Edible Packaging Applications for Instant Chocolate Packers due to the Effect of CMC and Plasticizer Concentration

by Yusman Taufik -

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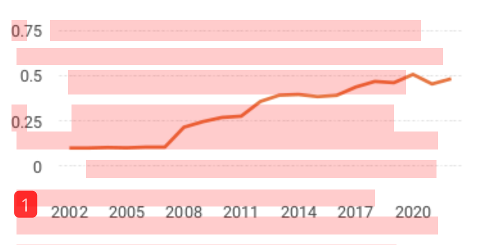

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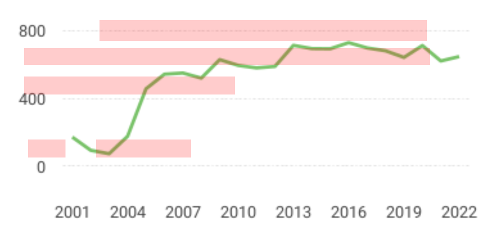

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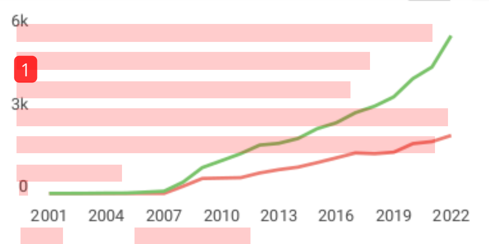

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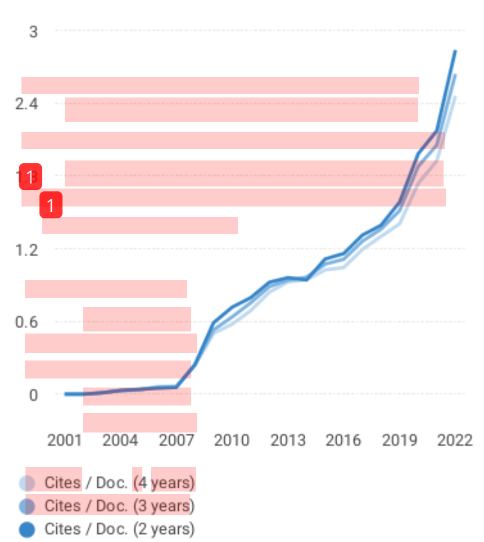

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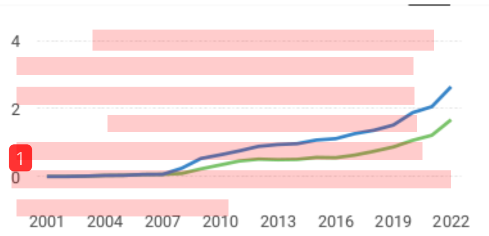

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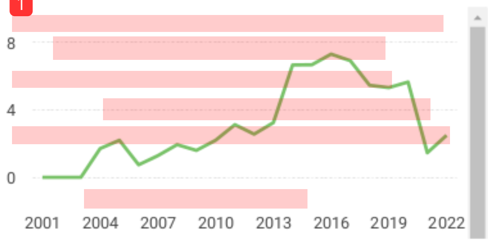

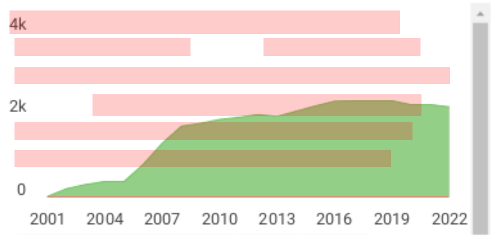

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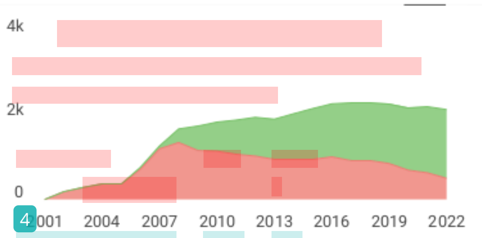

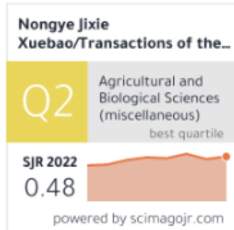

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Research article
Agricultural product health and safety: Product freshness

Edible Packaging Applications for Instant Chocolate Packers due to the Effect of CMC and Plasticizer Concentration

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(Food Technology Department, Pasundan University, Bandung, Indonesia)

Abstract: The purpose of this study was to use mung bean starch as a raw material in the manufacture of edible packaging and determine the concentration of CMC and plasticizer on the characteristics of edible packaging of mung bean starch. The main research consisted of treatment design, experimental design, analysis design, and response design. Preliminary research was carried out in two stages: analysis of starch content in green beans and selection of the best type of plasticizer used in the main study. The plasticizers used were glycerol, sorbitol, and beeswax with a concentration of 2% with low water content, high tensile strength (analyzed on selected samples), dissolving speed and organoleptic assessment using hedonic tests. mung bean which is 5.5%, starch content of mung bean starch is 87.59% and plasticizer glycerol has the largest elongation value of 70%, the tensile strength value is 1.46755 MPa, and the dissolving speed is 0.0139 g/second so that the use of glycerol plasticizer was chosen as a plasticizer for treatment in the main study. The study included treatment c1p2 with 1% CMC concentration and 2% glycerol concentration, c1p3 with 1% CMC concentration and 3% glycerol concentration, and c2p2 with 2% CMC concentration and 2% glycerol concentration. Tensile strength is 2.48193 MPa, elongation percent is 70%, c1p3 has a tensile strength value of 3.94362 MPa, percent elongation is 37% and c2p2 has a tensile strength value of 1.093815 MPa, percent elongation is 106%.
Keywords: edible packaging; green bean starch; plasticizer; carboxymethylcellulose

由于CMC和增塑剂浓度的影响，速溶巧克力包装机的可食用包装应用

Yudi Garnida, Yusman Taufik, Musabbiq Rahman
（食品技术系，百顺丹大学，印度尼西亚万隆）

摘要:
本研究的目的是以绿豆淀粉为原料制造可食用包装，测定CMC和增塑剂的浓度对绿豆淀粉可食用包装特性的影响。主要研究包括处理设计、实验设计、分析设计和反应设计。初步研究分两个阶段进行：分析生豆中的淀粉含量和选择主要研究中使用的最佳增塑剂类型。使用的增塑剂是甘油、山梨糖醇和浓度为2%的蜂蜡，含水量低，拉伸强度高（对选定样品进行分析），溶解速度和使

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用享乐试验的感官评估。绿豆为5.5%，绿豆淀粉的淀粉含量为87.59%，增塑剂甘油的最大伸长值为470%，拉伸强度值为1.46755兆帕，溶解速度为0.0139 g/秒，因此使用在主要研究中选择甘油增塑剂作为治疗增塑剂。该研究包括用1% CMC浓度和2%甘油浓度处理c1p2，用1% CMC浓度和3%甘油浓度处理c1p3，以及用2% CMC浓度和2%甘油浓度处理c2p2。抗拉强度为2.48193兆帕，伸长率为70%，c1p3的抗拉强度值为 3.94362兆帕，伸长率为37%，c2p2的抗拉强度值为1.093815兆帕，伸长率为106%。

关键词：可食用包装； 绿豆淀粉； 增塑剂； 羧甲基纤维素

1 Introduction

Plastic is one of the packaging that is widely used because it can make human life easier. The increasingly widespread use of plastic is due to its advantages, namely that it is easy to manufacture in various shapes and sizes, has high chemical resistance, can be adjusted for elasticity, is inexpensive, and can last for a long time.

The purpose of this research is to create the latest innovation regarding smart packaging, which can be directly consumed or used.

Edible film is a thin and continuous layer made of edible materials, formed on top of food components (coating) or placed between food components (films) that function as barriers to mass transfer and/or as carriers of food ingredients and additives and to enhance ease of handling food[1]. Edible film can act as a layer that can be degraded by bacteria and is made from renewable resources. This film replaces petroleum-based films or attempts to increase environmental awareness. Currently, degradable films are derived from proteins and polysaccharides[3].

Several previous studies have been carried out to produce edible packaging. However, edible packaging made from starch has several drawbacks. This edible packaging is less resistant to water (less hydrophilic or hydrophilic), and its mechanical properties are still low (tensile strength). One way to reduce the hydrophilic nature is to mix the starch with other hydrophobic biopolymers such as cellulose, chitosan, and protein[2]. Application of edible packaging starches of green beans for the primary packaging reduces the use of packaging made from non-degradable film.

The main components of edible films *are* divided into three groups, namely hydrocolloids, fats, and composites[4]. One of the main ingredients used in the manufacture of this edible film is starch, which belongs to the hydrocolloid group, which is an easily available material, the price is cheap, and there are various types in Indonesia[5].

Mung bean starch can be isolated by dry or wet method, but the wet method is more widely used[6]. In the wet method of starch isolation, certain modifications are needed, for example by grinding to damage some of the seed coat and seeds so that germination does not occur during soaking at room temperature. Studies of the properties of mung bean starch from various countries have been carried out quite a lot, but studies of the properties of local mung bean starch from Indonesia are still very limited. The properties of mung bean starch studied included physico-chemical properties (amylose content, swelling power, solubility, turbidity, iodine affinity/blue value, amylose leaching, and water holding capacity), thermal properties (gelatinization properties and retrogradation properties), paste (pasting properties), and starch gel texture properties, digestibility properties, starch granule properties (shape and size of starch granules). Information on the properties of starch is very important for further product development applications, including the development of RS-3 for the treatment of obesity problems.

Starch consists of two types of polymers: straight chain D-glucan amylose and branched chain amylopectin. The two types of polymers have different properties in the formation of gels and crystals. Amylose and amylopectin physically form inter- and intramolecular cross-links to form larger macromolecular networks in gelling[7]. The cross-links in the starch macromolecular network are mainly formed from amylose microcrystal domains, which contributes to the high strength and stretchability of the resulting films[8].

Cocoa powder, also known as fast chocolate and cocoa powder, is a beverage made from brewed cocoa beans. Instant chocolate is generally produced for commercial purposes either by freeze-drying or spray drying; after that, it can be rehydrated.

Edible films made from polysaccharides act as permeable membranes that are selective for the exchange of O2 and CO2 gases so that they can reduce respiration rates of fruits and vegetables[1].

The advantages of edible films made from hydrocolloids include having a good ability to protect products against oxygen, carbon dioxide, and lipids as well as having the desired mechanical properties and increasing the structural integrity of the product. The disadvantage is that the film from carbohydrates is not well used to regulate the migration of water vapor while the film from protein is strongly influenced by changes in pH. The advantage of edible films from lipids is that they have a good ability to protect the product from evaporation of water. While the drawback is that its use in pure form as a coating is still limited, because it has shortcomings in terms of durability. Edible films from composites (a combination of hydrocolloids and lipids) can increase the advantages of films from hydrocolloids and films from lipids, and reduce their weaknesses. The formation of edible films is a process of growing small fragments that will form a polymer. The principle of the formation of edible films is the interaction of polymer chains to produce larger and more stable polymers[9].

Mung bean starch was chosen as the raw material for making instant chocolate edible packaging because it is easy to obtain, cheap and the amylose content in green beans is high enough so that it can increase water solubility, while mung bean protein, namely isoflavones, is difficult to dissolve in water. Green has the potential to be used as raw material for edible packaging, which is suitable for instant chocolate

Plasticizer is a material that is added to a film-forming material to increase its flexibility because it can reduce the intermolecular forces along the polymer chain, so that the film will be flexible when bent[10]. According to [11], the physical characteristics of edible films are influenced by the type of material and the type and concentration of plasticizers.

The addition of stabilizer aims to improve the physical properties of the edible film that will be produced. One of the stabilizers widely used is carboxymethylcellulose (CMC), which is a stabilizer that has a strong bonding power and plays a role in increasing the viscosity and improving the texture of the film-forming.

2 Research Methods

2.1 Materials and Tools

2.1.1 Ingredients

The main raw materials used in this study were mung beans, cocoa powder, aquadest, glycerol, sorbitol, beeswax, CMC, polyvinyl alcohol (PVA), and Luff-Schoorl's solution.

2.1.2 Tools

500-ml beaker, 50-ml measuring cup, 500-ml Erlenmeyer, filter paper, stirring rod, thermometer, dropper pipette, volumetric pipette, stopwatch, film printing glass plate measuring 20 cm x 20 cm, frame with size 30 cm x 30 cm, plastic berkelium, chopper, Labo Plastomill (extruder-mixer), digital balance, Teflon sheet, compression molding, hot press, cold press, spacer, medium size bowl, cutting board, knife, ohous brand technical scale, oven, tray, heating mantle, desiccator, percent elongation.

2.2 Research Methods

The research method used consisted of preliminary and main research methods.

2.2.1 Preliminary Research

The purpose of this preliminary research was carried out in two stages: analyzing the starch content of mung bean flour and looking for the type of plasticizer that could produce the best edible film. The type of plasticizer used is glycerol, sorbitol, and beeswax with a concentration of 2%. The plasticizer selected from this preliminary study was based on high tensile strength (analyzed on selected samples), dissolving speed, and organoleptic assessment using hedonic tests[12].

2.2.2 Main Research

The purpose of this research is to determine the effect of CMC concentration and plasticizer concentration on the characteristics of the edible film of mung bean starch.

2.3 Response Plan

The response design for the characteristics of edible packaging made from mung bean starch includes physical responses.

2.3.1 Physical Response

The physical and mechanical response is to analyze the dominant characteristics of edible packaging. Analysis of the characteristics of edible packaging includes:

a. Tensile Strength, Percent Elongation, and Water Vapor Transmission Rate

Tensile strength and percent elongation test used ASTM D638M method, and the rate of water vapor transmission was measured using

ASTM D1653-93 method. In the preliminary study, tensile strength and percent elongation were tested to obtain the best plasticizer. In the main study, this test was carried out on selected samples of edible packaging of mung bean starch

b. Dissolving Speed

[13] used the method of determining the dissolution rate. The speed of dissolution is determined by preparing 100 ml of cold water with temperature of approximately 25°C, and the weighed sample is put into 100 ml of the water. The time required to dissolve the entire sample was calculated using a stopwatch. Edible packaging samples that have been tested for soluble speed are then statistically processed.

2.3.2 Chemical Response

The chemical response was the analysis of starch content using the Luff-Schoorl method[28] based on the sugar content after inversion II and inversion I sugar content contained in the product. The water content test was carried out using the gravimetric method[14] based on the evaporation in the material by heating using an oven, then weighed to a constant weight. Weight reduction is the water content contained in the material.

2.4 Preliminary Research Results

The preliminary research was carried out in two stages: namely the analysis of the starch content of green beans and the selection of the best type of plasticizer used in the main study. The plasticizers used are glycerol, sorbitol, and beeswax with a concentration of 2%, low water content, high tensile strength (analyzed on selected samples), dissolving speed and organoleptic assessment using hedonic tests.

2.4.1 Starch Content Analysis of Mung Beans

Analysis of raw materials was carried out to determine the level of starch contained in mung bean starch, which will be used as raw material in the manufacture of edible packaging of mung bean starch.

The data from the raw material analysis showed that the raw material for mung bean starch contained 87.59% starch. These results indicate that green beans have the potential to be used as food products that require a high source of starch.

Starch compounds are composed of two components, namely amylose and amylopectin. According to [15], the stability of edible films is influenced by amylopectin, while amylose affects its compactness.

Starch with high amylose content produces a flexible and strong edible film[16] because the amylose structure allows the formation of hydrogen bonds between its constituent glucose molecules and during heating is able to form a three-dimensional network that can trap water to produce a strong gel[17].

The advantages of edible films made from hydrocolloids include having a good ability to protect products against oxygen, carbon dioxide, and lipids as well as having the desired mechanical properties and increasing the structural integrity of the product. The disadvantage is that the film from carbohydrates is not well used to regulate the migration of water vapour, while the film from protein is strongly influenced by changes in pH. The advantage of edible films from lipids is that they have a good ability to protect the product from evaporation of water. The drawback is that its use in pure form as a coating is still limited because it has shortcomings in terms of durability. Edible films from composites (a combination of hydrocolloids and lipids) can increase the advantages of films from hydrocolloids and films from lipids, and reduce their weaknesses. The formation of edible films is a process of growing small fragments that will form a polymer. The principle of the formation of edible films is the interaction of polymer chains to produce larger and more stable polymers[18].

2.4.2 Water Content Analysis

The analysis of the water content of mung bean starch was carried out to determine whether the water content in mung bean starch after drying met the specified quality requirements.

The water content in food ingredients also determines the freshness and durability of the ingredients. To extend the durability of the material, some of the water in the material must be removed in a manner appropriate to the type of material, such as drying. Materials that have high water content usually rot faster than materials with low water content, due to the activity of microorganisms. The minimum water content limit where microbes can still grow is 14-15%[19].

Data from the water content analysis of mung bean starch show that mung bean starch has a water content of 5.5%. The results of previous studies showed that the water content of mung bean starch was 15.97%[20]. The quality standards of mung bean flour according to SNI 01-3728-1995 are as follows:

Tab. 1 Green bean flour quality requirements (SNI-01-3728-1995)

No.	Test Criteria	Unit	Condition
1	Condition: Smell, Taste, Color	-	Normal
2	Foreign bodies, insects in the form of stadia and legumes, type of starch other than mung bean starch	-	Cannot be there
3	Subtleties:		
	- Passed 60 mesh sieve	%b/b	Min. 95
	- Passed 60 mesh sieve	%b/b	100
4	Water	%b/b	Max. 10
5	Coarse Fiber	%b/b	Max. 3,0
6	Acid Degree	M 1 N.m1 N	Max. 2,0

2.5 Plasticizer Type Selection

Solubility in water is to predict the stability of edible films against the influence of water. The results of the analysis show that with the addition of each composition variation affects the physical properties of solubility in water. The amount of solubility of a substance in a solvent is influenced by the nature and intensity of the strength and the interaction between the solute and the solvent[21].

The solubility of edible films is a very important factor in packaging materials. Solubility is influenced by hydrophilic and hydrophobic components. Hydrophilic components are components that like water or are soluble in water; in this study, sorbitol and CMC are components that are easily soluble in water. This is in accordance with the statement[22].

Tab. 2 Results of the analysis of the dissolving rate of edible packaging from mung bean starch

Sample	Weight (g)	Late Time (seconds)	Dissolving speed (g/s)
Beeswax 2%	2 grams	202	0,0099
Glycerol 2%	2 grams	143	0,0139
Sorbitol 2%	2 grams	161	0,0124

Tab. 2 shows that the sample with 2% glycerol plasticizer has the highest dissolving rate of 0.0139 g/s when compared to 2% beeswax plasticizer and 2% sorbitol. According to [23], the addition of glycerol to edible films greatly affects the raw materials used such as starch. Compared to solvents such as sorbitol, glycerol is more advantageous because it is easily miscible in film solutions and is soluble in water (hydrophilic). Meanwhile, sorbitol is difficult to mix and easily crystallizes at room temperature. Another advantage of glycerol is that it is an organic material with a low molecular weight so that the addition of raw materials can reduce the stiffness of the polymer while increasing the flexibility of the edible film.

3 Results

The main research was conducted to determine the effect of CMC concentration, the concentration of the selected plasticizer, namely glycerol, and the interaction between CMC concentration and glycerol concentration on the characteristics of edible packaging of mung bean starch. The main research used the responses tested, namely chemical (moisture content) and physical analyses (dissolving speed); the resulting edible film was analyzed by one of the test responses, namely analysis of tensile strength and percent elongation. The selected formulations from chemical, physical, organoleptic tests will be analyzed for tensile strength, elongation, and chemical testing (moisture content) on instant chocolate products with and without using edible packaging.

3.1 Water Content Analysis of Edible Packaging

Water is an important component in foodstuffs because water can affect the appearance, texture, taste and shelf life of the food itself. To extend the shelf life of a material so that the material becomes more durable, some of the water in the material must be removed in several ways, generally drying, either natural drying or artificial drying[24].

The results of analysis of variance (ANOVA) on the water content in mung bean starch edible packaging show that the CMC concentration factor (C), the plasticizer concentration (G), and the interaction between the CMC concentration and the plasticizer concentration (CG) have an effect on the water content in the mung bean starch edible packaging.

Tab. 3 The effect of the interaction between CMC concentration (C) and plasticizer concentration (G) on water content (%) in mung bean starch edible packaging

CMC Concentration (C) (%)	Glycerol Concentration (G) (%)		
	G1 (1%)	G2 (2%)	G3 (3%)
C1 (1%)	3,17 A a	4,83 A b	5,00 A b
C2 (2%)	5,92 B a	6,00 B a	6,17 B a
C3 (3%)	6,33 C a	6,42 C a	6,83 C a

Note: Each mean value followed by a different letter represents a significant difference according to Duncan's test at a 5% significance level (lowercase letters are read horizontally, while uppercase letters are read vertically).

Based on the results of Ducan's further test (Tab. 3), it can be seen that the higher the concentration of CMC and the concentration of plasticizer, the water content of the resulting edible packaging will increase. This is due to the addition of CMC, which has a high water binding ability. The more concentration of CMC added, the greater the amount of water bound to the edible packaging of mung bean starch which will increase the water content of the edible packaging itself. According to [25], another factor for increasing water content is the addition of glycerol which is a fat group. The addition of fat with a high concentration can increase the water content of edible packaging.

Plasticizer is a non-volatile substance, has a high boiling point, and if added to other materials, can change the physical or mechanical properties of the material[26].

The addition of CMC, which has a high water binding ability, can increase the water content. The more concentration of CMC added, the greater the amount of water bound to the edible packaging of mung bean starch which will increase the water content of the edible packaging itself. According to [27], another factor in increasing the water content is the addition of glycerol which is a fat group. The addition of fat with a high concentration can increase the water content of edible packaging.

During the process of making edible packaging, drying at a temperature of 60°C for 4 hours will evaporate free water that is not bound by CMC and plasticizers, but not all free water can be evaporated. The low concentration of CMC and plasticizer results in a low amount of bound water, so that the water content in the edible packaging formed has a low water content value. Meanwhile, high concentrations of CMC and plasticizers increase the ability to bind water and increase the total amount of water so that the water content in the edible packaging formed has a high water content value.

Cellulose derivatives known as carboxymethyl cellulose (CMC) are often used in the food industry to obtain a good texture, e.g., in the manufacture of ice cream. The use of CMC will improve the texture and the lactose crystals formed will be smoother. CMC is also often used in foodstuffs to prevent retrogradation. CMC has a carboxyl group, so its viscosity is influenced by the pH of the solution; the optimum pH is 5; if the pH is too low (< 3), CMC will precipitate.

CMC is a substance that can bind water. Based on [5,27], the amount of water absorbed depends on the levels of CMC in the sample. The greater the CMC content, the greater the amount of water absorbed.

Measurement of water content using the gravimetric method will evaporate the total water in the material without showing the condition or degree of water attachment, so that in addition to the free water remaining during drying, the bound water will also be evaporated and measured as the water content of the edible film[13].

The water content contained in the edible film is expected to be as low as possible to prevent the increase in the water content of the food that will be packaged by the mung bean starch edible film due to the migration of the water content in the edible film into the food[15].

3.2 Edible Film Dissolution Rate Analysis

Edible film is a layer that can be eaten, so one of the requirements for it is to have a low solubility value.

Solubility in water is to predict the stability of edible films against the influence of water. The results of the analysis show that with the addition of each composition variation affects the physical properties of solubility in water. The amount of solubility of a substance in a solvent is influenced by the nature and intensity of the strength and the interaction between the solute and the solvent[22].

Edible film solubility is a very important factor in packaging materials. Solubility is influenced by hydrophilic and hydrophobic components. Hydrophilic components are components that like water or are soluble in water; in this study, sorbitol and CMC are components that are easily soluble in water. This is in accordance with [22].

Tab. 4 The effect of interaction between CMC concentration (C) and plasticizer concentration on dissolution rate (g/s) of mung bean starch edible packaging

CMC Concentration (C) (%)	Glycerol Concentration (G) (%)		
	G1 (1%)	G2 (2%)	G3 (3%)
C1 (1%)	0,0135 B c	0,0130 B b	0,0112 B a
C2 (2%)	0,0139 C b	0,0187 C c	0,0119 C a
C3 (3%)	0,0094 A c	0,0091 A b	0,0087 A a

Note: Each average value followed by a different letter indicates a significant difference according to Duncan's test at a 5% significance level (lowercase letters are read horizontally, while uppercase letters are read vertically).

Based on Duncan's further test results (Tab. 6), it can be seen that 1% CMC concentration affects 1% glycerol concentration and 2% CMC concentration affects 1% and 2% glycerol concentration. The concentration of 3% CMC has an effect on the glycerol concentration of 1% and 2%. At a concentration of 3% CMC, the value of the dissolving speed of edibles decreases because more CMC is added, it requires more water to dissolve it so that with the amount of water added as much as 100 ml of edible packaging with 3% CMC it takes longer to dissolve in water.

According to Thirathumhavorn and [3] in [6], the decrease in solubility is also caused by amylose with substituent groups forming strong bonds, causing entrapment of water molecules in starch molecules, which results in increased swelling power and prevents amylose molecules from dissolving in the system, which causes the solubility of starch to decrease.

According to [2], the type and concentration of the plasticizer used will have an effect on the solubility of the starch-based film.

Glycerol belongs to the polyhydroxy alcohol group with three hydroxy groups in one molecule, which is commonly called trivalent alcohol. Glycerol has water-soluble properties, is able to increase viscosity, bind water and can reduce water content [4].

In the solubility test, the most determining factor is the hydrophilic nature of the plastic film and is supported by agitation, which can mechanically accelerate the solubility of the plastic film in water [4].

According to [13], amylopectin is generally the main constituent of most starch granules. With high amyloketin content, the solubility of glutinous rice flour in water is lower.

Carboxymethyl cellulose (CMC) is a stabilizer that can form colloids in water. This type of stabilizer has a molecular structure derived from carbohydrates which are included in hydrocolloids. The colloidal nature of this substance functions as a stabilizer or can stabilize a suspension. The more concentration of CMC that is added, the more water is absorbed and bound, which is because CMC is hygroscopic. The effect of the speed of dissolving edible film can be caused by this, the more CMC is added, the water content will increase and the edible film formed will be more soluble in water[23].

The length of the hydrocarbon chain of a compound greatly affects its solubility in water. This is due to the hydrophobic nature of the hydrocarbon chain. The longer the hydrocarbon chain, the lower the solubility in water. The longer the hydrocarbon chain, the fewer hydroxyl groups adsorbed on the membrane surface area[29].

3.3 Hedonic Quality Test

The hedonic quality test aims to see the effect of which plasticizer is the best. Of the three types of plasticizers, namely glycerol, sorbitol, and beeswax, and in this hedonic quality test, the selected plasticizer will be used in the main research.

3.3.1 Texture

The results of the ANOVA show that the concentration of CMC (C) and that of plasticizer (G) also allow finding the best plasticizer to be used in the main study. The interaction (CG) affects the texture attributes of the edible packaging of mung bean starch.

Tab. 5 The effect of interaction between CMC concentration (C) and plasticizer concentration (G) on texture attributes of mung bean starch edible packaging

CMC Concentration (C) (%)	Glycerol Concentration (G) (%)		
	G1 (1%)	G2 (2%)	G3 (3%)
C1 (1%)	3,16 A a	4,06 A b	4,47 B C
C2 (2%)	3,61 B a	4,47 B b	4,52 B b
C3 (3%)	3,73 B a	4,02 A b	3,93 A b

Note: Each mean value followed by a different letter indicates a significant difference according to Duncan's test at a 5% significance level (Lower letters are read horizontally, while uppercase letters are read vertically).

The data in Tab. 5 show that the treatment c1g3, which is a factor (C) of CMC concentration (1%) and factor (G) of glycerol concentration (3%), and c2g2, which is a factor (C) of CMC concentration (2%) and factor (G) of glycerol concentration (2%), showed the highest results in the organoleptic test of texture attributes; this was due to CMC concentration and glycerol concentration, which could affect the texture of the edible packaging of mung bean starch. The higher the glycerol concentration, the greater the hedonic quality number, and the more flexible the edible packaging is. At various concentrations of glycerol, the higher the concentration of CMC stabilizer, the lower the hedonic quality, and the less flexibility of edible packaging. This is because one of the properties of CMC is to bind and form a suspension in water. The higher the CMC content, the greater the cross-link formation, and the higher the immobilization of the solvent molecules, causing the viscosity to increase. The cross-links produced by CMC make the edible packaging matrix stronger and produce edible packaging with better texture. The more concentration of CMC added, the more rigid and brittle (less flexible) the edible packaging will produce[24].

Glycerol is widely used as a plasticizer to produce thinner films that are more flexible. Research carried out shows that the addition of glycerol will reduce the mechanical strength of various types of films with protein and polysaccharide base materials.

Glycerol proved to be effective in increasing the plastic properties. The addition of glycerol as a plasticizer will reduce the density and intermolecular forces of the substrate (starch) with glycerol, so that the thin layer formed is more flexible and smoother. The addition of excess glycerol will cause the thin layer to become soft and sticky making it difficult to remove from the mold because glycerol is more water-binding and softens the surface. Preferably a lack of glycerol will cause the thin layer to become rough and brittle[30].

3.3.2 Appearance

Based on the results of the ANOVA, the concentration of CMC (C), that of plasticizer (G), and their interactions (CG) have no significant effect on the appearance attributes of edible packaging of mung bean starch.

CMC and glycerol and their interactions do not have a significant effect on the appearance because CMC is a cellulose derivative that binds water and is often used as a fine former[31]. The addition of CMC stabilizer and glycerol plasticizer does not affect the smooth or rough appearance of edible packaging because glycerol is in liquid form and CMC will form a gel that does not have a smooth or rough appearance.

Mung bean starch in this attribute is the only factor that can cause an appearance in the smooth or rough form, but because the starch used has a uniform particle of 100-mesh size, the edible packaging of mung bean starch produced has a smooth appearance.

3.3.3 Color

Based on the results of ANOVA, the concentration of CMC (C) has a significant effect on the appearance attributes of edible packaging of mung bean starch, while the concentration of plasticizer (G) and its interaction (CG) have no significant effect on the appearance attributes of edible packaging of mung bean starch.

Tab. 6 The effect of CMC concentration (C) on color attributes of mung bean starch edible packaging

Treatment	Average Color	Kindness 5%
C3 (3%)	3,356	a
C1 (1%)	4,385	a
C2 (2%)	4,544	b

Note: The same letter in the 5% significance level column shows no significant difference, while the different letters in the 5% significance level column indicate significantly different.

The data in Tab. 6 show that the concentration of CMC at each level gives a significant difference to the color attribute of the edible packaging of mung bean starch. The CMC concentration (2%) had a higher rating than the treatment c1 CMC concentration (1%) and c3 CMC concentration (3%). This is because the more concentration of CMC stabilizer added, the lower the hedonic quality of the edible packaging color of mung bean starch because the edible packaging of mung bean starch formed will be yellowish in color, tend to be darker and softer. In this case the possible different colors are influenced by the presence of starch and CMC which are exposed to heat during drying. Color is the quickest and easiest way to give an impression, but it is the most difficult to describe and difficult to measure because it is subjectively assessed, that is, sight is very decisive in the valuation of commodities[32].

The addition of CMC has an influence on the hedonic quality of the color of the edible packaging; the gloss produced in several treatments is caused by the addition of the fat group in this study, namely glycerol, which will give off its luster when exposed to the resulting light reflection.

The largest hedonic quality has a yellowish white color and tends to be bright. This happens because the less CMC is added, the smaller the water content; it can be seen in the brighter color of the edible packaging because a lot of water evaporates during drying. A high concentration of CMC will result in more bound water and less water evaporating during drying

Color in foodstuffs is caused by several factors, including the presence of pigment from the ingredients used or due to the influence of heat on sugar, the reaction between sugar and amino acids (the Maillard reaction), and the contact between organic acids and air[23].

3.3.4 Selected Sample Research Results

Based on the results of organoleptic responses, including texture, appearance, and color, chemical response, namely water content, and physical response, namely dissolving speed testing, the selected treatment refers to the desired characteristics of the edible packaging of mung bean starch. Based on Tab. 10, the results of the calculation of the scoring method, a conclusion can be drawn to determine the selected sample from this study as follows:

Tab. 7 Determination of the selected sample scoring method

Sample Code	Water Rate	Late time	Organoleptic (Color, Texture, Appearance)	Amount
c1p1	5	3	2	10

Continuation of Tab. 7

c1p2	3	3	4	10
c1p3	3	2	5	10
c2p1	2	3	3	8
c2p2	2	5	5	12
c2p3	1	2	5	8
c3p1	1	1	1	3
c3p2	1	1	2	4
c3p3	1	1	1	3

Based on Tab. 7, the results of the scoring method show that the selected samples were treatment c1p2, c1p3, and c2p2 because the three treatments had the highest number of responses. The selected samples were then analyzed for tensile strength, percent elongation, and TPC (total plate count) to determine the physical and mechanical response to the edible packaging of mung bean starch.

3.3.5 Analysis of the Tensile Strength and Percent Elongation

The selected sample was tested for tensile strength to determine the magnitude of the force required to achieve maximum tensile strength in each area of the film. The tensile strength properties depend on the concentration and type of edible packaging constituent materials, especially structural cohesion properties. Structural cohesion is the ability of polymers to determine the strength or absence of bonds between molecular chains between polymer chains.

Tensile strength and elongation are important for the edible packaging. The mechanical properties of tensile strength are expressed by the ability of edible packaging to withstand maximum tension or load when tested. The tensile strength test is carried out together with the measurement of the elongation value or the percent elongation. Elongation states the ability of an edible packaging to stretch or increase the length of the material from the initial length before withdrawal to breaking.

The characteristics of edible packaging with a low elongation value indicated that the film was stiff and easily broken. Generally, the film structure is softer, the tensile strength decreases and the percent elongation increases. A higher elongation percent indicates that the film is more flexible. This proves that the film is resistant to mechanical damage in machine handling processes in the food industry. Tensile strength and elongation are influenced by the raw materials used and the combination of constituent materials. Edible packaging made of hydrocolloid has good mechanical strength compared to edible packaging made of fat and composites. Edible packaging that has a weak tensile strength value will be difficult to apply because it will tear easily.

Tab. 8 Tensile strength and elongation test results on the selected samples

No	Sample	Tensile Strength (MPa)	Elongation (%)
1	c1p2	2,48108	70
2	c1p3	3,94227	37
3	c2p2	1,09344	106

In Tab. 8, the tensile strength results for sample c1p2 are 2.48108 MPa, c1p3 is 3.94227 MPa, and c2p2 is 1.09344 MPa; elongation result for samples c1p2 is 70%, c1p3 is 37%, and c2p2 is 106 %; tensile strength results for c1p3 samples already meet the minimum standards for tensile strength, set by the Japanese Industrial Standards (1975), namely at least 3.92 MPa (40 kgf/cm^2), while samples c1p2 and c2p2 do not meet the minimum tensile strength value standard determined by the Japanese Industrial Standard (1975). The results of the elongation of samples c1p2 and c2p2 have met the standard elongation value of edible films according to the Japanese Industrial Standard (1975), where the edible film has a minimum elongation value of 70%, while the sample c1p3 has not met the standard elongation value according to the Japanese Industrial Standard (1975).

The higher amylose content will increase the retrogradation properties of the suspension edible packaging after being heated, causing the high tensile strength of edible packaging. Heating polysaccharides with water will bind and release water to form a compact three-dimensional network to produce a strong gel. The gel consists of macromolecules[33].

The addition of CMC with a higher concentration will also affect the tensile strength because CMC is classified as a polysaccharide which makes edible packaging more compact. Another research on edible packaging from ginger starch states that polysaccharides can function in maintaining cohesiveness in the stability of edible packaging. The more polysaccharide constituents, the greater the tensile strength, so the ability to stretch is greater and resistant to fracture.

[12] state that the percentage of elongation of edible packaging is said to be good if the value is more than 50% and said to be bad if the value is less than 10%.

Glycerol as a plasticizer effectively reduces the internal hydrogen bonds associated with the hydroxyl group on amylopectin. The reduced hydrogen bonds can cause the distance between the molecules to stretch further so that the strength of the film will decrease[30].

The percentage of elongation decreases with the higher the fat component contained in the edible packaging. The decrease and increase in elongation were thought to be influenced by the presence of glycerol. Glycerol acts as a plasticizer so that edible packaging becomes more elastic. Glycerol has a small molecular weight so that it can enter the intermolecular bonds of amylose or even between hydrogen bonds of starch and CMC. Glycerol molecules will interfere with the cohesiveness of starch, reduce intermolecular interactions and increase polymer mobility, resulting in increased elongation. The interaction of glycerol with the starch matrix will affect its elasticity, and it is assumed that an appropriate ratio between glycerol and starch is needed. The presence of plasticizers in the starch film can interrupt the formation of a double helix of amylose with amylopectin branches, thereby reducing the interaction between amylose and amylopectin molecules, thereby increasing the flexibility of the starch film[34].

The hydroxyl groups along the glycerol chain are the cause of the formation of hydrogen bonds between starch polymers and plasticizers that replace hydrogen bonds between starch polymers during the formation of biopolymer films[35]. Glycerol functions effectively as a plasticizer by virtue of its ability to reduce internal hydrogen bonds by increasing the free space between molecules, thereby decreasing stiffness and increasing film flexibility. The empty space between the molecules is filled by a plasticizer so that the presence of a plasticizer will reduce the interaction tension between starch molecules[33].

3.3.6 Analysis of Moisture Content in Instant Chocolate

Analysis of the moisture content of instant chocolate was carried out to determine the moisture content of the chocolate after it was put into edible packaging.

The water content in food ingredients also determines the durability of the material. To extend the durability of the material, some of the water in the material must be removed in a way that is suitable for the type of material such as drying. Materials with high water content usually decompose faster than materials with low water content due to the activity of microorganisms.

Tab. 9 Analysis of moisture content in instant chocolate

No.	Sample	Water Content without Edible Packaging, 0 hours	Water Content without Edible Packaging, 24 hours	Moisture Content with Edible Packaging, 24 hours
1	c1g2	3,5%	8%	6%
2	c1g3	3,5%	8%	6%
3	c2g2	3,5%	8%	5%

3.3.7 Total Plate Count (TPC) Analysis

The microbiological analysis carried out in this study was an analysis of the total number of bacteria (TPC) that included TPC in instant chocolate edible packaging stored at room temperature. Analysis of instant chocolate edible packaging determined the number of bacterial colonies in instant chocolate edible packaging and the effect of edible packaging on instant chocolate to increase the number of bacterial colonies during storage.

The following are the results of the total plate count (TPC) analysis on instant chocolate edible packaging (Tab. 10).

Tab. 10 TPC analysis

No.	Sample Code	10×10^{-1}	10×10^{-2}	10×10^{-3}	Σ Colony/g
1.	Days to-1 25°C	8	0	0	8×10^{-1}
2.	Days to-2 25°C	9	0	0	9×10^{-1}
3.	Days to-3 25°C	10	0	0	10×10^{-1}
4	Days to-4 25°C	11	0	0	11×10^{-1}
5	Days to-5 25°C	11	0	0	11×10^{-1}
6	Days to-6 25°C	12	0	0	12×10^{-1}
7.	Days to-7 25°C	13	0	0	13×10^{-1}

Tab. 10 states the number of colonies or the results of bacteriological tests using room temperature of 25°C on the 1st day: the total number of colonies is 8×10^{-1}; then, on the 2nd day, it is 9×10^{-1}, on the 3rd day - 10×10^{-1}, on the 4th day - 11×10^{-1}, on the 5th day - 11×10^{-1}, on the 6th day - 12×10^{-1}, and on the last day - -7 by 13×10^{-1}.

According to the standard SNI 7388:2009, Minister of Health No. 416/MENKES/PER/IX/1990, and BPOM Regulation No. HK.00.061.S2.4011, if the results of the bacteriological test show 1 x 101 – 1 x 104 cfu/ml (< 105 cfu/ml), the product is Grade A or B; if the results of the bacterial test show at > 106 cfu/ml, they indicate Grade C, where Grade A is good, Grade B is border line, and Grade C is rejected.

4 Conclusion

In the study, the results of the test of the water content of mung bean starch were 5.5%, the starch content of mung bean starch was 87.59% and the plasticizer glycerol had the largest percent elongation value of 470%, the tensile strength value was 1.46755 MPa, and dissolving speed of 0.0139 g/second so that the use of glycerol plasticizer was chosen as a plasticizer for treatment in the main study. The selected treatments from the main study were c1p2 treatment with 1% CMC concentration and 2% glycerol concentration, c1p3 with 1% CMC concentration and 3% glycerol concentration and c2p2 with 2% CMC concentration and 2% glycerol concentration. The selected sample c1p2 has a tensile strength of 2.48193 MPa, a percent elongation of 70%; c1p3 has a tensile strength value of 3.94362 MPa, a percent elongation of 37%; c2p2 has a tensile strength value of 1.093815 MPa, a percent elongation of 106%. In the TPC (total plate count) analysis test with the selected sample, the bacteriological test using room temperature of 25°C showed the total number of colonies 8 x 10^{-1} on the 1st day; on the 2nd day, it was 9 x 10^{-1}, on the 3rd day - 10 x 10^{-1}, on the 4th day - 11 x 10^{-1}, on the 5th day - 11 x 10^{-1}, on the 6th day - 12 x 10^{-1}, and on the last day - -7 by 13 x 10^{-1}.

5 Suggestions and Future Research

1. It is better to do a better mung bean starch extraction process to obtain a high yield;
2. It is advisable to test gas transmission such as 0_2 and CO_2 to determine the resistance of edible packaging from gas transmission and analyze its permeability;
3. It is advisable to conduct antioxidant analysis because to observe the shelf life and growth of bacteria, TPC analysis alone is not enough;
4. It is better to add materials that are easily soluble in water to improve the speed of dissolving edible packaging;
5. It is necessary to further study the durability or shelf life of the packaged product;
6. It is better if the mixing process using a magnetic stirrer is longer due to the lack of homogeneity during the process of making edibles.

References

参 考 文 献

[1] THE ASSOCIATION OF EUROPEAN AIRLINES. Hygiene guidelines. Brussels, 2006.
[2] ANONIM. Prospek Pengembangan Agribisnis Kacang Hijau. Jakarta: Direktorat Budidaya Aneka Kacang dan Umbi, 2013.
[3] ARPAH. Edible packaging. Bogor, 1997.
[4] AMERICAN SOCIETY FOR TESTING AND MATERIALS. ASTM D638-94: Standard test method for tensile properties of plastics. Philadelphia, 1980.
[5] BANKER G S. Film coating theory and practice. Journal of Pharmaceutical Sciences, 1996, 15, 30–38.
[6] BELITZ H D, GROSCH W. Food chemistry. Berlin, Heldenberg, New York: Springer Verlag, 1987.
[7] CHO S Y, RHEE C. Mechanical properties and water vapor permeability of edible films made from fractionated soy proteins with ultrafiltration. LWT - Food Science and Technology, 2004, 37(8), 833–839.
[8] DAS M, CHOWDHURY T. Heat sealing property of starch based self-supporting edible films. Food Packaging and Shelf Life, 2016, 9, 64–68.
[9] DAMAT. Efek Jenis dan Konsentrasi Plasticizer Terhadap Karakteristik Edible Film Dari Pati Garut Butirat. Agritek, 2008, 16(3), 333–339.
[10] DEVIWINGS. *CMC,* 2008. http://deviwings.blogspot.com/2008/03/cmc.html
[11] FARDIAZ S. Mikrobiologi Pangan I. Jakarta: Gramedia Pustaka Utama, 1986.
[12] GASPERZ V. Teknik Analisis dalam Penelitian Percobaan. Bandung: Tarsito, 1995.
[13] GONTARD N, GUILBERT S, CUQ J. Water and glycerol as plasticizers affect mechanical and water vapor barrier properties of an edible wheat gluten film. Journal of Food Science, 1993, 58(1), 206–211.
[14] HART S. Kimia Organik Edisi Ke Enam. Jakarta: Erlangga, 1983.
[15] HERBERT. Teori dan Praktek Farmasi Indonesia, Volume II. 3rd ed. Jakarta: UI Press, 1994.
[16] HURI D, NISA F C. Pengaruh Konsentrasi Gliserol dan Ekstrak Ampas Kulit Apel Terhadap

Karakteristik Fisik dan Kimia Edible Film. Jurnal Pangan dan Agroindustri, 2014, 2(4), 29–40.
[17] INDRIYATI, INDRARTI L, RAHIMI E. Pengaruh Carboxymethyl Cellulose (CMC) dan Gliserol Terhadap Sifat Mekanik Lapisan Tipis Komposit Bakterial Selulosa. Jurnal Sains Materi Indonesia, 2006, 8, 40–44.
[18] LAGA J. Karakterisasi Fisiko-Kimia Biji dan Pati Kacang Hijau (Phaseolus radiatus L.) Asal Kabupaten Kebumen Jawa Tengah Serta Aplikasinya Pada Produk Sohun. Skripsi. Yogyakarta: UGM, 2017.
[19] JULIANTI E, NURMINAH M. Teknologi Pengemasan. Departemen Teknologi Pertanian Fakultas Pertanian, Universitas Sumatera Utara, 2006.
[20] MARTANINGTYAS D. *Potensi Plastik Biodegradable*, 2004. http://www.pikiranrakyat.com/cetak/0904/02/cakrawala/lainnya06.htm
[21] MUCHTADI D. Petunjuk Laboratorium Evaluasi Nilai Gizi Pangan. Departemen Pendidikan dan Kebudayaan Direktorat Jendral Pendidikan Tinggi. Pusat Antara Universitas Pangan dan Gizi. Bogor: Institut Pertanian Bogor, 1989.
[22] MUCHTADI D. Karbohidrat Pangan dan Kesehatan. Bandung: Alfabeta, 2011.
[23] NASUTION M E U, HASNELLY, INA S N. Pemanfaatan Whey Susu Menjadi Edible Film Sebagai Kemasan Dengan Pengaruh Penambahan CMC, Gelatin dan Plasticizer. Skripsi. Bandung: Fakultas Teknik, Universitas Pasundan, 2014.
[24] PURWONO M S, HARTONO R. Kacang Hijau. Jakarta: Penebar Swadaya, 2012.
[25] TRIWITONO P, MARSONO Y, MURDIATI A, et al. Isolasi dan Karakterisasi Sifat Pati Kacang Hijau (Vigna radiata L.) Beberapa Varietas Lokal Indonesia. Jurnal Agritech, 2017, 37(2), 192–198.
[26] WINARNO F G. Kimia Pangan dan Gizi. Jakarta: Gramedia Pustaka Utama, 2004.
[27] YUSRA Z D. Pengaruh Konsentrasi CMC (Carboxyl Methyl Cellulose) Terhadap Karakteristik Biosellulosa Berbasis Edible Film. Skripsi. Bandung: Universitas Pasundan, 2019.
[28] ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS. Official methods of analysis: official method for protein. Method No. 920.87. Washington, District of Columbia, 1995.
[29] NAIM R, RAHBARI-SISAKHT M, ISMAIL A F. Membrane contactor for carbon dioxide absorption and stripping. In: HILAL N, ISMAIL A F, WRIGHT C J. (eds.) Membrane fabrication: principles, optimization and applications. 1st ed. CRC Press, 2014: 285–314.
[30] MCHUGH T H, AUJARD J-F, KROCHTA J M. Plasticized whey protein edible films: water vapor permeability properties. Journal of Food Science, 1994, 59(2), 416–419.
[31] SANDERSON M. Word sense disambiguation and information retrieval. In: CROFT B W, VAN RIJSBERGEN C J. (eds.) SIGIR '94. London: Springer, 1994: 142–151.
[32] SOEKARTO S T. Penilaian Organoleptik. Jakarta: Bhatara Karya Aksara, 1985.
[33] KROCHTA J, BALDWIN E, NISPEROS-CARRIEDO M. (eds.) Edible coatings and films to improve food quality. Basel: Technomic Publ. Co., 1994.
[34] ZHANG Y, HAN J H. Plasticization of pea starch films with monosaccharides and polyols. Journal of Food Science, 2006, 71(6), E253–E261.
[35] BOURTOOM T. Effect of some process parameters on the properties of edible movie prepared from starch. Songkhala: Department of Material Product Technology, 2007.

[1] 欧洲航空公司协会。卫生准则。布鲁塞尔，2006年。
[2] 阿诺尼姆。绿豆农商发展前景。雅加达：各种坚果和球茎植物种植局，2013年。
[3] 阿帕赫。食用包装。茂物，1997年。
[4] 美国测试与材料学会。ASTM丁638-94：塑料拉伸性能的标准测试方法。费城，1980年。
[5] BANKER G S. 薄膜包衣理论与实践。药学杂志，1996，15，30-38。
[6] BELITZ H D, GROSCH W. 食品化学。柏林、海尔登贝格、纽约：施普林格出版社，1987年。
[7] CHO S Y, RHEE C. 超滤分离大豆蛋白制成的可食用薄膜的机械性能和水蒸气渗透性。长波-食品科学与技术, 2004, 37(8), 833–839。
[8] DAS M, CHOWDHURY T. 淀粉基自支撑可食用薄膜的热封性能。食品包装和保质期，2016年，9，64–68。
[9] 达马特。类型和浓度效应增塑剂反对特征食用薄膜来自淀粉嘎律丁酸盐。农业科技， 2008, 16(3), 333–339。
[10] 飞翼。中央军委，2008年。http://deviwings.blogspot.com/2008/03/cmc.html
[11] FARDIAZ S. 食品微生物学 I. 雅加达：主图书馆格拉梅迪亚，1986。

[12] GASPERZ V. 试验研究中的分析技术。万隆：塔西托，1995年。

[13] GONTARD N, GUILBERT S, CUQ J. 水和甘油作为增塑剂影响可食用小麦面筋膜的机械和水蒸气阻隔性能。食品科学杂志，1993年，58(1)，206-211。

[14] HART S. 有机化学第六版。雅加达：埃尔兰加出版社，1983年。

[15] 赫伯特。印尼药学理论与实践，第二卷。第三版。雅加达：用户界面出版社，1994年。

[16] HURI D, NISA F C. 甘油浓度和苹果皮果肉提取物对可食膜理化特性的影响。农业工业杂志, 2014, 2(4), 29–40.

[17] INDRIYATI、INDRARTI L、RAHIMI E. 彭加鲁羧甲基纤维素(CMC)和甘油对纤维素细菌复合薄膜力学性能的影响。印度尼西亚材料科学杂志, 2006, 8, 40–44.

[18] LAGA J. 中爪哇客布门摄政绿豆种子和淀粉（绿豆.）的理化特性及其在粉丝产品中的应用。斯克里皮斯。日惹：UGM，2017年。

[19] JULIANTI E, NURMINAH M. 工艺技术。北苏门答腊大学农学院农业技术系，2006年。

[20] MARTANINGTYAS D. 波坦西塑料可生物降解，2004。http://www.pikiranrakyat.com/cetak/0904/02/cakrawala/lainnya06.htm

[21] MUCHTADI D. 食品营养价值评价实验室指导书。政府部门。食品与营养大学中级中心。茂物：茂物研究所，1989。

[22] MUCHTADI D. 食物碳水化合物与健康。万隆：阿尔法贝塔，2011年。

[23] NASUTION M E U、HASNELLY、INA S N. 乳清蛋白的利用食用薄膜作为添加CMC效果的包装、明胶和增塑剂。斯克里普西。万隆：巴顺丹大学工程学院，2014年。

[24] PURWONO M S，HARTONO R. 绿豆。雅加达：佩尼巴·斯瓦达亚，2012年。

[25] TRIWITONO P, MARSONO Y, MURDIATI A, 等人。几个印度尼西亚地方品种绿豆(绿豆.)淀粉特性的分离和表征。农业技术杂志, 2017, 37(2), 192–198.

[26] WINARNO F G. 基米亚潘根和吉孜。雅加达：主图书馆格拉梅迪亚，2004年。

[27] YUSRA Z D. CMC浓度的影响（羧甲基纤维素）对基于生物纤维素的特性可食用薄膜。斯克里普西。万隆：巴顺丹大学，2019年。

[28] 官方分析化学家协会。官方分析方法：蛋白质的官方方法。方法编号920.87。哥伦比亚特区华盛顿，1995年。

[29] NAIM R、RAHBARI-SISAKHT M、ISMAIL A F. 用于二氧化碳吸收和汽提的膜接触器。在：HILAL N、ISMAIL A F、WRIGHT C J.（编辑）膜制造：原理、优化和应用。第一版。钢筋混凝土出版社，2014：285-314。

[30] MCHUGH T H, AUJARD J-F, KROCHTA J M. 塑化乳清蛋白可食用薄膜：水蒸气渗透性能。食品科学杂志，1994，59（2），416-419。

[31] SANDERSON M. 词义消歧和信息检索。在：CROFT B W，VAN RIJSBERGEN C J.（编辑）信号'94。伦敦：斯普林格，1994：142-151。

[32] SOEKARTO S T. 佩尼莱感官。雅加达：巴塔拉卡亚阿克萨拉，1985年。

[33] KROCHTA J、BALDWIN E、NISPEROS-CARRIEDO M.（编辑）提高食品质量的可食用涂层和薄膜。巴塞尔：技术刊物。有限公司，1994年。

[34] ZHANG Y, HAN J H. 单糖和多元醇对豌豆淀粉膜的增塑作用。食品科学杂志，2006年，71(6)，乙253–乙261。

[35] BOURTOOM T. 一些工艺参数对淀粉制备的可食用薄膜特性的影响。宋卡拉：材料产品技术部，2007。

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