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Indonesian Research Institute for Biotechnology and Bioindustry, Indonesia
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Important Dates
Online Registration : April 30th, 2021
Full Manuscript Submission : May 31st, 2021
Notification of Acceptance : June 7th, 2021
Payment Complete : July 5th, 2021
Conference : July 28th-29th, 2021
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PREFACE: the 2nd ICoN - BEAT 2021

On behalf of the organizing committee of the 2nd International Conference on Bioenergy and Environmentally Sustainable Agriculture Technology (ICoN - BEAT 2021). It is an honor and delight to welcome all participants to this conference, which will be held on July 28 and July 29, 2021. The conference theme is "Bioenergy and Environmentally Sustainable Agriculture Technologies: Toward Food, Energy and Water Sovereignty," organized by the Faculty of Agriculture and Animal Science, University of Muhammadiyah Malang, Indonesia.

The organizing committee of the 2nd ICoN - BEAT 2021 apologized because, in the last week before D-Day, it changed the conference format to totally online – virtual by Zoom due to the increasing level of COVID-19 attacks in Indonesia. Two main topics have been discussed, *i.e.*, bioenergy and other renewable energy and environmentally sustainable agriculture. This conference will positively influence and contribute to developing the academic field.

Supporting two main topics, the 2nd ICoN - BEAT invited five experts in the fields of energy, environment and agriculture from Indonesia, Japan, Latvia, and Poland. The speakers are Dr. Dadan Kusdiana (Director General of New, Renewable Energy and Energy Conservation, Jakarta), Prof. Dr. Didiek Hadjar Goenadi (Indonesian Research Institute for Biotechnology and Bioindustry, Bogor), Prof. Hiroyuki Sakakibara (Department of Biochemistry and Applied Bioscience, University of Miyazaki, Japan), Assoc. Prof. Zane Vincēviča-Gaile (Department of Environmental Science, University of Latvia, Latvia), Assoc. Prof. Juris Burlakovs (The Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Poland), and Assoc. Prof. Henik Sukorini (University of Muhammadiyah Malang)

We are proud of the number of participants who have already sent the paper, about 98 presenters. After a rigorous selection process, the Scientific & Editorial Board of the 2nd ICoN - BEAT 2021 decided to publish 38 articles in E3S Web of Conferences, an open-access proceeding in environment, energy. and earth sciences, managed by EDP Sciences, Paris, France, and indexed on Scopus, Scimago, Conference Proceedings Citation Index-Science (CPCI-S) of Clarivate Analytics's Web of Science, DOAJ (Directory of Open Access Journals), ProQuest (part of Clarivate), and six other International Indexing Body.

The Proceeding of the 2nd ICoN - BEAT 2021 consists of 38 selected papers, amounting to 36 articles, which were the results of joint research by Indonesian and overseas scholars. In the collaboration research, 97 institutions were involved, 15 of which were from abroad Indonesia. The overseas institutions are from Algeria, China (PRC), Estonia, India, Japan, Jordan, Latvia, Malaysia, Pakistan, Poland, Sweden, Taiwan (ROC), Thailand, the United Kingdom, and Vietnam.

Each paper submitted in the E3S Web of Conferences was reviewed by at least two experts using the double-blind system. The published articles have passed all necessary improvement requirements under the Web of Conferences standard, reviewer's comments, SI (*Système International d'Unités*), similarity tests by the Turnitin program (with the highest threshold of 20 %), 90 % of references must be at least dated from 15 years and reflected on Google, as well as editing procedure by professional editors from four countries (Indonesia, Pakistan, Lithuania, and Vietnam).

Lastly, I would like to thank you the official committees, organizing partners, and scientific & editorial board. Special thanks as well to our publication publisher partners, *i.e.*, Prof. Dr. Manar Fayiz Mousa Atoum (Jordan Journal of Biological Sciences) and Prof. Dr. Asad Jan (Sarhad Journal of Agriculture) who agreed to be a resource expert for the "scientific writing - workshop and coaching clinic”, which was held as a complement to the 2nd ICoN - BEAT.

Finally, I would like to express my gratitude for your participation, and please prepare yourself to gain the treasure of knowledge from the passionate experts. Then, share the valuable enlightenment for a better future. It is my pleasure to see many of you in the 2nd ICoN - BEAT 2021 and see you again in the 3rd ICoN - BEAT 2022.

Stay safe and stay healthy in the COVID-19 pandemic.

With warmest regards
Malang - Indonesia, September 28, 2023
Mawlid al-Nabi -1445H

Prof. Dr. Ir. Damat, MP.,IPM
Conference Chair

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PS - **post scriptum**
The committee and SE Board apologized because the 2nd ICoN - BEAT 2021 proceedings were published late because E3S Web of Conference, our partner publisher in 2021 and 2022, experienced suspension of Scopus assessment.

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These proceedings consist of 38 selected papers compiled by 237 authors from 97 institutions. In addition, 15 institutions outside Indonesia were involved in collaboration research, i.e., Algeria, China (PRC), Estonia, India, Japan, Jordan, Latvia, Malaysia, Pakistan, Poland, Sweden, Taiwan (ROC), Thailand, the United Kingdom and Vietnam.


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Study of Physical, Mechanical, and Barrier Edible Film Based on Yellow Sweet Potato with Additional Glycerol and Palm Oil

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Abstract. The increasing use of plastic packaging can pollute the environment because it cannot be decomposed naturally. Therefore, alternative packaging materials are needed that can reduce these problems, such as edible films. The main material for this study is yellow sweet potato starch. Generally, edible films made with starch have a more compact physical character. But less flexible, brittle, and not resistant to moisture. Therefore, it is necessary to add glycerol as a plasticizer and palm oil as a barrier. This study aims to determine the effect of the concentration of glycerol and palm oil on the characteristics of edible films. This study used the factorial Randomized Block Design method with two factors, namely the concentration of glycerol (5 %, 10 %, 15 %) and palm oil (1 %, 3 %, 5 %). Variables observed in this study include thickness, solubility, transparency, brightness, yellowness, tensile strength, elongation, and WVTR. The results showed that the best treatment was 10 % glycerol concentration and 1 % palm oil concentration with a thickness value of 0.21 mm; solubility in water 29.48 %; transparency 1.30 A546 mm^{-1}; brightness 60.27; yellowish 13.80; tensile strength 0.47 MPa; elongation 58.48 %; and WVTR 4.28 $gm^{-2} d^{-1}$.

Keywords: Enviromental friendly, hydrocolloid compounds, *Ipomea batatas* L., packaging

1 Introduction

Packaging is an important factor to protect food products from damage. The most widely used packaging material today is plastic. The high use of plastic as packaging can pollute the environment because it cannot be decomposed naturally. This is a concern because currently

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the consumption of plastic packaging reaches 100 × 10^6 t yr^{-1} worldwide and can increase along with the increase in population [1]. Therefore, alternative packaging materials are needed that can reduce these problems, such as edible films. Edible film is a packaging material in the form of a thin layer made of natural materials and can be consumed so that it is environmentally friendly [2]. Edible films are composed of hydrocolloid compounds, fats, or a combination of both. Starch is a hydrocolloid compound that is naturally found in various plant foods such as tubers [3]. The use of starch as the main ingredient in the manufacture of edible films can protect the product from oxygen and carbon dioxide and produce a compact film structure. However, its use also causes edible films to become more brittle and less flexible [4]. Therefore, it is necessary to have other treatments that can improve these properties, one of which is the use of plasticizers. Glycerol, which acts as a plasticizer can increase the flexibility of edible films. However, because it is hydrophilic, the use of glycerol is less able to suppress the rate of permeability to water vapor. An alternative solution that can be used is the addition of palm oil. Palm oil (*Elaeis guineensis* Jacq.) contains long chain fatty acids which are commonly used in the manufacture of edible films because they have a high melting point and are hydrophobic so that they can improve the characteristics of edible films.

2 Material and Method

2.1 Materials and tools

The materials used for the manufacture of edible films are yellow sweet potato (*Ipomea batatas* L) obtained from the local market, palm oil, commercial glycerol, aquadest, surfactant tween 80, silica gel, and 40 % NaCl. The tools used for the edible film manufacturing process include a glass beaker (100 mL and 250 mL), stirring rod, measuring pipette, petri dish, porcelain dish, thermometer, rubber bulb, Pionerr Ohaus PA13 analytical scale, hot plate, cabinet dryer, micrometer scrub. HERMA, color reader, spectrophotometer (UV-vis genesys 20), and Shimadzu EZ-SX texture analyzer, 19 cm × 14 cm plastic tray, polypropylene (PP) plastic, jar, knife, basin, spoon, flour, and sieve.

2.2 Method

2.2.1 Making yellow sweet potato starch

The process of making starch begins with sorting fresh yellow sweet potatoes, followed by washing with clean water, and peeling. Furthermore, it is reduced in size by grating and adding 1 L of water (1:1), filtered using a filter cloth, and deposited for 12 h. The starch precipitate formed was separated and then dried using a cabinet dryer at a temperature of 50 °C for 12 h. Coarse starch is ground or floured using a flouring device and then sieved with an 80-mesh sieve, and sweet potato starch is obtained.

2.2.2 Edible film making

The first step in the process of making edible films is dissolving yellow sweet potato starch in 100 mL of distilled water, then adding glycerol and palm oil in proportions according to treatment and adding 0.2 % (v v^{-1} 100 mL) tween 80. After that, it was homogenized and heated using a hot plate at 80 °C for 10 min until a gel was formed. Next, the solution was poured into a plastic mold measuring 19 cm × 14 cm and dried using a cabinet dryer at a temperature of 50 °C for 24 h. The plastic mold is removed from the cabinet and cooled at room temperature to 50 °C. The edible film formed is peeled off and put in an airtight container. Then, the physical, mechanical and barrier characteristics of the edible film were tested.

2.3 Research design

This study used a factorial randomized block design consisting of two factors, namely factor I (G) as the concentration of glycerol (G1 = 5 %; G2 = 10 %; G3 = 15 %) and factor II (S) as the concentration of coconut oil. palm oil (S1 = 1 %; S2 = 3 %; S3 = 5 %). There are nine combinations carried out, each combination is repeated three times. Based on the design, an analysis of variance (ANOVA) was made to obtain conclusions about the effect of treatment. The analysis was carried out by Duncan's further test. Analysis The resulting edible film was then analyzed for thickness [5], film solubility [6], transparency [7], color intensity [8], tensile strength [9], percent elongation [9], and water vapor transmission rate [10].

3 Result and discussion

3.1 Thickness

The results of the analysis of variance showed that there was no interaction between the glycerol and palm oil concentrations, while the glycerol and palm oil treatments with different concentrations had a significant effect on the thickness of the edible film (Table 1). Based on Table 1, the thickness of the edible film increases as the glycerol concentration increases. This happens because the addition of glycerol causes the total dissolved solids in the solution to increase, so that the thickness of the film increases. According to [11] the more the total solids in the solution, the more polymers that make up the edible film. Glycerol can bind to hydrocolloids (starch) so that the polymer bonds between starches are replaced by starch-glycerol-starch bonds [12]. The addition of higher concentrations of palm oil also increases the thickness of the edible film. This is due to the presence of substances and solids in the edible film, where the higher the addition of palm oil, the more substances and solids in the edible film. The increase in film thickness was caused by differences in the concentration of the material, while the molds used were of the same size [13]. The addition of triglycerides can increase the film thickness by 0 m to 60 m [14].

3.2 Solubility

The results of the analysis of variance showed that there was no interaction between the concentration of glycerol and palm oil on the solubility of the edible film. The addition of glycerol concentration did not have a significant effect on the water solubility of the edible film (Table 1). The percentage of the solubility of the film in water increases as the proportion of glycerol increases. This happens because glycerol has hydrophilic properties so that it can interact with water through the formation of hydrogen bonds. The higher the proportion of hydrophilic components in the film solution, the higher the water solubility of the film. According to [4] the hydrophilic nature of glycerol can increase the percentage of solubility of starch-based films. This situation is in line with the results of research by [15] where the addition of 40 % glycerol concentration produces edible film with a higher percentage of solubility compared to 20 % glycerol concentration. The concentration of palm oil has a significant effect on the percentage of the solubility of the edible film. Table 8 shows that the percentage of film solubility decreased with increasing palm oil concentration. This is related to the hydrophobic nature of the fatty acids in palm oil itself. According to [16] the length of the fatty acid carbon chain will affect the solubility of the film. The longer the carbon chain, the more difficult the fatty acid is to dissolve in water.

3.3 Transparency

The results of the analysis of variance showed that there was no interaction between the concentration of glycerol and palm oil, but the addition of the concentration of glycerol and palm oil had a significant effect on the value of the transparency of the edible film (Table 1). Based on Table 1, the higher the concentration of glycerol and palm oil, the higher the transparency value of the edible. Edible film formulations at higher concentrations of glycerol and palm oil caused more total dissolved solids and increased film thickness, so that the resulting film was more opaque and the transparency value increased. This is inversely proportional to the degree of clarity, where the higher the transparency value, the lower the degree of clarity of the resulting film. According to [17] the value of film transparency is related to the number and size of particles scattered in the matrix. The high number and size of particles that exceed visible wavelengths can block light so that the value of transparency is high.

3.4 Lightness

The results of the analysis of variance showed that there was no interaction between the concentration of glycerol and palm oil on the brightness of the edible film. However, the addition of glycerol and palm oil with various concentrations gave a significant effect (Table 1). In contrast to transparency, brightness indicates a color level that is based on white. The brightness of the edible film is inversely proportional to the concentration of glycerol and palm oil. The higher the concentration of glycerol and palm oil, the lower the brightness of the film. This happens because the higher the proportion of glycerol and palm oil, the more dissolved components that make up the film, causing the brightness to decrease.

This situation is similar to the results of [18] which showed a decrease in the brightness level of edible films with higher glycerol concentrations. Increasing the amount of edible film polymer will increase the thickness of the film and light scatter, as a result the resulting film will look blurry and dull. In addition to the increase in the polymer making up the film, the decrease in the brightness level of the edible film is also influenced by the yellow color of the palm oil.

3.5 Yellowish

Based on the results of the analysis of variance, the interaction between the concentration of glycerol and palm oil on the yellowness of the edible film did not have a significant effect (Table 1). However, the concentration of glycerol and palm oil had a significant effect on the average yellowish value of the edible film. The level of yellowness of the edible film is also influenced by the concentration of palm oil. The higher the concentration of palm oil added, the more yellow the edible film produced. The palm oil contains an orange color of carotenoids, which most likely contributes to the yellow color of the edible film [19]. The results showed that the addition of 8 % palm oil had a higher yellowness level than 6 % palm oil.

3.6 Tensile Strength

The results of the analysis of variance showed that there was no interaction between the concentration of glycerol and palm oil. The addition of glycerol concentration had a significant effect on the tensile strength of the edible film, while the concentration of palm oil had an insignificant effect (Table 2). The tensile strength of edible films decreased with increasing glycerol concentration. Increasing the concentration of glycerol will decrease the stability of the solid dispersion system, then cause a decrease in the pressure of the molecules making up the edible film so that the mechanical properties of the edible film are getting weaker. The addition of plasticizers to edible films will also increase hygroscopic properties which affect the increase in film moisture, this causes the macromolecular bonds of edible films to decrease [20]. In addition, the tensile strength of edible films is also influenced by the concentration of palm oil. The tensile strength of edible film increased with the addition of 1 % and 3 % palm oil but decreased at 5 % concentration. This situation is in line with the results of research conducted by [21] where increasing the proportion of lipids to a certain extent results in higher film tensile strength and lower elongation. According to [22] too high a concentration of palm oil will reduce the elongation strength and the surface of the film will become too oily, while too low an addition will reduce its ability to inhibit the rate of water vapor.

3.7 Elongation

The results of the analysis of variance showed that there was no interaction between the concentration of glycerol and palm oil. The glycerol concentration treatment had a significant effect, while the palm oil concentration had no significant effect on the average edible film elongation value (Table 2). The elongation value increased as the glycerol concentration increased. This is because glycerol can reduce hydrogen bonds and increase the level of stretch in the edible film matrix so that the brittleness is low, so the flexibility is increased. According to [23] increasing the concentration of glycerol can increase the percentage of film elongation. The interaction of glycerol with starch to form a starch-glycerol bond will increase the flexibility of the film [12]. This is supported by [14] which states that the higher hydrophilic content will increase the percentage of film elongation. The addition of palm oil concentration also has a role in the elongation value of the edible film. The higher the concentration of palm oil, the lower the elongation value. The interaction between starch molecules and palm oil forms a starch-lipid complex that can inhibit the elongation of the film so that the percentage of elongation decreases [24]. The hydrophobic nature of palm oil will regulate the fatty acid components in the film structure so that the film becomes denser and reduces the level of elongation [25]. That the addition of a lipid component will cause the film to crack easily, be less elastic, and have a slightly opaque color, however, it has a low level of water vapor transmission [26].

3.8 Water vapor transmission rate (WVTR)

Analysis of variance showed that there was no interaction between the concentration of glycerol and palm oil on the tensile strength of edible films. However, the addition of glycerol and palm oil concentrations had a significant effect (Table 3). The rate of water vapor transmission at 10 % concentration treatment decreased, while at 15 % concentration it increased. According to [27] an increase in the proportion of glycerol can increase the WVTR value because its hydrophilic nature can loosen intermolecular bonds thereby increasing film permeability and facilitating the diffusion of water vapor. The high ability of glycerol to bind water causes a high WVTR value. The higher the concentration of palm oil, the lower the WVTR value produced. This is in accordance with the results of [14] which reported that the higher use of fatty acids resulted in edible films with lower WVTR values. Palm oil is composed of fatty acids which are hydrophobic so that can inhibit the rate of water vapor transmission [24]. The addition of more palm oil will increase the hydrophobicity of the film and have an effect on the lower WVTR value.

4 Conclusion

There was no interaction between the concentration of glycerol and palm oil on the thickness, solubility in water, transparency, brightness, yellowness, tensile strength, elongation, and WVTR of edible films. The addition of glycerol with various concentrations gave a significant effect on the thickness, transparency, brightness, yellowness, tensile strength, elongation, and WVTR of edible films. The addition of palm oil with various concentrations significantly affected the thickness, solubility, transparency, brightness, yellowness, and WVTR of edible films. The best treatment was obtained the treatment 10 % glycerol concentration and 1 % palm oil concentration with an average thickness of 0.21 mm; solubility in water 29.48 %; transparency 1.30 A546/mm; brightness 60.27; yellowish 13.80; tensile strength 0.47 MPa; elongation 58.48 %; and WVTR 4.28 $gm^{-2}d^{-1}$.

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Study of Physical, Mechanical, and Barrier Edible Film Based on Yellow Sweet Potato with Additional Glycerol and Palm Oil

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