste and Similar Types of Household Waste (Purwaningrum, 2016). Through this Presidential Decree, the government is promoting the "Plastic Free Indonesia" program by 2025 with a waste reduction percentage of 30% and waste handling of 70% (Chotimah, et al., 2021). To support this waste reduction program, environmentally friendly food packaging innovation is needed to replace plastic packaging in the form of edible bowls. Edible bowls are bowl-shaped food packaging that can be eaten from plant or animal starch as an alternative to single-use plastic packaging (Choeybundit, et al., 2022). Edible tableware is not a new concept. Although it seems very new to many people, it was introduced in the 1400s. The bread bowl was first introduced in 1427 by a scientist from England (Dordevic, et al., 2021). In the 1930s, a flour bowl was developed, known as the tortilla. Then in the 1980s, Sourdough boule bowls were introduced with the aim of marketing soup in San Francisco (Rajendran, et al., 2020). Unfortunately, this innovation is currently inferior to food packaging made from plastic and paper due to the increasing need for paper bowls, styrofoam, plastic cups and other packaging (Grzebieniarz, et al., 2023). Edible bowls are here as an effort to campaign again for the "Plastic Free Indonesia" program.

Papaya (*Carica papaya* L) is a fruit that is popular with the majority of Indonesian people. There are various types of papaya and are widespread in the Indonesian archipelago, such as in Central Java, Sumatra, Nusa Tenggara and other regions (Kumar, et al., 2018). Papaya fruit has an oval shape with skin that turns orange-yellow when ripe. Generally, only papaya flesh is used, while the skin is ignored (Koubala, et al., 2014). However, papaya skin contains many useful substances for health. Papaya skin contains vitamin A, vitamin B complex, vitamin E, folate, potassium, calcium and antioxidants. The edible bowls that have been developed so far come from wheat flour, shrimp shell flour, seaweed flour, and various other ingredients (Stuti & Virginia, 2022). However, the edible bowls produced are of poor quality, such as tapioca flour which is easily brittle (Nehra, et al., 2022). Seaweed flour is used quite a lot and generally the price is relatively high. Meanwhile, edible bowls made from papaya skin waste are the right choice because they are easy to find (Nazurah, et al., 2022).

Papaya skin was chosen as the material for making edible bowls because it contains pectin compounds which can be used as adhesive because of its sticky nature (Maran & Prakash, 2015). The advantage of edible bowl products made from papaya skin is that they are made from waste and are made based on scientific methods and basic research. Edible bowls from papaya skin

waste are different from existing edible bowls, they are made from natural ingredients and do not cause concern if you consume them. Edible bowls are easy to produce, made from natural materials and are environmentally friendly. Apart from that, it is very easy to apply, can be eaten straight away, is practical, and supports efforts to limit the use of plastic packaging so that it has a good impact on the environment. Therefore, the aim of this research is to characterize edible bowls made from papaya skin by testing the water absorption capacity, oil absorption capacity, decomposition capacity and durability of edible bowls.

METHOD

Making Edible Bowls Using Papaya Pectin

Making this edible bowl begins with getting papaya skin pectin. Tools used in making edible bowls include ovens, digital scales, blenders, thermometers, cutting boards, knives, beakers, measuring cups, basins, spoons, pans and stoves. The materials needed are 5% citric acid, 96% ethanol, distilled water, papaya skin, filter cloth and water. The step taken is to extract papaya skin to obtain pectin using the maceration extraction method. After getting the pectin, next make the edible bowl mixture.

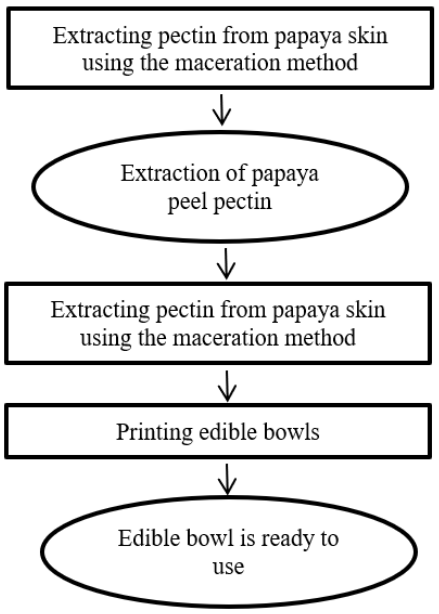

Figure 1. Process for Making Edible Bowls Made from Papaya Skin

Making edible bowls requires tools including an oven, edible bowl molds, basins, spoons and digital scales. The ingredients needed are 3 grams of papaya skin pectin, 7 grams of gelatin flour, 15 grams of wheat flour, 3 tablespoons of vegetable oil, and 5 tablespoons of water. The step taken is to mix all the ingredients in a bowl until evenly mixed. The texture of the dough does not stick to your hands when touched and is easy to shape. Then put the dough in the mold and shape it until it is neat. Next, bake the dough at 100°C for 15 minutes. Edible bowl is ready to use. The complete process of making edible bowls made from papaya skin can be seen in Figure 1.

Characteristics of Edible Bowls Made from Papaya Pectin

The characteristics of the edible bowl were determined by carrying out several tests, namely the water absorption test, temperature resistance test, and decomposition time test.

Water Absorption Test

The water absorption test is used to determine the amount of water that can be absorbed by an edible bowl at room temperature (25°C). There were 5 samples in this test, each sample was weighed as initial mass data (W1). Then fill the sample with 50 ml of water and wait for the sample with varying times of 10 minutes, 15 minutes, 20 minutes, 25 minutes and 30 minutes. Samples that have been tested are then measured again as final mass consumption (W2). The percentage of water absorption capacity is determined by the following formula.

Water Absorption (%) = W2-W1/W1 x 100%

Temperature Resistance Test

The temperature resistance test was carried out to measure the resistance of the edible bowl at different temperatures. First prepare water, thermometer and 6 edible bowls. Then pour water into each edible bowl with temperature variations of 90°C, 70°C, 50°C, 30°C, 10°C, and -10°C. In this test, the length of time required for the edible bowl to break is measured. Through this test, it will be known how long the edible bowl can withstand temperatures when used as food packaging.

Decomposition Time Test

The edible bowl's ability to decompose was tested by burying the edible bowl in the

ground. The time it takes for the edible bowl to disintegrate and merge with the soil is calculated and then summarized with a graph of the test results.

RESULTS AND DISCUSSION

Human needs for food packaging are slowly increasing. The ready-to-eat food trend has caused a significant increase in demand (Ramadhan & Hermawan, 2022). Single-use plastic food packaging, in particular, currently cannot be separated because it is considered practical and easy to use (Sa'diyah, et al., 2020). This poses a threat to environmental sustainability, because single-use food packaging has polluted the environment and disrupted the balance of ecosystems, both land and marine ecosystems (Putra, et al., 2022). Therefore, it is necessary to develop environmentally friendly food packaging to reduce the amount of plastic food packaging in our lives. Edible bowls are an innovation to replace food packaging made from plastic and paper such as paper bowls, styrofoam, plastic bowls and various other packages (Septiani, et al., 2019).

Figure 2. Edible Bowl appearance

Edible bowls are made from natural ingredients such as wheat flour, gelatin flour, pectin and vegetable oil to form bowl-shaped food packaging that is safe to eat (Natarajan, et al., 2019). Gluten from wheat flour makes the edible bowl dough elastic and does not break easily during the cooking process. Agar flour helps stick together the dough so that the resulting edible bowl is able to hold water or oil for a while (Mulalinda, et al., 2016). Papaya skin pectin basically has sticky properties and is shaped like a gel, this material is used as an adhesive in making edible bowls (Maran & Prakash, 2015). Vegetable oil helps glue the dough together and makes the dough less likely to break during the molding and cooking process (Istinganah, et al., 2017). This papaya skin-based edible bowl was developed using oven baking technology. The results obtained are edible bowls that are food grade with various advantages. The appearance of an edible bowl made from papaya skin can be seen in Figure 2 and Figure 3.

Figure 3. Edible Bowl as Packaging

The characteristics of the edible bowl were determined using several tests, namely the water absorption test, temperature resistance test, and decomposition time test. The results of these tests include the following.

Water Absorption Test

The water absorption test was carried out using water for 30 minutes at room temperature (25°C). Based on test results, edible bowls have different absorption capacities every minute. In the first 10 minutes, the edible bowl has not absorbed large amounts of water, this can be seen from the change in mass of the edible bowl by 3%. Then in the 15th minute the water absorption capacity of the edible bowl increased significantly until the 25th minute where the percentage change in mass was 7%, 15% and 23% respectively. Meanwhile, the percentage change in mass of the edible bowl at the 30th minute was 27%. After 30 minutes the edible bowl looks swollen and brittle so it is unable to hold food properly. A comparable water absorption phenomenon was also mentioned previously in the case of edible tableware developed using a combination of sorghum flour, wheat flour, and rice (Kumar, et al., 2021). The gelatin flour and pectin content of

papaya skin makes the edible bowl dense and quite hard. This makes the edible bowl not easily damaged when used as food packaging. The longer the resistance of the edible bowl to absorb water, the better the quality of the edible bowl as food packaging (Aldred & Wansink, 2017). A graph of the percentage of water absorption capacity in edible bowls can be seen in Figure 4.

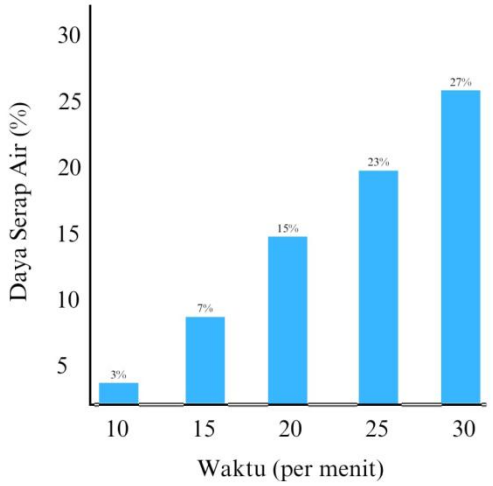

Figure 4. Graph of the Percentage of Water Absorption in Edible Bowls

Temperature Resistance Test

Good food packaging can withstand low and high temperatures. The temperature resistance test on the edible bowl was carried out by pouring water with 6 temperature variations, namely 90°C, 70°C, 50°C, 30°C, 10°C, and -10°C. Temperature resistance is measured according to the amount of time it takes for the edible bowl to break down. When testing at a temperature of 90°C, it was discovered that the edible bowl was damaged in the 18th minute. At a temperature of 70°C the edible bowl starts to experience damage in the 20th minute. At a temperature of 50°C the edible bowl was damaged in the 25th minute, while at a temperature of 30°C the edible bowl had quite good resistance because it was damaged in the 27th minute. The higher the water temperature provided, the lower the temperature resistance of the edible bowl. This is indicated by a change in the appearance of the edible bowl, becoming fluffy and easily damaged. High temperatures cause the bonds between adhesive components such as gelatin to weaken so that edible food packaging becomes brittle and damaged (Viswanathan & Pashupathy, 2017). In contrast to treatment at low temperatures, when water at a temperature of 10°C is added, the temperature resistance of the edible bowl can reach 29 minutes. Then, when small chunks of ice at a temperature of -10°C were inserted, the edible bowl was able to last until the 31st minute. Low temperatures help edible food packaging last longer (Okhuoya & Okogbo, 1990). Based on testing, the temperature resistance graph can be seen in Figure 5.

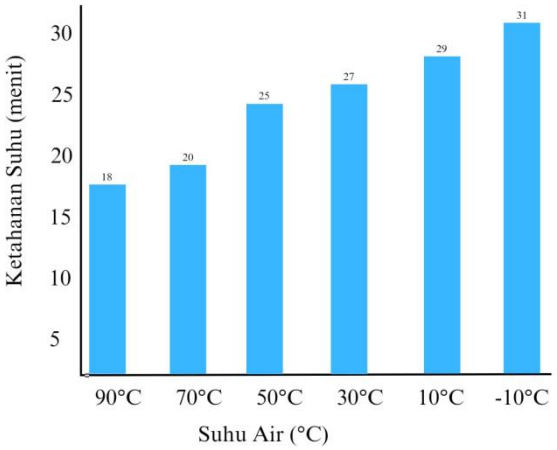

Figure 5. Temperature Resistance Test Graph on Edible Bowl

Decomposition Time Test

The decomposition time test was carried out by burying the edible bowl in the ground. Observations made included mass reduction and morphological changes. Based on the results of observations, the percentage of decomposition of edible bowls buried in the ground for biodegradation is -30% within 5 weeks. This observation continued at week 6, week 7, week 8, week 9, and week 10. The mass reduction obtained respectively was -42%, -56%, -72%, -79%, and -83%. Edible food packaging has good quality if it can decompose quickly. Based on test results, edible bowls can decompose within 2-3 months. With its ability to decompose, the use of edible bowls as food packaging does not cause concern if they are thrown into the environment because they will decompose well (Ministry & Kharate, 2018). Based on the analysis of the decomposition time test graph, it can be seen in Figure 6.

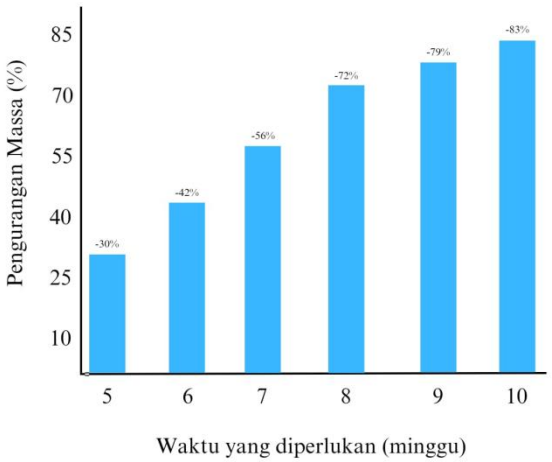

Figure 6. Graph of Edible Bowl Decomposition Time

CONCLUSION

Edible bowls made from papaya skin are an edible and environmentally friendly food packaging innovation. The characteristics of the edible bowl were determined by carrying out several tests, namely the water absorption test, temperature resistance test, and decomposition time test. The ability to absorb water is known by changes in the mass of the edible bowl. The percentage change in mass of the edible bowl at the 30th minute was 27%. Morphologically, the edible bowl looks more inflated and fragile so it is not able to hold food properly. Apart from that, in the temperature resistance test it was found that the higher the temperature used, the less durable the edible bowl became, becoming brittle and damaged. In contrast to treatment at low temperatures, the edible bowl was able to last until the 31st minute. This is because low temperatures help edible bowls last longer. Then, in the decomposition time test, the results showed that the edible bowl could decompose within 2-3 months. Edible bowls made from papaya skin are an alternative to plastic or paper packaging because they do not cause concern if they are thrown into the environment and can decompose well.

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