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4 Effect of addition of white turmeric extract against antibacterial properties in edible film sweet potato starch and whey protein

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2 **Abstract.** The addition of white turmeric extract as an antibacterial to edible starch-based films aims to improve the resilience of food packaged against bacteria so that the quality is more maintained. The method carried out in this study consists of three things. The first step was the preparation and characterization of orange sweet-potato starch (including starch and moisture content). The second stage is the preparation and characterization of white Turmeric extract by phytochemical tests. The third stage is the preparation and characterization of edible films (including water resistance tests, mechanical properties tests. The result of starch characterization obtained the starch content of 43.16% with a moisture content of 13.95%. The result of the characterization of edible films by adding the best white turmeric extract was 7% with the tensile strength, and combined-successful elongation values were 40.9209 ± 2.5290 MPa and 18.03%. The results of antibacterial testing on E. Coli ATCC 11229 did not produce an inhibitory zone and on S. aureus ATCC 6538 was a clear zone but could not construct that indicates the presence of very weak antibacterial potential in edible films by adding white turmeric extract.

1. Introduction

The intensity of using plastic as food packaging is still very high because plastic has strong, lightweight, economical, easy to obtain, and multipurpose properties. The nature of plastics that cannot be destroyed naturally causes the accumulation of plastic waste continuously. 7 One alternative that can be used as a substitute for plastic as food packaging is an edible film. The edible film is a layer made from edible material and as an inhibitor (moisture, oxygen, and solutes) in food [1]. Besides Edible Film can be used to coat food, protect food from microorganisms, help the process of preservation and carrier of antibacterial or antioxidant compounds. The advantage of using edible film as a packaging compared to synthetic packaging is that it can be eaten together directly with packaged products, environmentally friendly because it does not leave waste, can act as a flavouring, colour, and make the food longer because it has antimicrobial or antibacterial properties [2].

Bacteria that usually attack food are E.coli and S.aureus. E.coli and S.aureus. E. coli bacteria can contaminate food that will cause a decrease in the quality of food products and can even become contaminants that can cause disease or poisoning. As for S.aureus, the bacteria are not dangerous, but if the bacteria have moved to the food, the breeding will be faster and eventually cause infection. Foods

that usually contain high *S. aureus* bacteria are foods that are processed directly by hand [3]. So the role of edible film as an anti-bacterial carrier to protect food is needed.

Edible films are composed of three main components, hydrocolloid, lipid, and composite materials. In this research, edible film preparation and characterization using orange sweet potato starch and whey protein isolate will be added by sorbitol as a plasticizer and white turmeric extract as an antibacterial agent. The use of orange sweet potato is because it has high levels of starch, abundance is very much, and its utilization is still rare. The use of whey protein isolates to add nutritional value and cover up the deficiencies in starch. Sorbitol as a plasticizer is added to improve the mechanical properties of the resulting edible so that it has better elasticity and flexibility values. In making edible films plasticizer agents are used to obtain the flexible properties of edible films. White turmeric extract was chosen as an additive to add antibacterial properties to *E.coli* ATCC 11229 and *S.aureus* ATCC 6538. The selection was because white turmeric is well-known as a medicinal plant and contains active compounds, in other studies it was stated that the higher the concentration of white turmeric ethanol extract used, the inhibition of growth of each bacterium was also greater the ethanol extract of white turmeric rhizome (*Curcuma mango* Val.) has good antibacterial activity against *Staphylococcus aureus* ATCC 6538 and *Escherichia coli* ATCC 11229 in vitro [4].

Research on the effect of white turmeric extract on antibacterial edible sweet potato starch films and whey protein is expected to be able to add edible film types that have their own added value. In addition, this study was conducted to determine the effect of the addition of white turmeric extract to the characteristics of edible film so that it is expected to be able to expand the use of environmentally friendly packaging materials so that the use of plastics can be further reduced and can improve the quality of food products.

2. Materials and methods

In this research, the raw material used for making an edible film is starch from white sweet potato and whey protein which are included in the hydrocolloid group and using plasticizer as an additive, sorbitol, and antibacterial substances in the form of white turmeric extract. The resulting edible film is then subjected to several tests using special instruments and tools.

2.1. Material

The materials used in the research of making the edible film are white sweet potato from the Bandung area, sorbitol (70%), white turmeric, acetone, Mg powder, 96% HCl, Meyer, dragendorff, bouchardate, distilled water, whey protein isolate, Nutrien Broth (NB), Mueller Hinton Broth (MHB), bacteriological agar, *E.coli* ATCC 11229, *S.aureus* ATCC 6538, FeCl₃ (1%), 2N HCl, H₂SO₄ (1%), ethanol (70%), filter paper.

2.2. Method

The procedures performed in this study started from making white turmeric extract, Sample preparation, manufacture an edible film and some of the tests performed on the edible film has been finished.

2.2.1. Production of turmeric extract white. Making pure turmeric extract begins with the manufacture of white turmeric simplicia. White turmeric extract obtained after going through this process is then tested by phytochemicals. Phytochemical testing was carried out to determine the compounds contained in the extract. Phytochemical tests are carried out on groups of alkaloid compounds, flavonoids, tannins/phenols, saponins, terpenoids, and steroids.

2.2.2. Making the edible films. The process of making an edible film is started by heating 20 mL of 6% sweet potato starch solution with a hotplate while stirring using a magnetic stirrer at 85 °C for 30 minutes until it thickens or forms a gel. After the starch solution thickens, the heating process is stopped but the stirring process with a magnetic stirrer continues while adding 2 mL of whey protein isolate 4%. After stirring for 30 minutes then add 3 mL of 30% sorbitol as a plasticizer agent. Conducted 3 times the

making of the thick mixture which will later be carried out variations on each of the thick mixtures. Variations made on the first thick mixture that is not added white turmeric extract, the second variation added 1.75 mL of turmeric extract 7% and third variation added 2.75 mL of turmeric extract 11%. Each thick mixture that has been done variations is stirred again with a magnetic stirrer so that it is homogeneous for ± 30 minutes. The process of molding an edible film solution is done by pouring an edible solution as much as 20 mL on a glass plate and then dried using an oven at 50 °C for 9 hours [5]. Finished edible film on a glass plate mold is cooled to room temperature to be easily removed from the mold. Edible films that have been formed are then subjected to several tests, namely mechanical testing and antibacterial properties. Mechanical tests include measuring edible film thickness using a micrometer screw, tensile strength measurement and elongation using a testometric tool. Analysis of antibacterial properties carried out on *E.coli* and *S.aureus* bacteria using disk diffusion method by replacing discs with edible film samples that have been made to form discs, using positive control in the form of amoxicillin, and negative control using edible film without the addition of white turmeric extract.

3. Results and discussion

3.1. Making white turmeric extract

From the process of preparation of white turmeric, we get 500 grams of fine white turmeric or 50% yield. Fine turmeric that has been done maceration preparation and evaporation of solvents with a rotary evaporator obtained thick white turmeric extract thickness of approximately 25 grams. The extract of white turmeric is then subjected to phytochemical tests which include tests of flavonoids, tannins, phenols, alkaloids, saponins, terpenes/steroids. The test show the extract of white turmeric contain flavonoids and tannins/phenols.

3.2. Analysis of mechanical properties of edible film

This test aims to determine the mechanical characteristics of an edible film of sweet potato starch by adding variations of turmeric extract. In testing this edible film, strength measurements of thickness, tensile strength (tensile strength), elongation (elongation at break) and young modulus. Mechanical properties are affected by the edible film constituent formulations. The results of testing the mechanical properties of edible films can be seen in Table 1.

From the analysis, as shown in the figure shows that the tensile strength tends to increase until the addition of white turmeric extract 7% and drops sharply on the addition of white turmeric extract 11% and is inversely proportional to the decreasing elongation value.

The sharp decrease in tensile strength of edible white turmeric extract film 11% is influenced by the thickness which makes the film stiffer than the others so that when pulled it is not elastic and easily broken. The addition of white turmeric extract causes edible film thickness to increase because the addition of white turmeric extract will increase the total amount of solids.

Table 1. Test results of mechanical properties of edible film.

Samples	Thickness (mm)	Tensile Strength (MPa)	Elongation (%)	Youngs Modulus (MPa)
Edible sweet potato starch without white turmeric extract	0.0114 \pm 0.0008	32.5975 \pm 1.865	35.23	0.9253 \pm 0.0529
Edible sweet potato starch + 7%t white turmeric extract	0.0119 \pm 0.0005	40.9209 \pm 2.529	18.03	2.2696 \pm 0.1403
Edible sweet potato starch + 11%t white turmeric extract	0.0128 \pm 0.0008	15.0846 \pm 0.932	16.96	0.9064 \pm 0.055

Elongation measurements are carried out in conjunction with tensile strength measurements. Elongation testing is carried out to determine the magnitude of the length increase of a polymer before finally breaking up. The more addition of white turmeric extract to edible film, the elasticity value decreases so as to make the film matrix is not compact and easily torn. Krochta reports that the characteristics of standard edible films have a 10-15% elongation percent [6].

A low elongation value indicates that the edible film is rigid and easily broken. The decrease in elongation value is lower along with the addition of white turmeric extract which is getting higher because of more and more concentrations of filler material into the edible film. The more concentration of filler in the film makes the number of solids more and the film thicker, but the intermolecular polymer matrix space does not stretch perfectly so that the resulting edible film is not flexible [7]. In another study, it was reported that the addition of 1% turmeric extract into the polymer film was able to reduce the elongation value from 70.3% to 39.41% [8].

Meanwhile, the effect of the addition of white turmeric extract to the modulus of a young edible film can be seen in Figure 1.

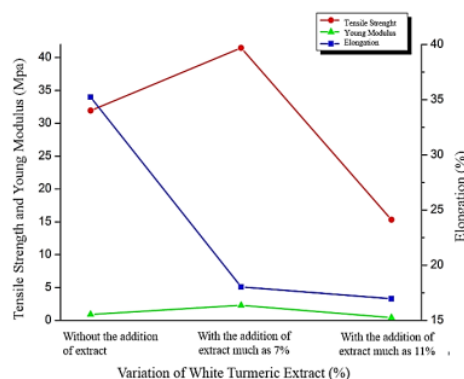


Figure 1. Graph of the relationship between tensile strength, elongation, modulus of young edible sweet potato starch film with white turmeric extract formulation.

Young modulus is obtained from a comparison between tensile strength and tensile elongation (elongation at break). From the picture, it can be seen that the highest modulus young value is found in edible film added with turmeric extract of 7%, which is 2.2999 MPa, which means that the edible film is stiffer compared to the other two edible films.

3.3. Analysis of edible film antibacterial properties

An analysis of the antibacterial properties of edible films was carried out to determine the ability of edible films to prevent bacterial growth. Tests were carried out on two different bacteria namely *E. Coli* ATCC 11229 and *S. aureus* ATCC 6538. The antibacterial properties of the edible film of white turmeric extract were obtained from flavonoid Gyras and tannin compounds as a positive phytochemical test on white turmeric extract used. The active bioactive compounds from an extract have various bacterial inhibition mechanisms, such as by damaging the cytoplasmic membrane and denaturing cell proteins so that they interfere with membrane permeability and cause leakage.

Flavonoids indicated in the extract of white turmeric used as an additive in the manufacture of edible films are known to inhibit DNA gyrase. Flavonoids bind to the GryB (Gyrase B) subunit of DNA gyrase and inhibit the activity of the enzyme ATPase. Inhibited DNA gyrase and ATPase activity can inhibit bacterial growth because DNA gyrase is an important DNA in the process of DNA replication in prokaryotic cells, which serves to reduce the tension in front of the replication fork and open strong bonds in the DNA supercoil structure.

However, in this study both the addition of turmeric extract as much as 7% and 11% on edible film did not provide sufficient antibacterial properties. The analysis results can be seen in **Figure 2** which shows the absence of a clear zone around the edible film sample of *E.coli* bacteria. Whereas in *S.aureus* bacteria there is a clear zone around the sample, but the diameter cannot be calculated because it is not evenly formed.

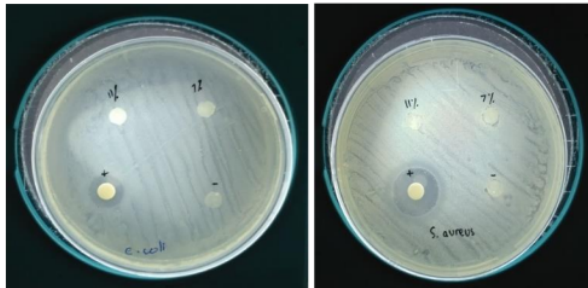


Figure 2. Above: Results of analysis of antibacterial properties against *E.Coli* ATCC 11229, Below; analysis of antibacterial properties against *S. aureus* ATCC 6538.

The presence of a clear zone in testing the antibacterial properties of *S. aureus* although it cannot be measured indicates that the addition of white turmeric extract in the manufacture of sweet potato starch edible films have potential as an antibacterial. But in this study the results obtained are not in accordance with previous studies. These results could have been caused by flavonoid and tannin compounds produced from white turmeric extract were so small that they work in the antibacterial activity was not optimal. When phenol is in high concentration it can work by totally destroying the cytoplasmic membrane by precipitating cell proteins, whereas if at low concentrations phenol only damages the cell membrane causing leakage of important metabolites and activating bacteria [9].

The higher the concentration of an antibacterial agent, the higher the content of the antibacterial agent, the higher the concentration of anti-bacterial agent, the more bacterial growth will be inhibited [10]. White turmeric extract contained in the edible film produced in this study does not have a good concentration of anti-bacterial substances or can be said to be still low. The low anti-bacterial substances in turmeric extract produced can be caused by the turmeric extraction process that is not optimal. This makes the turmeric extract obtained has not been optimized to be made antibacterial in edible film.

4. Conclusion

From the results of this study conclusions can be drawn as follows: The addition of white turmeric extract on edible films of sweet potato starch and whey protein influenced the mechanical and antibacterial properties of the edible produced. The addition of white turmeric extract caused the best tensile strength to occur with the addition of 7% turmeric extract, and the best extension value on edible films without the addition of white turmeric extract. As for modulus young, it is better to add white turmeric extract 11% which means it is more elastic. In the anti-bacterial properties of edible film the addition of white turmeric extract is not very influential because the anti-bacterial produced has very weak properties. So we need to review the use of anti-bacterial agents better.

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