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Physical Characteristics of the Development of Edible Film Gelatin-Xylitol Using Butterfly Pea Extract as an Antioxidant

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study aims to determine a gelatin-xylitol edible film with the addition of butterfly pea extract (*Clitoria ternatea* L) using the Microwave Assisted Extraction method with optimal physical characteristics of the edible film. The research method uses the experimental method with calculations using a Completely Randomized Design (CRD), followed by Duncan analysis (DMRT) if there are significant or very significant effects in each treatment. This research method focuses on differences in the percentage of butterfly pea extract in the manufacture of gelatin-xylitol edible films with 5 treatments P0 (0%), P1 (1%), P2 (2%) P3 (3%), and P4 (4%) and 3 repetitions. The results of the second phase of the study showed the effect of different butterfly pea extracts on

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edible gelatin-xylitol. There was no significant effect (P>0.05) in the sedimentation test, L and a color, there was a significant effect (P<0.05) in the b color test analysis and in the antioxidant test analysis. The functional groups identified in the eggplant extract were alkanes, alkenes, fluorides, and aromatics. The analysis of the Scanning Electron Microscope test showed the presence of particles in the edible film was 3% addition of butterfly pea extract produces an edible film that has antioxidants.

Keywords: Edible film; gelatin; xylitol; butterfly pea; antioxidant.

1. INTRODUCTION

Edible film is a product produced from processed animal husbandry, namely gelatin which has great potential in its utilization. Edible film is a thin layer made of edible material, formed to coat food (coating) or placed between food components (film) that functions as a barrier to mass transfer (eg moisture, oxygen, lipids, solutes) and as an additive carrier as well as to improve the handling of food [1]. Edible film has the advantage of being able to increase the shelf life of food and could increase the nutritional value of food [2]. There are three main components that make up edible films, namely hydrocolloids, fats, and composites [3].

Variation of food products from livestock is one of the attempts to provide food for the community while at the same time increasing the usability of livestock commodities [4]. One of the main ingredients used in making edible films is gelatin, which belongs to the hydrocolloid group, which is a material that is easy to get, cheap, and has various types in Indonesia [5]. Edible films could be consumed directly, improve the organoleptic properties of the product, and function as nutritional supplements, flavors, dyes, antimicrobial agents, and antioxidants [6]

Gelatin is widely used for food as a stabilizer, gelling agent, binder, thickener, emulsifier, adhesive, and edible film wrapper. Gelatin films could be formed in the presence of 20-30% gelatin and 10-30% plasticizer (glycerin or sorbitol) and 40-70% water when drying the gelatin gel [7]. Gelatin is a type of protein extracted from the collagen network of animal skin, bones, or ligaments. Gelatin's characteristics include its ability to transform reversibly from solutions to gel form, swell after being exposed to cold water, and generate films [8].

The addition of a plasticizer would improve the characteristics of the edible film to become elastic, flexible, and not easily brittle. Sorbitol and glycerol have a content equivalent to xylitol which is widely used in making edible films [9]. Plasticizers are non-volatile materials, with high boiling points which, when added to other materials, could change the physical properties of the material. The addition of plasticizers could reduce intermolecular hydrogen bonds between polymers/termolecular strength (overcoming the brittle nature of film layers), increase film flexibility and reduce film barrier properties [10]. Sorbitol is used because it has the benefit of reducing internal hydrogen bonds in intermolecular bonds, which is good for preventing the evaporation of water from the product, and it can dissolve in each polymer chain to help with polymer molecule movement. Sorbitol also has the advantages of being readily available, inexpensive, non-toxic, and able to dissolve in each polymer chain [11].

Butterfly pea (*Clitoria ternatea* L.) often referred to as blue pea is a flower that contains tannins, flobatanins, carbohydrates, saponins, triterpenoids, polyphenols, flavanol glycosides, proteins, alkaloids, anthraquinones, anthocyanins, 4-ena- 3,6 diones, volatile oils, and steroids. Butterfly pea has many pharmacological potentials, including as an antioxidant, antibacterial, antidiabetic and anti-cancer [12]. Butterly pea has a flavonoid content of 1.50 mg EK/g [13]. The main component of the butterfly pea which functions as a dye is caused by the presence of anthocyanin pigments which are red to deep purple [14]. The large amount of antioxidant content in the butterfly pea would cause a thick color in the butterfly pea extract. Anthocyanins in butterfly peas are included in the class of flavonoids which have high antioxidant activity [15].

Extraction is an operational method used in the process of separating a component from a mixture by using a mass amount of material (solvent) as a separating force [16]. Microwave Assisted Extraction (MAE) is an extraction that utilizes microwave radiation to accelerate selective extraction by heating the solvent quickly

and efficiently [17]. The Microwave Assisted Extraction (MAE) method combines microwave and solvent extraction.

The use of the MAE method produces microwave extraction in MAE technology which heats and evaporates water, as a result the cells experience swelling, stretching and breaking so that the metabolite compounds come out and are extracted by the solvent [18]. The effect of using the power level and extraction time using the MAE method has been studied to produce butterfly pea flower extract. using the 4-minute MAE method, where the polyphenols obtained in MAE are higher than other methods [19]. This study will also use the MAE method to obtain butterfly pea extract which has antioxidant content with medium power for 10 minutes with a 1 minute pause, then evaluate the butterfly pea extract by Antioxidant test, functional group test (FTIR), Scanning Electron Microscope (SEM) test, color using the CIEL*a*b* method with color spectrum and thickness.

2. MATERIALS AND METHODS

2.1 Materials and Tools

The materials used in the study consisted of the essential brand Gelatin obtained from a foodstuff store in Malang, Xylitol Soho brand, and dried butterfly pea obtained from the Online Market (Tokopedia). Aquades, Ethanol 70%, Ascorbic acid, and DPPH (1,1-diphenyl-2-picrylhydrazyl) were obtained from a Chemicals Store in Malang.

The equipment used in the study consisted of Erlenmeyer 250 ml brand pyrex, measuring cup 100 ml Pyrex brand, 50 ml beaker glass Duran brand, 10 ml measuring cup Pyrex brand, spoon spatula, thermometer, I-2000 digital scale, hot plate, and magnetic stirrer (SBS-A06), aluminum foil, plastic clips, filter cloth, silicone mat, and teflon.

The equipment used in the test consisted of scissors, ruler, pencil or pen, paper, oil paper, plastic clips, 25 ml, 50 ml and 100 ml pyrex flasks, centrifugation tubes, centrifugation tube racks, 100 ml plastic bottles, tissue , cuvette, 250 ml wash bottle, micro pipette, and spectrophotometer.

2.2 Research Methods

The method used was the experimental method (experiment) in the laboratory with Completely Randomized Design (CRD). Based on preliminary research, it was found that the control treatment was P0 without the addition of butterfly pea extract, while the comparison factor was different at the concentration of using the butterfly pea extract, which consisted of the addition of P1 (1 ml), P2 (2 ml), P3 (3 ml) and P4 (4 ml). Three repetitions were carried out. In the first phase of the study, an analysis of physical characteristics was carried out in the form of antioxidants, functional groups (FTIR), scanning electron microscopy (SEM), colors using the CIEL*a*b* method, followed by color spectrum, and thickness.

2.3 Research Methods

Gelatin was weighed as much as 3 g, dissolved with 30 ml of distilled water using a 250 ml Erlenmeyer, then added xylitol as much as 0.5 g. then added 1 ml, 2 ml, 3 ml, and 4 ml of butterfly pea extract. The edible solution was heated and homogenized using a hot plate-magnetic stirrer for 5 minutes until all the ingredients were thoroughly mixed at 60°C. The solution was poured into a 50 ml beaker glass and filter using a filter cloth, measure 10 ml of the edible film solution with a measuring cup and pour it into a teflon mold that has a silicone plastic backing, the edible film then was waited to dry for 24 hours. The edible film from the silicone mat finally could be removed and stored in plastic clips.

2.4 Making Edible Films

Gelatin was weighed as much as 3 g, dissolved with 30 ml of distilled water using a 250 ml Erlenmeyer, then added xylitol as much as 0.5 g. then added 1 ml, 2 ml, 3 ml, and 4 ml of butterfly pea extract. The edible solution was heated and homogenized using a hot plate-magnetic stirrer for 5 minutes until all the ingredients were thoroughly mixed at 60°C. The solution was poured into a 50 ml beaker glass and filter using a filter cloth, measure 10 ml of the edible film solution with a measuring cup and pour it into a teflon mold that has a silicone plastic backing, the edible film then was waited to dry for 24 hours. The edible film from the silicone mat finally could be removed and stored in plastic clips.

2.5 Antioxidants

10 mg of edible film gelatin-xylitol samples were taken with the addition of butterfly pea extract

and dissolved in 10 ml of pro-analysis methanol (1000 ug/ml) then dilutions were made of 1 ml, 3 ml, 5 ml, 7 ml and 9 ml in a 50 ml volumetric flask to obtain concentrations of 10, 30, 50, 70, 90 ppm, then 1 ml of 0.4 mM DPPH solution was added to each mother and reference solution, then homogenized and covered with aluminum foil to protect it from light. The samples were incubated for 30 minutes at temperature of 37ºC and the absorbance was measured at a wavelength of 517 nm.

2.6 Functional Groups (FTIR)

2 g of dried sample was taken and 200 mg KBr homogenized with the sample using a mortar pestle until smooth, then the sample was analyzed using a spectrophotometer with a wavelength of 500 nm to obtain the average spectra.

2.7 Scanning Electron Microscopy (SEM)

0.1 g powder sample was taken and the sample powder was coated with gold (Au) using an ion sputter, hence it reached a thickness of 15 nm and then observed using an electron microscope at 100x magnification with a depth of field of 1 mm and a voltage of 5.0 kV.

2.8 CIELAB Colors

75 ml sample was prepared in the form of a solution, then turned on the color reader by pressing the ON button. Attached the color reader lens to the surface of the sample, then determine the target for L*a*b* readings and measure the color and record the readings printed on the tool, then turned off the tool by pressing the button. OFF.

The color spectrum could be determined by calculating the Chroma and Hue Angle formulas below:

1. $Chroma = (a^2 + b^2)^{\frac{1}{2}}$
2. $Hue\ Angle = tan^{-1}\left(\frac{b*}{a*}\right)$

2.9 Thickness

A digital thickness gauge was prepared, then 5 different points were determined on the sample and pressed the button on the digital thickness gauge, then the handle of the digital thickness gauge was pulled, then the edible film was placed and clamped on the jaw of the digital thickness gauge, precisely between the anvil and spindle. The tool could be turned off by pressing the off button, then was observed and the average thickness of the edible film was measured at 5 different points randomly with an accuracy of 0.01 mm.

Thickness was calculated by the formula:

Thickness (mm) = (A+B+C+D+E)/5

Note:

A = Thickness area 1 (mm)
B = Thickness area 2 (mm)
C = Thickness area 3 (mm)
D = Thickness area 4 (mm)
E = Thickness area 5 (mm)
5 = Number measurement area

3. RESULTS AND DISCUSSION

3.1 Antioxidants

The average value of IC50 antioxidant on gelatin-xylitol edible film with the addition of butterfly pea extract used a different percentage of 1%. 2%, 3%, and 4% showed very significant differences ($P<0.01$) in antioxidants which could be seen in Table 1.

The results of the analysis of variance showed that the treatment using different concentrations of butterfly pea extract gave a very significant effect ($P<0.01$) on Antioxidant IC50 which could be seen in Table 1. Data analysis of variance of Antioxidants in treatments P0, P1, P2, P3 and P4 produced an average value of 2.050; 1.582; 1.614; 1.515 and 1.225. The IC50 antioxidant value with the highest yield was in the gelatin-xylitol edible film without the addition of butterfly pea extract. This was because the lower the IC50 value, the stronger the inhibitory power against free radicals. The average antioxidant activity ranged from 1.225-2.050. the lower the IC50 value was, the better the antioxidant activity possessed by the eggplant extract samples would be.

Antioxidant was an oxidation reaction due to free radicals. An antioxidant activity test was needed to determine the content of antioxidant activity in the solubility contained in the sample. Test the antioxidant activity itself using the DPPH (1,1-diphenyl-2-picrylhidrazyl) method. DPPH was an organic compound containing unstable nitrogen and had a strong absorbance at a wavelength of

Table 1. Antioxidant IC50 in Edible Film Gelatin-xylitol with the addition of butterfly pea extract

Treatments	Antioxidant IC50 (%)
P0 (0%)	$2,05^{a}$±0,003
P1 (1%)	$1,58^{b}$±0,002
P2 (2%)	$1,61^{bc}$±0,001
P3 (3%)	$1,51^{d}$±0,002
P4 (4%)	$1,22^{e}$±0,001

Note: a, b on different superscripts in the same column showed a very significant effect (P<0.01)

517 nm and was dark in color. DPPH would change color after being reduced with antioxidant compounds and would change color to yellow. The value of antioxidant activity in the sample had a percent inhibition value between 2.050% - 1.225%. The best value obtained for antioxidant activity was the addition of 4% concentration of butterfly pea extract. The results obtained were that the higher the concentration added to the gelatin-xylitol edible film with the addition of butterfly pea extract, the higher the value of its antioxidant activity. According to Kusumawati [20] the antioxidant activity of edible films was influenced by the antioxidant compounds contained in the material and the ability of these compounds to reduce free radicals.

Butterfly pea flowers contain phenolic compounds which are thought to play a major role in the antioxidant activity of edible films because phenolic compounds have a free radical scavenging mechanism through reactions with -OH groups. Huri and Nisa [21] identified that phenol has a very significant contribution to the antioxidant activity of edible films. The higher the total phenol, the higher the antioxidant activity. Antioxidant activity is the result of several phytochemical compounds in the butterfly pea flower. The antioxidant activity of the ethanol extract of the butterfly pea flower was quantitatively determined by the DPPH (1,1-diphenyl-2-picrylhydrazyl) method, which was based on the ability of the ethanol extract of the butterfly pea flower to reduce or capture DPPH radicals. The ability of the ethanol extract of butterfly pea and vitamin C as a comparison can be seen from the reduced intensity of the purple color of the DPPH solution that has been added to the sample and the comparison. The reduced color intensity of the DPPH solution can indicate that there is a reaction between the hydrogen atoms released by the test material and the DPPH radical molecule to form a yellow 1,1-diphenyl-2-picrylhydrazine compound. The greater the concentration of the test substance, the stronger the yellow color produced [22].

The reduction in the intensity of the purple color of the DPPH solution can be quantitatively calculated from the reduced absorbance of the solution. The greater the concentration of the test material, the smaller the readable absorbance, which means that the activity of the test material in capturing DPPH radicals is greater. The absorbance measured is the residual absorbance of DPPH which does not react with the test solution [22] The antiradical activity test with the DPPH method was carried out at a wavelength of 517 nm with an incubation time of 30 minutes. Antiradical activity was determined by calculating the inhibitory concentration (IC). The IC50 value is the concentration of the extract and standard which gives % antiradical activity by 50% compared to the control through a linear regression line equation between levels and % radical scavenging (Mailandari, 2012). The greater the IC50 value, the smaller the antioxidant activity and conversely the lower the IC50 value, the greater the antioxidant activity. Specifically, a compound is said to be a very strong antioxidant if the IC50 value is less than 50 µg/ml, strong for IC50 is 50-100 µg/ml, while if IC50 is 151-200µg/ml [22].

3.2 Functional Groups (FTIR)

Fourier Transform Infra Red was a structural analysis based on the presence of polar bonds and functional group vibrations which were used to detect changes during processing. The image above showed the FTIR spectrum of meat with different treatments at detected wavelengths of 4000–500 cm^{-1}. The results of the FTIR spectra as shown above showed that the functional groups of gelatin which include O-H, C-H, C=C, C-N, C-O and aromatic C-H were identified in the three gelatin products above. This was proof that the product produced in this study was really gelatin. This was in accordance with the state of Puspawati et al. [23] which described that gelatin, like proteins in general, had a structure composed of carbon, hydrogen, hydroxyl groups, carbonyl groups, and amine groups.

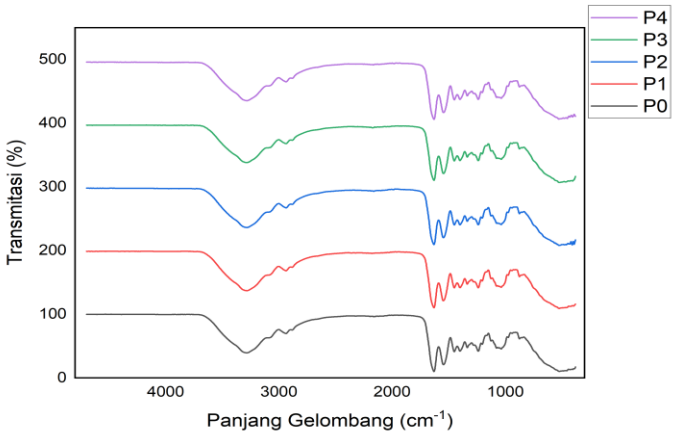

Fig. 1. Wavelength (Functional group) of FTIR

Based on the table of functional groups (FTIR) above, it showed the results of a wavelength of 874.27 cm^{-1} which produced the C-H functional group and produced aromatic compounds, at a wavelength of 1035.43-1237.95 cm^{-1} produced the C-O functional group and produced ester compounds, at a wavelength of 1336.36 cm^{-1} there was a C-N functional group and produced amines compounds, at a wavelength of 1400.54 cm^{-1} it produced a fluoride compound, at a wavelength of 1450.46 cm^{-1} there was a C-H functional group and buckling occured, at a wavelength of wave 1630.16 cm^{-1} there was a C=C functional group to produce alkane compounds, at a wavelength of 2882.37 cm^{-1} there was a C-H functional group to produce an aldehyde compound, at a wavelength of 2938-3093.43 cm^{-1} there was a C-H functional group with alkane compounds and at a wavelength of 3284.57 cm^{-1} there were O-H compounds that bind H groups.

The addition of glycerol resulted in the large number of OH groups it had, so it was very possible for the edible film to bind with water and result in a change in the location of the functional groups [24]. The occurrence of this kind of wave number-shifting process indicated a polymerization reaction of biodegradable plastic materials during blending [25]. Based on the results of the FTIR test above, it showed that there are new functional groups, this was because the addition of plasticizer resulted in edible films occurring chemically. Sarkar (1995) stated that gelatin as a product of the hydrolysis of skin collagen protein is determined by the collagen protein content in the fresh skin. Gelatin-based edible films previously interacted with glycerol. Edible film is made by using different variations of gelatin and fixed quantity of glycerol.

The FTIR frequency for gelatin-xylitol edible film with the addition of butterfly pea extract consists of the following frequencies. The band widths between 3000 and 3200 cm^{-1} are associated with stretching vibrational complexes caused by free, inter- and intramolecular hydroxyl groups bonded between molecules. The sharp peak at 2938 cm^{-1} is characteristic of the CH stretching. The peak appears at 1630 cm^{-1} related to the addition of ingredients in the manufacture of edible films. Similar results were mentioned by Zhang and Han [26], namely in general, a peak shift at 3369 cm^{-1} to 3248 cm^{-1} for plasticizer films increased intermolecular hydrogen bonding and an anti-plasticizing effect by increasing the hydroxyl groups in the plasticizer. This shows that all the hydroxyl groups in the polymer contribute to the hydroxyl groups of the plasticizer causing the substitution of polymer-polymer interactions to polymer-plasticizer interactions and more new hydroxyl groups are involved in hydrogen bonding with the polymer. The shift to lower wavenumbers indicates the formation of strong hydrogen bonds (cross-links) within the film.

Film FTIR analysis was performed to evaluate the interaction between components. Molecular interactions between various film components are vibrational stretching of hydroxyl groups (–OH) in the wavelength range 3352 cm^{-1} - 3451 cm^{-1}. At wave numbers 2936cm^{-1} and 2882 cm^{-1}, aliphatic group (–CH) vibrational stretching and asymmetric methylene bending occur. in the structure of α, β-unsaturated ketones, aromatic rings of phenolic and carbonyl groups at a

frequency of 875 cm^{-1} caused by C–H distortion of the aromatic ring. The determination of this band indicates that the butterfly pea flower extract has the same functional group as (COO) carboxylic acid esters and polyphenolic alcohols (Liu et al., 2020).

The increase in the butterfly pea extract on the edible film shows that the hydrogen bonds between the gelatin molecular chains and the flavonoid compounds that form strong hydrogen bonds are formed between the phenolic compounds of the butterfly pea extract and the edible film components reduce the release of phenolics (Hu et al., 2017). The fingerprint area at 1400-1000 cm^{-1} indicates the fluoride and phenol functional groups in the edible film. Increasing the intensity of the carbonyl group indicates the formation of bonds between flavonoid compounds. According to Wang, et al. (2016) characteristic of the band vibration fingerprint at 1043 cm^{-1} is sensitive to ordered crystal structures, whereas at 1022 cm^{-1} is characteristic of an amorphous structure. Changes in the intensity of these bands are closely related to changes in the orderly structure of macromolecules (crystalline and amorphous) due to gelatinization

3.3 Scanning Electron Microscopy (SEM)

Observations on the surface appearance of the gelatin-xylitol edible film with the addition of butterfly pea extract could be seen in Fig. 2.

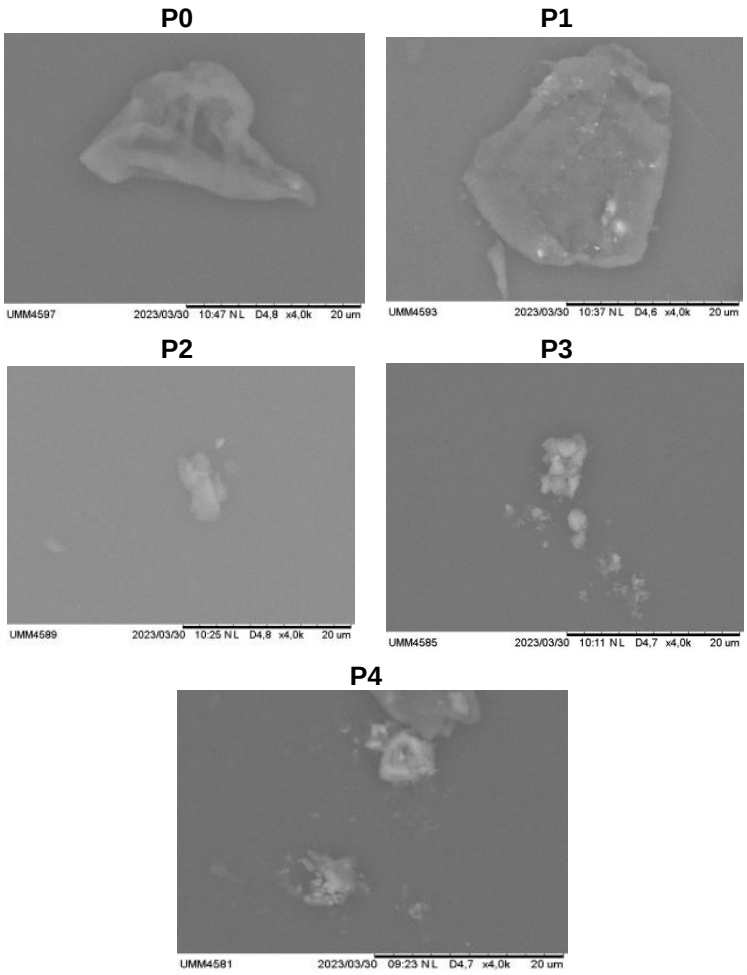

Fig. 2. Microstructure of edible film particles of gelatin-xylitol of butterfly Pea

Note:

P0: Gelatin-xylitol edible film microstructure without the use of butterfly pea extract
P1: Gelatin-xylitol edible film microstructure using 1% sea cucumber extract
P2: Gelatin-xylitol Edible film microstructure using 2% butterfly pea extract
P3: Edible film Gelatin-xylitol microstructure using 3% butterfly pea extract
P4: Gelatin-xylitol Edible film microstructure using 4% butterfly pea extract

The surface appearance of the gelatin-xylitol edible film with high concentrations of butterfly pea extract, namely P4 of 4%, looked rougher, while the surface appearance of the gelatin-xylitol edible film without the addition of butterfly pea extract, namely P0 of 0%, the appearance of the film looked flat/smooth and soft. This was due to the addition of gelatin-xylitol with butterfly pea extract resulting in a smaller ratio of these ingredients and smaller opportunities for the formation of small cracks on the surface of the film, resulting in a smoother and softer appearance on the film surface. This was in accordance with what Al-Hasan and Norziah [27] stated that the gelatin film produced a flatter/smoother surface as the addition of greater gelatin produced a smoother film surface. The presence of pores or holes associated with the formation of channels was not visible on the gelatin film.

Edible film gelatin-xylitol with butterfly pea extract showed that the surface of the pectin film without the butterfly pea extract was relatively smooth, even compared to the surface of the gelatin-xylitol film plus the butterfly pea extract, which was rough, dense, and brittle with irregularly distributed particles. Pranoto et al., [28] stated that the addition of gelatin to the film could reduce the presence of gaps or cracks, therefore, the surface appearance was more compact. De Carvalho and Grosso [29] stated that gelatin films with glycerol plasticizers showed discontinuous zones characterized by the presence of cracks distributed along the network, and the presence of these zones was possible as a result of special channels that occured through drying.

Scanning electron microscopy (SEM) was performed to examine the appearance of the surface microstructure of edible gelatin-xylitol with different butterfly pea flower extracts. A study of the film microstructure provides a relationship between the molecular orientation in the matrix and the physicomechanical characteristics of the film. Edible film without butterfly pea extract showed a less compact structure, with large pores and cracks, which was in accordance with the results of the initial visual inspection. Surface micrograph of the films, at 1000× magnification, showing distinguishable differences between the films containing different plasticizers. The film displays a surface without cracks, breaks or openings which are an indicator of the miscibility and compatibility of the plasticizer used with the film. Films containing low molecular weight plasticizers show a more compact, homogeneous, uniform and denser structure when compared to films with high molecular weight plasticizers. The plastic film displays some irregular particles evenly distributed throughout the tissue, which can be attributed to the swelling of the starch granules and their remnants (Saberi, et al., 2017).

3.4 Color L*a*b*

The average color value on the edible film used gelatin-xylitol with the addition of butterfly pea extract at a different percentage, namely 0%. 1%, 2%, 3%, and 4% showed results that were no significant effect (P>0.05) on the L* value and a* value, while the b* value showed significantly effect (P<0.05) to L*a*b* color which could be seen in Table 2.

The results of the analysis of variance showed that the treatment using different concentrations of flower extract did not have significant effect on the L* and a* values (P>0.05). The b* value showed a significant effect (P<0.05) on the L*a*b* color. Data analysis of variance P0, P1, P2, P3 and P4 produced average value of 31.75; 33.19; 31.82; 31.03 and 31.04. The L* value on the color test with the highest result was the addition of butterfly pea extract, namely the P0 of 33.75. It could be seen in the table below that the L* value decreased with the addition of butterfly pea extract causing the resulting color to get

Table 2. L*a*b* Color on Edible Film Gelatin-xylitol with the addition of butterfly pea extract

Treatments	Average ± SD		
	L*	a*	b*
P0	33,75 ± 0,69	-1.94^{a} ± 0,73	8,27 ± 0,60
P1	33,19 ± 2,37	2.18^{ab} ± 0,49	-9,12 ± 0,40
P2	31,82 ± 1,04	2,19^{b} ± 0,82	-8,88 ± 1,70
P3	31,03 ± 1,41	0,89^{c} ± 0,78	-7,53 ± 0,14
P4	31,04 ± 1,41	0,39^{d} ± 0,37	-7,00 ± 0,49

Note: The addition of butterfly pea extract with different concentrations showed no significant effect on L and a* values (P>0.05). The b* value showed a significant effect (P<0.05)*

darker, this was because the L* value was an indicator of color brightness, the higher the L* value, the brighter the resulting color would be. The lower the L* value, the darker the resulting color would be. According to Isnaini's study [30], the lowest brightness level was affected by the proportion of anthocyanin pigments added, which tended to be thicker when it was higher, and paler when the number of proportions was lower. Therefore, it would affect the decrease and increase in brightness of an anthocyanin-based product.

Data analysis of variance P0, P1, P2, P3 and P4 yielded an average value of 1.94; 2.18; 2.19; 0.89 and 0.39. The a* value on the color test with the highest result was the addition of butterfly pea extract, namely P2 of 2.19. It could be seen in the table above that the a* value decreased with the addition of butterfly pea extract, causing the resulting color to become more reddish, this was because the a* value was an indicator of reddish and greenish colors. A positive a* value indicated a reddish color and a negative value indicated a greenish color, hence the edible film produced reddish color. According to Nurhasanah et al., [31], the addition of extracts with high anthocyanin concentrations, the intensity of redness produced was also high and if there was a decrease in anthocyanin concentrations, the intensity of red also decreased accompanied by an increase in the value of brightness.

Analysis of variance data P0, P1, P2, P3 and P4 produced an average value of -8.27 -9.12; -8.88; -7.53 and -7.00. The b* value in the color test with the highest result was found in the addition of -9.12 butterfly pea extract, namely at P1. It coulc be seen in the table above that the b* value decreased with the addition of butterfly pea extract causing the resulting color to become more bluish, this was because the b* value was an indicator of yellowish and bluish colors. A positive b* value indicated a yellowish color and a negative value indicated a bluish color in the sample. According to the study by Fizriani et al., [32], the color of the edible film produced by adding eggplant extract had color variations, namely from light blue to dark blue, the higher the concentration of eggplant added to the edible film, the darker the resulting color intensity would be.

3.5 Color Spectrum

In the color spectrum image above, it can be seen that the gelatin-xylitol edible film with the addition of butterfly pea extract has a purplish-blue color. Hartono et al., [33] stated that a bluish-red color with increasing concentration of butterfly pea flower extract appeared due to the color degradation of anthocyanins. The degradation of anthocyanin in the form of flavilium cations which turn red to blue is caused by quinodal bases, causing a bluish-red color. The above coordinate points can be determined by calculating the L*a*b* value and then entering the Hue angel formula to determine the coordinates of the color determination so that a value of 89.19 was converted into an angle of degrees so that the correct coordinates were obtained for edible film gelatin-xylitol with the addition of purplish blue butterfly pea flower extract according to the coordinates shown in the figure.

Visual appearance such as color is one of the most important qualities in influencing consumer opinion about food quality such as sensory, nutrition and freshness of food products Fig. 3. Displays a color spectrum image with color parameters L*, a* and b* gelatin-xylitol edible film with the addition of butterfly pea flower extract. The L* indicator, namely the brightness of the edible film, shows a slightly darker blue color. This is due to the presence of anthocyanins which cause a deep blue color on the edible film. The red color (a*) of the edible film changes significantly from greenish to reddish in the presence of ingredients contained in the edible film, namely gelatin and xylitol, while the blue color (b*) is due to the addition of butterfly pea flower extract as a carrier for the blue pigment. The resulting edible film has a bluish color due to the presence of flavonoid compounds such as delphinidin and ternatin in the outer layer of the endosperm Lamberts et al. (2006).

According to the color spectrum image above, it could be seen that the edible film gelatin-xylitol with the addition of butterfly pea extract had a blue-purple color. Hartono et al., [33] stated that a bluish red color with increasing concentration of butterfly pea extract appeared due to the degradation of the color of anthocyanins. The degradation of anthocyanin in the form of flavilium cations which turn red to blue was caused by quinodal bases, resulting a bluish-red color. The above coordinate points could be determined by calculating the L*a*b* value and then entering the Hue angel formula to determine the coordinates of the color determination. Therefore, a value of 89.19 was converted into a degree angle, hence the correct coordinates

were obtained for the gelatin-xylitol edible film with the addition of purplish blue butterfly pea extract according to the coordinates shown in the figure.

3.6 Thickness

The average thickness of the gelatin-xylitol edible film with different percentages of butterfly pea extract, namely 0%, 1%, 2%, 3% and 4%, showed a very significant effect (P<0.01) on the thickness which could be seen in Table 3.
The results of the analysis of variance showed that the treatment using different concentrations of xylitol had a very significant effect (P<0.01) on the thickness which could be seen in Table 3. average 0.09 mm, 0.09 mm, 0.12 mm, 0.10 mm, and 0.15 mm. The thickness with the highest result was found in edible film with the addition of 4% xylitol at P4, namely 0.153. This was due to the increase in the level of xylitol and the level of butterfly pea extract, the thickness of the film increased. This was because the addition of xylitol and butterfly pea extract increased the amount of polymer or material that made up the edible film, hence that the edible film became thicker. Garcia et al., [34] stated that the greater the concentration of solids, the thicker the edible film produced. The thicker film was caused by the more protein content used, the greater the total solids contained in the film after drying, resulting in a thicker film [35].

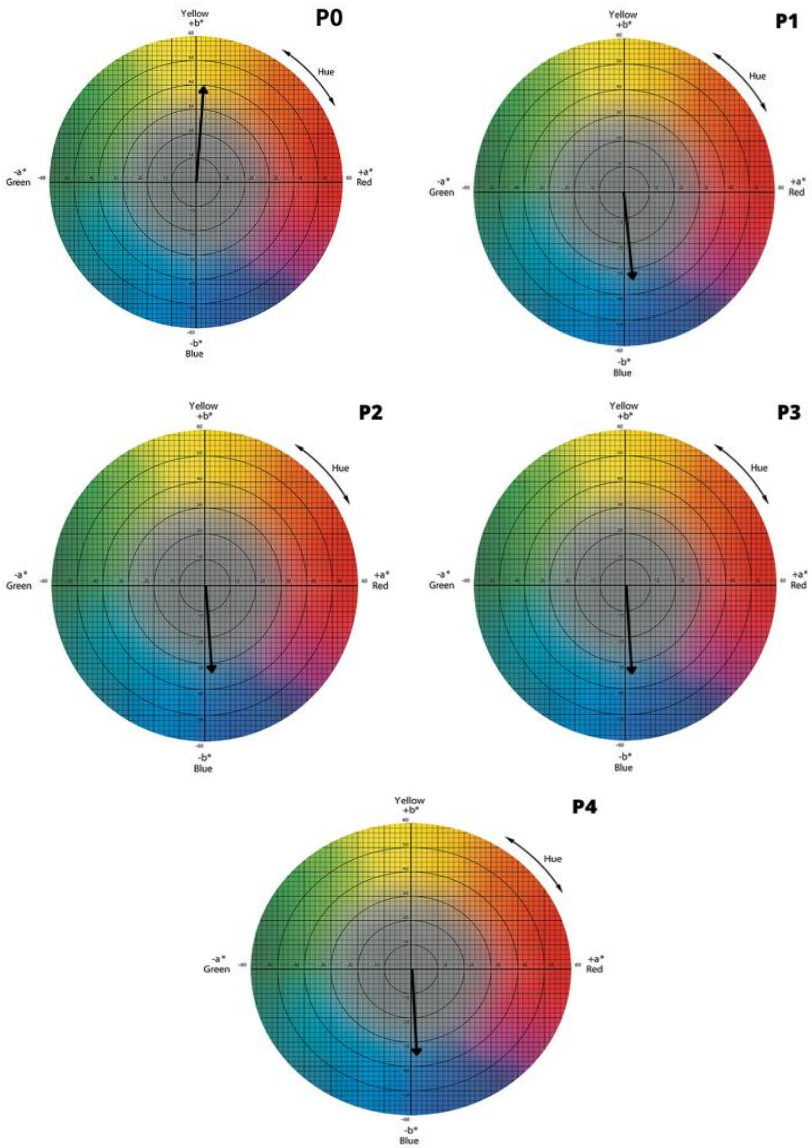

Fig. 3. Color spectrum

Table 3. The thickness of edible film gelatin-xylitol with the addition of butterfly pea extract

Treatments	Thickness (mm)
P0 (0%)	0,09 ± 0.007
P1 (1%)	0,09 ± 0.023
P2 (2%)	0,12 ± 0.004
P3 (3%)	0,10 ± 0.006
P4 (4%)	0,15 ± 0.011

Note: a, b on different superscripts in the same column showed a very significant effect (P<0.01)

Increasing the concentration of xylitol could increase the thickness value of the edible film. This was because the more sorbitol concentration added would increase the total solids in the solution which would affect the thickness of the edible film, when the substance evaporated, the formed edible film became thicker along with the increasing total solids that precipitated as an edible film-forming material in accordance with Marseno's statement [36] which described that the addition of plasticizer concentration would increase the polymer making up the film matrix as well as the total dissolved solids in the film solution increased, causing the film thickness to increase.

The average thickness value of the film obtained was 0.116 mm, thus edible film could be said to meet the standard in processed products, namely the maximum value of edible film thickness according to the Japanese Industrial Standard [37] which was 0.25 mm. The thickness of the edible film was affected by the area of the mold, the volume of the solution, and the total amount of solids in the solution. The greater the amount of xylitol added to the volume of the solution and the same mold area, the total solids in the solution would increase. Therefore, more solids settled as edible film formers and when the substance evaporated, the thicker the edible film would be formed.

4. CONCLUSION

Based on the results of the study that had been carried out using the experimental method, the product results were in the form of a gelatin-xylitol edible film with the addition of butterfly pea extract at a concentration of 3% at P3 which had optimal physical characteristics as measured by an antioxidant value of 1.225, which indicated that edible gelatin-xylitol with the addition Butterfly pea extract had a strong antioxidant content. The functional group (FTIR) had a wavelength based on wave number of 3281.71 cm^{-1} found in the O-H functional groups of alkanes, alkenes, fluorides, and aromatics. Scanning electron microscope (SEM) produced a slightly rough textured surface layer, L*a*b color values, and color spectrum indicated that the edible film produced was purplish-blue in color and the thickness value was 0.153 mm according to the standards for edible films.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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