Edible coating made of taro starch and red dragon fruit peel extract

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Abstract. Edible coating is a technique for food preservation that improves product quality. This research was conducted to introduce innovative edible coating packaging that is environmentally friendly and safe in food products with the aim to extend shelf life and the ability to prevent microbial growth. Edible coating was made from taro starch, CMC, glycerin, stearic acid, and dragon fruit peel extract, then pH analysis and antibacterial activity test against Staphylococcus aureus were carried out. It is known that the characteristic of the edible coating produce with the best pH value and antibacterial activity against Staphylococcus aureus were obtained in 1.0 % concentration namely 5.197 and 1.685 mm, respectively. The average inhibition zone formed by dragon fruit peel extract has a weak inhibitory power against Staphylococcus aureus bacteria.

1. Introduction
Edible coating is a packaging technique that is environmentally friendly and safe for a food product. The advantages of this edible coating include that do not pollute the environment, improved the organoleptic properties and that can be consumed directly with packaged products, functions as a nutritional enhancement supplement, as a flavour, dye, antimicrobial substance, and antioxidant [1]. Packaging with edible coating/film is a technique can be used for food preservation. Research on edible coating food products with edible coating/films has been widely carried out, and has been proven to improve the quality of food products to extend shelf life [2]. Edible coating polymer materials are generally based on starch such as cassava starch, corn starch, taro starch, wheat starch, and pectin. Starch is included in the hydrocolloid group, which is widely used because it is cheap and easy to obtain. The use of starch-based edible packaging with antimicrobial agents is a good alternative to increase the durability, and quality of materials during storage. The physical and mechanical characteristics of edible packaging will change with antimicrobial agents [3].

Taro starch is one alternative product that can be used as an additive for food coating materials that is easy to digest because it has small starch grains and is hypoallergenic, making taro a unique product. Taro has a high starch content of about 80%, which is a good alternative for making edible coatings [4]. Previous research has been done related to the utilization of edible coating made from starch such as breadfruit starch [5] sago starch [6], white sweet potato starch [7] and durian seed starch [8]. Besides films made from starch have low oxygen permeability, are colourless, tasteless, and transparent [9].
In addition, some researchers used a combination of starch in making edible coatings such as cornstarch, CMC, and nano ZnO [10]. Antibacterial packaging is a package that can inhibit, reduce, or slow down the growth of pathogenic microorganisms in food and packaging materials. Various studies have shown that edible coating can function as carriers for food additives, such as anti-browning, coloring agents, flavouring agents, nutrients, and antimicrobial [11].

The use of natural antimicrobial agents tends to increase as consumers are increasingly concerned about the health and potential dangers of synthetic preservatives [12]. Several types of antimicrobial ingredients that can be added to edible packaging includes spices in powder form and essential oils such as cinnamon, pepper, cloves, oregano [13], lemongrass oil [14], and garlic [15]. Another antimicrobial ingredient that can be added to edible packaging include dragon fruit peel extract. Red dragon fruit peel has not been used optimally because it is usually treated as waste and will be disposed of during processing. In comparison the percentage of red dragon fruit skin is 30%–35% of the fruit weight [16]. Besides, methanolic extract of dragon fruit peel contains based on phytochemical identification tests contain alkaloids, phenolics, saponins, steroids, tannins, and terpenoids [17].

Dragon fruit peel extract contains phytochemicals, which are useful as natural antibacterial and antimicrobial agents that effectively increase antioxidants so that dragon fruit peels are not only worth waste but can reduce production [18]. Previous research on the application of the ability of red dragon fruit peel has been tested as a natural antioxidant in beef sausage [19], while its effectiveness as an antimicrobial in the edible coating has not been studied. Therefore, this research was conducted to make an edible coating from taro starch and dragon fruit peel extract used and applied as direct food packaging.

2. Materials and methods

2.1. The process of making extract
The red dragon fruit was chosen to be used as a raw material in this study. It was washed and divided into two parts, in which the skin was taken, then cut/chopped to speed up the drying process. Then, the dragon fruit peel was dried in an oven with Memmert UN110 universal at a temperature of 30°C for 48 hours, until moisture content was obtained from 12 to 16.30% (w/w). After drying, mashed using a blender sieved with an 80mesh sieve to obtain dragon fruit peel flour. Extraction was carried out by soaking the red dragon peel flour with ethanol PA solvents for 24 hours at room temperature. The solvents and ingredients ratio 4:1. Then filtered used filter paper to separate the filtrate and pulp. Maceration was carried out 2 times until the last clear macerate was obtained. Furthermore, the macerate was concentrated by means of a rotary tool at 70°C to produce a thick solution was produced. The solvent was separated from filtrate by using a vacuum rotary of 70°C to obtain a thick red dragon fruit extract.

2.2. Preparation edible coating
The main raw materials used in making edible coatings were taro starch, distilled water, CMC, glycerol, and stearic acid. Edible coating was made using a spatula, hot plate and magnetic stirrer for the homogenization process. First, the distilled water was mixed with 6.0% (w/v) taro starch and heated using a hot plate of 70°C until gelatinization occurred. Then CMC 0.4% (w/v) was dissolved gradually into the taro starch solution while stirring for 3 minutes until it was homogeneous. After the mixture of taro starch and CMC was homogeneous, 5.0% (v/v) glycerol was added to increase the elasticity of the layer. After all dissolved, added 0.5% (w/v) stearic acid while stirring until homogeneous. Furthermore, cooling the edible coating at room temperature. Finally, after the temperature reached 40°C, the dragon fruit peel extract antimicrobial was added according to the concentration, namely dragon fruit peel extract 0.5% and 1.0% for 30 minutes. Edible coating was done when the mixture of ingredients was homogeneous.
2.3. pH measurement
Test the degree of acidity (pH) was done by with a pH meter that had been calibrated using standard buffers pH [20]. 10 grams of edible coating samples were crushed and homogenized using 90 ml distilled water. Homogeneous samples were measured using a calibrated pH meter. The electrodes were immersed in the mixture and the pH value was read on a display monitor. The pH or acidity level indicates the H⁺ ion content in an edible coating product. The more H⁺ ions contained in it, the lower the pH value, which indicates a higher acidity level.

2.4. Antimicrobial activity test of edible coating against Staphylococcus aureus
The antimicrobial activity test with edible coating uses blank disc paper with a diameter of 6 mm. the blank disc was immersed in edible coating with and without extract with various concentrations for 30 minutes. Furthermore, 15 ml of NA media were added into a sterile petri dish. A sterile cotton was dipped in suspense and then rubbed gently. The disc contained edible coating were placed regularly on the surface on the test media used sterile and positive control used chloramphenicol capsulates as comparison. Antimicrobial activity was observed by measured the zone of inhibition against the growth each test microbe used calliper.

3. Results and discussion

3.1. Quantitative test of phytochemical
Table 1 presents the types of phytochemical compounds contained in dragon fruit peel extract were flavonoids, alkaloid, triterpenoid, saponins, and tannin.

Table 1. Quantitative test of phytochemical compounds in the extract

| Phytochemical Compounds extract | Results |
|---------------------------------|---------|
| Flavonoids                      | (+)     |
| Alkaloid                        | (-)     |
| Saponins                        | (+)     |
| Tannin                          | (+)     |
| Triterpenoids                   | (+)     |

Note: +/− indicates the existence of substances in the extract

Phytochemical qualitative test on the extract showed positive results on the examination of flavonoids, saponins, tannins and triterpenoids. This is in accordance with previous studies of previous studies which stated that the results of phytochemical tests on the peel of red dragon fruit showed positive results against flavonoids compounds, tannins and triterpenoids [21]. The phytochemical qualitative test on dragon fruit peel extract showed negative results for alkaloid compounds. This is different from previous studies which stated that phytochemical tests on the dragon fruit peel extract showed the presence of alkaloid compounds found in abundance in the extract which affected the antimicrobial activity of the extract [22]. The difference in the presence of alkaloids is due to differences in solvents during maceration of dragon fruit peels.

3.2. Edible coating characteristics

3.2.1. pH value. Table 2 presents the pH of several edible coating in this research, which showed that the pH of the edible coating of the extract was lower than the pH value of the edible coating without the extract. The addition of the extract caused the change in pH and the appearance of produced coating. The pH value of the edible coating produced without dragon fruit peel extract, edible coating with 0.5% and 1.0% dragon fruit peel were 6.107, 5.629 and 5.196 respectively. The decrease in the edible coating after adding the extract was due to the slightly acidic nature of the extract. This result is supported by
previous research which states that one of pH value the factors that determine the stability of dragon fruit peel syrup is 5.380 [23].

Table 2. Characteristic of edible coating with and without dragon fruit peel extract

| Characteristics                        | pH           | Inhibition zone diameter S. aureus bacteria (mm) |
|----------------------------------------|--------------|-----------------------------------------------|
| Edible coating of Taro Starch          |              |                                               |
| Without Dragon Fruit peel extract (control) | 6.107±0.140\textsuperscript{a} | 0±0.000\textsuperscript{a}                  |
| Dragon fruit peel extract (0.5%)       | 5.629±0.098\textsuperscript{b} | 1.246±0.295\textsuperscript{b}              |
| Dragon fruit peel extract (1%)         | 5.197±0.072\textsuperscript{c} | 1.685±0.530\textsuperscript{b}              |
| Positive control (chloramphenicol)     | -            | 11.933±1.141\textsuperscript{c}              |

Note: The sign (±) shows the standard deviation value. The value denoted by different letter in the same row is significantly different (p<0.05)

3.2.2. Antibacterial activity of edible coating with and without extract against Staphylococcus aureus. Figure 1 shows the results of the edible coating antibacterial test of extract against *Staphylococcus aureus*. It shows that the edible coating with 1.0% extract has an average inhibition diameter of 1.685 mm. From the observation, it can be seen that all concentrations of edible coating with dragon fruit peel extract are able to inhibit bacteria. This is in line with research [24]. Phytochemical content contained in the extract can inhibit several pathogenic bacteria. It is content contents includes flavonoids, triterpenoids, steroid, saponin, and tannins. It's just that these developments are still in a weak condition (≤5 mm). The antibacterial strength of the weak category was classified if the diameter of the clear zone formed was ≤ 5 mm, the medium category was 5-10 mm, and the strong category if the diameter of the clear zone formed was ≥ 10 mm [7]. This is probably because the concentration of the extract used is still inaccurate so that the yield or inhibition zone diameter obtained is in the weak category.

![Figure 1. Inhibition zone diameter of *Staphylococcus aureus* bacteria against ethanol extract of dragon fruit extract](image-url)
4. Conclusions

This study demonstrated that edible coating could be made from taro starch and dragon fruit peel extract. The addition of 1.0% dragon fruit peel extract caused a change in pH value was 5.197. Changes in the pH value of the edible coating of extract 1.0% can affect the antibacterial activity against *Staphylococcus aureus* with an inhibition zone of 1.685 mm. In the future, the coating might add more valuation on dragon fruit peel extract to be used as material for food coating.

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