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Research Article

Edible Film Application of Mung Bean Starch with the Addition Glycerol as a Button Mushrooms Packer

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ABSTRACT

The research on the production of edible films from mung bean starch with the addition of glycerol as packaging for button mushrooms aims to analyze the effect of varying glycerol concentrations on the physical and mechanical properties of the edible film, as well as the shelf life of button mushrooms in terms of weight loss. The stages of this research include the production of mung bean starch, the creation of edible films, characterization of the starch and edible films, and their application to button mushrooms using weight loss tests. The edible films were made with glycerol concentrations of 6.3%, 12.6%, and 18.9% of the total starch weight used. The results showed that the edible films at each glycerol variation exhibited a reduction in weight loss that was generally lower compared to the weight loss of the control button mushrooms.

Keywords: Button Mushroom, Edible Film, Glycerol, Mung Bean Starch

1. Introduction

Button mushrooms are known to be rich in nutrients and beneficial for human health. This food source has a high carbohydrate content and crude protein. Button mushrooms are widely cultivated and consumed by people. Their high-water content makes them prone to damage and quality deterioration, resulting in a relatively short shelf life of 2-3 days at room temperature [1].

One way to extend the shelf life of agricultural products is through efficient packaging, such as plastic, which has barrier properties against oxygen, carbon dioxide, and water vapor [2]. However, synthetic plastics are not easily biodegradable, which can lead to environmental issues.

Innovations in the production of edible film packaging need to be implemented. Edible film packaging can be made from natural materials, making it safe for the environment [3]. The use of edible film as packaging can slow down the degradation of food quality due to its functions as a barrier to gas exchange, moisture transfer, improving physical properties, and as a carrier of additives.

According to Santoso [4], the basic materials for making edible films can come from hydrocolloids, lipids, and composites. The hydrocolloid components include starch, protein, cellulose derivatives, pectin, and other polysaccharides. One of the edible film materials from the hydrocolloid group is starch. Starch-based edible films are widely used in various food packaging and represent a beneficial alternative for the environment. Mung bean starch has very promising properties as a base material for making edible films.

One of the weaknesses of edible films is their brittleness, which makes them prone to breaking. This brittleness is due to the fact that the base materials used to create edible films come from natural polymers. To reduce this brittleness, plasticizers need to be added. Commonly used plasticizers include glycerol and sorbitol. Glycerol is a hydrophilic plasticizer, making it suitable for forming films that are hydrophobic, such as starch. The role of glycerol as a plasticizer and its concentration can enhance the flexibility of the edible film.

Previous research has been conducted on the characteristics of edible packaging made from mung bean starch with the addition of CMC and glycerol, resulting in the best edible film with 1% CMC and 3% glycerol. Subsequently, various tests were carried out on this edible film to determine its characteristics. The physical and mechanical properties tested include tensile strength, elongation, and water vapor transmission rate [5].

2. Materials and Methods

2.1 Materials

The materials used in this research include mung beans, glycerol 85% (Chem-mix), acetic acid 100% (Merck), silica gel (Carikimia), table salt (Daun), aquades (Jaya Sentosa), and button mushrooms (Etira). The tools used in the study were a set of beakers, spatula, thermometer, acrylic mold, magnetic stirrer, porcelain dish, jars, 140 mesh sieve, hotplate, Universal Testing Machine, and FTIR instrument.

2.2 Methods

2.1.1 Preparation of Mung Bean Starch

Prepare cleaned, peeled mung beans, then blend them and add aquades in a ratio of (1:2). The mixture is then squeezed and filtered into a container. The resulting filtrate is allowed to settle for 24 hours. The precipitate of mung bean starch is dried in an oven for 2 hours at 50°C. The dried starch is then ground and sieved using a 140 mesh sieve. Mung bean starch is now ready for use.

2.1.2 Preparation of Edible Film

A total of 3.5 grams of mung bean starch was placed in a beaker and mixed with 25 ml of aquades and 12.5 ml of acetic acid 1%, then stirred until homogeneous. The mixture was then heated on a hotplate while stirring with a stirrer until the solution reached 60°C. After that, glycerol was added in varying amounts (6.3%, 12.6%, and 18.9%) of the weight of the starch used. The mixture was stirred until fully homogeneous and reached a temperature of 70°C. Heating continued until the solution became gelatinous, and then it was poured into a 20 x 20 cm acrylic mold. The mold was then dried in an oven at 50°C for 55 minutes, and the edible film was left for 24 hours to allow for removal from the mold and preparation for testing.

2.3 Characterization

2.3.1 Thickness

The thickness of the edible film is measured using a screw micrometer with an accuracy of 0.01 mm at five different points to obtain the average measurement of the edible film.

2.3.2 Tensile Strength

The tensile strength of the edible film is measured using a Universal Testing Machine (UTM) by clamping both ends of the sample, then the edible film is pulled by the machine until it breaks.

$$\sigma = \frac{F}{A} \qquad (1)$$

Where σ = tensile strength (Mpa), F = Maximum tensile forve (N), A = Surface area of the edible film (mm^2).

2.3.3 Elongation

The percentage of elongation of the edible film is measured using a UTM by clamping both ends of the sample, then the edible film is pulled by the machine until it breaks.

$$\text{Elongation (\%)} = \frac{m_1 - m_2}{m_1} \times 100\% \qquad (2)$$

Where m_1 = initial length (cm), m_2 = final length (cm).

2.3.4 Modulus Young

The modulus young value indicates the elasticity of a sample based on the ratio of the tensile strength of the sample to its percentage elongation.

$$E = \frac{\sigma}{e} \qquad (3)$$

Where E = modulus young (MPa), σ = tensile strength (MPa), e = elongation (%).

2.3.5 Water Vapor Transmission Rate

WVTR test is conducted using the cup method. 10 grams of silica gel are placed in a petri dish, then covered with aluminium foil that has a hole in the center and sealed with modeling clay. The edible film sample is cut to a size of 3 cm² and sealed over the hole in the aluminum foil using tape. The petri dish is placed in a closed jar containing 40% table salt. The petri dish with the edible film is weighed every hour for 5 hours using an analytical balance.

$$\mathrm{WVTR} = \frac{\Delta \mathrm{W}}{\mathrm{A} \times \mathrm{t}} \quad (4)$$

Where ΔW = change in the weight of the edible film after 24 hours (gram), A = Surface area of the edible film (m^2), t = storage time interval (hours).

2.3.6 Ash Content

According to SNI 01-2891-1992, the ash content testing of edible film is conducted by preparing a two gram sample of edible film, which is then placed in a porcelain crucible with a known weight. It is then charred over a burner flame and ashed in an electric furnace at a maximum temperature of 550°C until complete ashing. The sample is cooled in a desiccator and weighed until a constant weight is obtained.

$$\text{Ash content (\%)} = \frac{\mathrm{W_1} - \mathrm{W_2}}{\mathrm{W}} \times 100\% \quad (5)$$

Where w = weight of the edible film before ashing (grams), w_1 = weight of the edible film and crucible after ashing (grams), w_2 = weight of the empty crucible (grams).

2.3.7 Fourier Transform Infrared Analysis

The sample was analyzed using FTIR with a wavenumber range of 4000 cm^{-1} to 400 cm^{-1}, conducted at the Faculty of Mathematics and Natural Sciences, Gadjah Mada University.

2.4 Weight Loss Test

Button mushrooms were coated with samples of edible film made from mung bean starch with varying concentrations of glycerol as a plasticizer. The mushrooms were wrapped and sealed using tape. Then, the mushrooms were weighed on days 1, 3, 6, and 9.

$$\text{Weight Loss (\%)} = \frac{\mathrm{W_0} - \mathrm{W_1}}{\mathrm{W_0}} \times 100\% \quad (6)$$

Where W_0 = Initial weight of the button mushrooms before treatment (grams), W_1 = Final weight of the button mushrooms after treatment (grams).

3. Result and Discussion

The basic principle used in the production of hydrocolloid-based edible films is gelatinization. The gelatinization process causes the amylose bonds to tighten due to hydrogen bonding, and the drying process during the edible film production leads to shrinkage as water is released, allowing the gel to form a stable film.

3.1 Mung Bean Starch

Mung bean starch is obtained through the wet extraction method, which is carried out by soaking using distilled water. The mung bean starch obtained was in the form of dry starch powder with a milky white color and a yield value of 10.39%. The yield indicates amount of starch produced from the dry weight of the material obtained compared to the weight of the raw material from the extraction process. Meanwhile, the starch content of the mung bean obtained was 83.68%. This result indicates that the starch produced is quite pure. Next, the obtained mung bean starch was characterized qualitatively. The qualitative test used was functional group analysis with FTIR using an infrared spectrophotometer instrument to determine the purity of the mung bean starch. The FTIR spectra results of the mung bean starch shown in **Figure 1**.

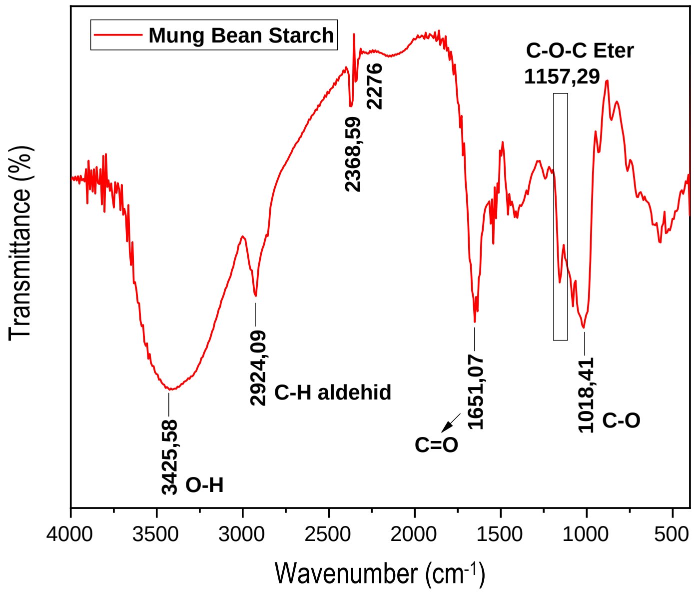

Figure 1. FTIR spectrum of mung bean starch

Based on **Figure 1**, it can be seen that the FTIR results of mung bean starch show several absorptions, including a strong -OH group absorption at a wavenumber of 3425.58 cm^{-1}. Then, there is an aldehyde C-H group at a wavenumber of 2924.09 cm^{-1}. A sharp absorption at a wavenumber of 1651.07 cm^{-1} indicates the presence of an aldehyde functional group (C=O). An ether group (C-O-C) is present at wavenumbers 1157 cm^{-1} and 1080.14 cm^{-1}. The C-O group, as a specific starch group in the fingerprint region, is found at a wavenumber of 1018.41 cm^{-1}. The obtained data indicate that the produced mung bean starch contains the functional groups of starch, as confirmed by the literature results of mung bean starch spectra in **Table 1**.

Table 1. Results of Mung Bean Starch Absorption

Functional group	Results of synthetic starch absorption (cm^{-1})	Absorption results of mung bean starch (Literature)
-OH	3425	3200-3600
C-H	2924	2933
C=O	1651	1653
C-O-C	1157	1158
C-O	1018	995

3.2 *Gelatinization in the Production of Edible Film*

The production of edible film in this study was carried out using mung bean starch with the addition of distilled water and acetic acid. The use of starch in edible film production has an impact on mechanical testing, specifically the tensile strength of the edible film. Acetic acid functions as a catalyst to accelerate the gelatinization process by breaking the bonds between starch molecules, making the starch polymers shorter and easier to bond with glycerol. The addition of the right amount of acetic acid will result in a gel-like solution, making it more homogeneous. Moreover, the addition of acetic acid affects the viscosity and thickness of the edible film produced. The edible film solution, when heated, undergoes a gelatinization process. Gelatinization is the process of heating water and starch, resulting in a thick liquid due to the swelling of starch granules and the diffusion of amylose out of the granules [6].

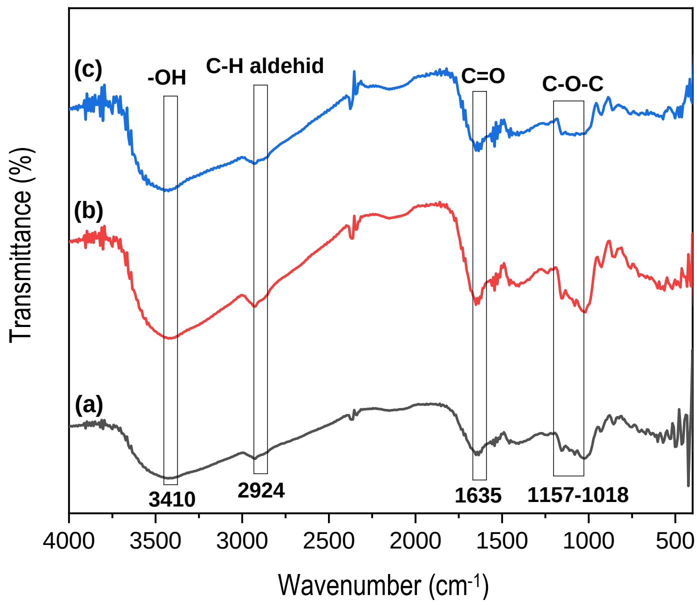

Figure 2. Spectra FTIR (a) glycerol 6,3% (b) glycerol 12,6% (c) glycerol 18,9%

The FTIR results of the edible film with glycerol variations of 6.3%, 12.6%, and 18.9% in **Figure 2** show that no new functional groups were formed across all concentration variations of the edible film. Based on the figure above, there is a -OH functional group at a wavenumber of 3410 cm^{-1}, which originates from the starch, glycerol, and acetic acid. The peak spectrum of the -OH group in the edible film experiences a slight shift from a wavenumber of 3425 cm^{-1} to 3410 cm^{-1} due to the addition of glycerol and acetic acid. Additionally, the -OH peak in the produced edible film becomes sharper due to the interaction between water, starch, and glycerol. At wavenumbers 2924 cm^{-1} and 2931 cm^{-1}, there are -CH groups originating from the starch used. All three variations exhibit weak absorption at wavenumbers 1620 cm^{-1}, 1635 cm^{-1}, and 1651 cm^{-1}, which indicate the presence of C=O groups from the acetic acid used. The FTIR spectrum at wavenumbers 1260–1050 cm^{-1} indicates the presence of ether C-O-C groups. Almost all variations of the produced edible film have C-O-C groups obtained at wavenumbers 1157 cm^{-1} – 1018 cm^{-1}. The generated IR groups can identify chemical changes that occur by comparing the IR spectra before and after the reaction.

3.3 Thickness

The thickness value determines the feasibility of an edible film as a food packaging material, as it can affect the characteristics of the edible film, including tensile strength, elongation, Young's modulus, and water vapor permeability. The higher the thickness value, the stiffer the resulting edible film [7][8], and the water vapor transmission rate decreases [9]. The thickness values of the edible film with glycerol variations are shown in **Figure 3**.

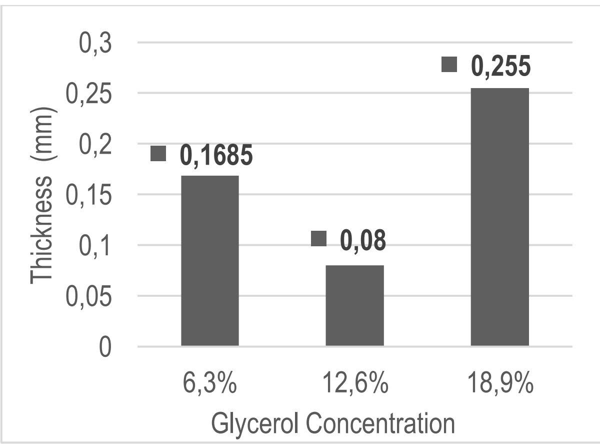

Figure 3. Diagram of the results of the thickness of the edible film of mung bean starch and glycerol

Based on **Figure 3**, it can be seen that the thickness values that meet the Japanese International Standard 1975 are the edible films with glycerol concentrations of 6.3% and 12.6%. The difference in thickness values for each variation is influenced by the process of casting the edible film on the acrylic mold.

3.4 Tensile Strength

The tensile strength value determines the strength of the produced edible film. The tensile strength test aims to determine how strong the edible film is in withstanding the materials or products being packaged [10]. The greater the tensile strength value, the better the edible film is at resisting mechanical damage, while elongation decreases. The tensile strength values of the edible film with glycerol variations are shown in **Figure 4**.

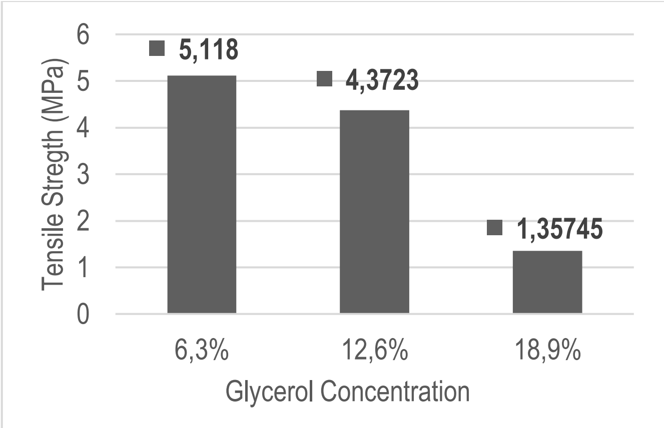

Figure 4. Diagram of the results of the tensile stregth of the edible film of mung bean starch and glycerol

Based on **Figure 4**, it is shown that the tensile strength decreases as the concentration of the plasticizer glycerol increases. The tensile strength tends to decrease due to the increased concentration of glycerol. This is because glycerol can reduce the interaction forces between molecules and decrease the elongation capacity of the produced edible film, resulting in a more elastic edible film. According to the quality standards for edible films in the Japanese Industrial Standard (1975), the minimum standard tensile strength value is 0.392 MPa; thus, all edible films with glycerol variations have met the specified standards.

3.5 Elongation

The percentage of elongation indicates the flexibility of the produced edible film. The elongation value tends to be inversely proportional to the tensile strength value. The higher the percentage of elongation, the lower the tensile strength of the resulting edible film [11]. The elongation values of the edible film with variations in glycerol concentration are shown in **Figure 5**.

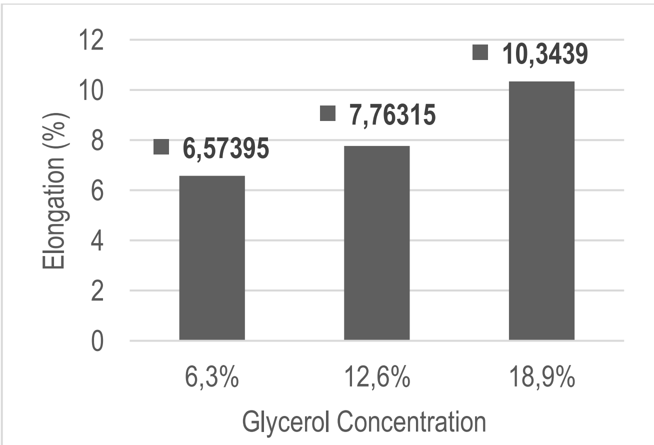

Figure 5. Diagram of the results of the elongation of the edible film of mung bean starch and glycerol

Based on the figure above, it can be seen that the elongation value increases with the increasing concentration of glycerol. The increase in the elongation value is due to the plasticizing properties of glycerol, which enhance the flexibility of the edible film. Glycerol interacts with starch, forming bonds that lead to increased elasticity of the edible film. The use of glycerol as a plasticizer can also reduce the intermolecular forces in the polymer chain, thereby enhancing the flexibility of the edible film [12]. According to the quality standards for edible films in the Japanese Industrial Standard (1975), the minimum standard elongation value is 70%, indicating that all variations do not meet the established standards.

3.6 Modulus Young

Modulus young indicates the elasticity of the produced edible film as a packaging material for food. The Young's modulus value of the edible film is obtained from the ratio of tensile strength to the elongation produced [13]. Elasticity is defined as the ability of the edible film to return to its original shape after being subjected to a certain force. The Young's modulus values of the edible film with variations in glycerol concentration are shown in **Figure 6**.

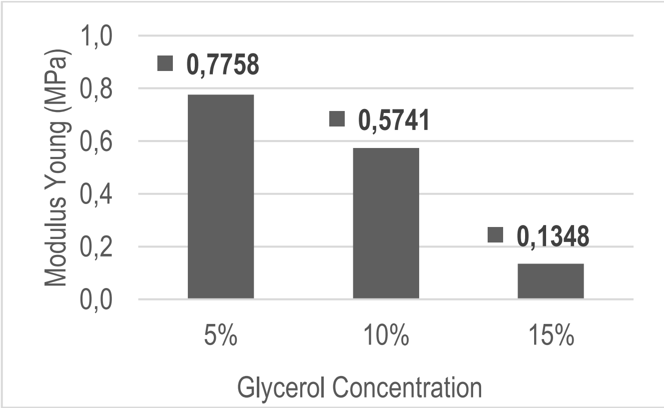

Figure 6. Diagram of the modulus young result of the edible film from mung bean starch and glycerol

Based on **Figure 6**, it can be seen that the Young's modulus value decreases as the concentration of glycerol increases. This result is influenced by the tensile strength value. The lower the concentration of glycerol added, the greater the tensile strength, resulting in a higher elasticity of the edible film. According to the Japanese Industrial Standard (1975), the minimum standard value for modulus young is 0.35 MPa; therefore, the variation with 18.9% glycerol does not meet the JIS 1975 standard.

3.7 Water Vapor Transmission Rate

The water vapor transmission rate (WVTR) indicates the ability of the edible film to hinder the rate of water vapor transfer as a food packaging material. The lower the WVTR value, the better the produced edible film [14], making it suitable for packaging food with relatively high moisture content [15]. The water vapor transmission rate values of the edible film are shown in **Figure 7**.

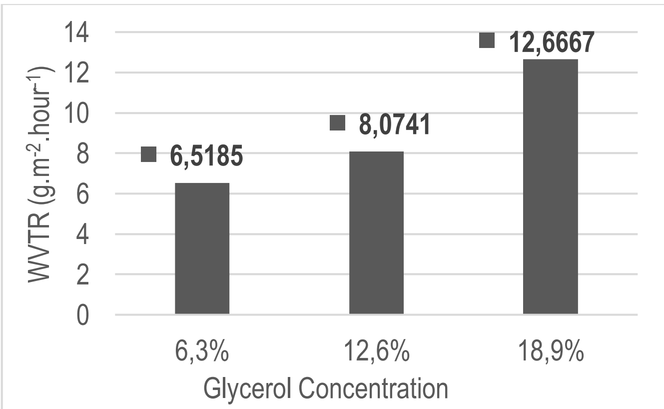

Figure 7. Diagram of the results of the WVTR of the edible film of mung bean starch and glycerol

Based on **Figure 7**, it can be observed that the water vapor transmission rate of the edible film increases with the addition of glycerol. This is due to the hydrophilic nature of the materials used in the production of the edible film, specifically glycerol. Additionally, glycerol causes a decrease in internal hydrogen bonding and an increase in intermolecular spacing, facilitating the penetration of water vapor, which results in an increase in the permeability of the edible film [16]. According to JIS 1975, the maximum standard value for the water vapor transmission rate is 10 $m.g^{-2}.hour^{-1}$, indicating that the variation with 6.3% glycerol meets the established standard.

3.8 Ash Content

The ash content testing on the edible film is conducted to determine the inorganic substances contained in the edible film. The ash content value can be utilized for various purposes, including identifying the composition of the materials used and determining the nutrients in the produced product. The higher the ash content, the higher the mineral content. The results of the ash content testing of the edible film with variations in glycerol are shown in **Figure 8**.

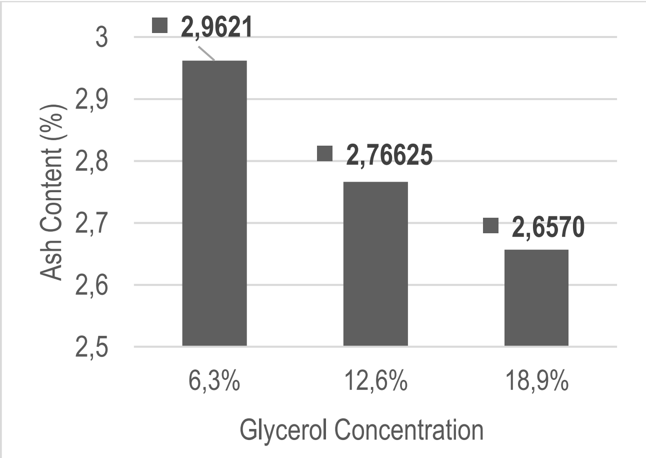

Figure 8. Diagram of the results of the ash content of the edible film of mung bean starch and glycerol

Glycerol, as an organic compound, helps reduce the bonds between inorganic mineral particles, resulting in a decrease in ash content as the concentration of glycerol increases. The ash content values of the edible film from all glycerol variations are below the maximum limit value according to SNI 06-3735-1995, which is 3.5%. This result indicates that the edible films from all variations meet the established standards.

3.9 Application of edible film on button mushrooms

Weight loss determines the quality of the food packaged with edible film during storage at room temperature. A high weight loss value indicates that the packaged food undergoes respiration and transpiration processes, which can lead to damage and decrease the quality of the material [16]. Weight loss testing was analyzed on days 1, 3, 6, and 9. The weight loss values of the button mushrooms packaged using edible film with variations in glycerol are shown in **Table 2**.

Table 2. Percentage of Weight Loss

Time	Percentage of Weight Loss (%)			
	Control	6.3%	12.6%	18.9%
Day 1	70.10	31.65	36.14	34.41
Day 2	92.114	50.44	50.96	51.66
Day 6	92.22	51.21	51.64	52.20
Day 9	92.69	52.71	52.98	.53.35

Based on the figure above, the best application of edible film on button mushrooms was obtained at a concentration of 6.3%. Compared to the control sample, the button mushrooms coated with the edible film were able to significantly inhibit the decrease in weight loss. Based on the obtained data, the percentage of weight loss is directly proportional to the WVTR value. If the water vapor transmission rate is high, the weight loss of the button mushrooms will also be greater [17]. Theoretically, edible films with high water vapor transmission rates cause transpiration processes, making it easier for food products to lose their water content, which affects the weight of the food [13].

Figure 9. Application of edible film on button mushrooms in day one and day nine

In **Figure 9**, the application of edible film on button mushrooms is shown. The samples were stored at room temperature to demonstrate how effective the edible film is in maintaining the quality and shelf life of the button mushrooms. By day 9, the control mushrooms had already experienced shrinkage and wrinkling as the moisture content in the mushrooms had been lost.

4. Conclusion

The research results shows that the addition of glycerol plasticizer affects the characteristics of the mung bean starch based edible films. Furthermore, the addition of 6.3% glycerol to the mung bean-based edible film was able to reduce the weight loss of button mushrooms by a margin of 40% compared to the control.

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References

[1] Ganjdoost, M., Aboonajmi, M., Mirsaeedghazi, H., & Asefpour Vakilian, K. (2021). Effects of power ultrasound treatment on the shelf life of button mushrooms: Digital image processing and microbial counting can reveal the effects. *Food Science and Nutrition*, *9*(7), 3538–3548. https://doi.org/10.1002/fsn3.2303

[2] Nakamoto, M. M., Assis, M., Filho, J. G. O., & Braga, A. R. C. (2023). Spirulina Application in Food Packaging: Gaps of Knowledge and Future Trends . *Food and Technology Journal*, *133*, 139-147.

[3] Sharma, S., Nakano, K., Katiyar, V., & Kumar, S. (2024). Edible Packaging to Prolog Postharvest Shelf-Life of Fruits and Vegetables: A Review. *Food Chemistry Advances* *4*(3), 2-14.

[4] Santoso, B. (2020). Edible Film Teknologi dan Aplikasinya. Palembang: NoerFikri.

[5] Gozali, T., & Wijaya, W. P. (2020). Pengaruh Konsentrasi CMC dan Konsentrasi Gliserol terhadap Karakteristik Edible Packaging Kopi Instan dari Pati Kacang Hijau (Vigna radiata L.). *Pasundan Food Technology Journal*, *7*(1), 1–9. https://doi.org/10.23969/pftj.v7i1.2690

[6] Florentina, F., Syamsir, E., Hunaefi, D., & Budijanto, S. (2017). Gelatinization Technique of Rice Flour to Reduce Oil Uptake during Deep Fat Frying. *Agritech*, *36*(4), 387. https://doi.org/10.22146/agritech.16760

[7] Juliani, D., Suyatama, E. Nu., & Taqi, M. F. (2022). The Effect of Heating Time, Type and Plasticizer Concentration on Characteristics of Edible Film K-carrageenan. *Jurnal Keteknikan Pertanian*, *10*(1), 29–40. https://doi.org/10.19028/jtep.10.1.29-40

[8] Putri, C. I., Warkoyo, W., & Siskawardani, D. D. (2022). Karakteristik Edible Film Berbasis Pati Bentul (Colacasia Esculenta (L) Schoott) dengan Penambahan Gliserol dan Filtrat Kunyit Putih (Curcuma zedoaria Rosc). *Food Technology and Halal Science Journal*, *5*(1), 109–124. https://doi.org/10.22219/fths.v5i1.18785

[9] Mudaffar, R. A. (2019). Karakteristik Edible Film Komposit Dari Pati Sagu, Gelatin Dan Lilin Lebah (Beeswax). *Journal TABARO Agriculture Science*, *2*(2), 247. https://doi.org/10.35914/tabaro.v2i2.134

[10] Surhaini., Indriyani., & Affandi. (2023). The Effect of Glyserol Concentration on The Characteristics of Edible Film of Kimpul Starch (*Xanthosoma sagittifolium*). *Journal of Bio & Geo Material and Energy*, *3*(2), 68–80.

[11] Fera, M., & Nurkholik. (2017). Physical Properties Of Edible Film Produced From Combination Of Gelatin Sheep Skin And Agar (Gracilaria Sp). *Jfls*, *2*(1), 45–56.

[12] Cipta Ismaya, F., Fithriyah, N. H., & Hendrawati, T. Y. (2021). Pembuatan Dan Karakterisasi Edible Film Dari Nata De Coco Dan Gliserol. *Jurnal Teknologi*, *13*(1), 81. https://dx.doi.org/10.24853/jurtek.13.1.81-88

[13] Syaputra, M. D., Sedyadi, E., Fajriati, I., & Sudarlin. (2020). Aplikasi Edible Film Pati Singkong Dengan Penambahan Ekstrak Lidah Buaya (Aloe Vera) Pada Cabai Rawit (Capisum Frutascens L.). *Integrated Lab Journal*, *01*(01), 1–16.

[14] Sedyadi, E., Aini, S. K., Anggraini, D., & Ekawati, D. P. (2016). Starch-Glycerol Based Edible Film and Effect of Rosella (Hibiscus Sabdariffa Linn) Extract and Surimi Dumbo Catfish (Clarias gariepinus) Addition on Its Mechanical Properties. *Biology, Medicine, & Natural Product Chemistry*, *5*(2), 33. https://doi.org/10.14421/biomedich.2016.52.33-40

[15] Polnaya, F. J., Ega, L., & Wattimena, D. (2016). Characteristics of Edible Film from Native and Phosphate Sago Starches with the Addition of Glycerol. *Jurnal Agritech*, *36*(03), 247. https://doi.org/10.22146/agritech.16661

[16] Kusumawati, M., Sedyadi, E., & Nugraha, I. (2018). Pengaruh Penambahan Ekstrak Kunyit Pada Edible Film Umbi Ganyong dan Lidah Buaya (Aloe vera L) terhadap Kualitas Buah Tomat. *Integrated Lab Journal*, *06*(01), 13–20.

[17] Fadhallah, E. G., Herdiana, N., Susilawati & Zulferiyenni. (2023). Quality Changes of Button Mushrooms (*Agaricus bisporus*) Under Different Storage Conditions. *Jurnal Keteknikan Pertanian Tropis dan Biosistem*, *11*(3), 265–274.