International Journal on Advanced Science Engineering Information Technology

Vol.6 (2016) No. 2
ISSN: 2088-5334

The Properties of *Zingiberaceae* Starch Films for *Galamai* Packaging

Wenny Surya Murtius and Purnama Dini Hari

[#] *Department of Agriculture Technology Product, Faculty Agriculture Technology, Andalas University, Indonesia*
E-mail: wenny.murtius@gmail.com

***Abstract*— This research was aimed to determine the characters of edible film from *Zingiberaceae* starch for *galamai* packaging. This research design was Complete Randomized Design with 4 treatments (temulawak starch, turmeric starch, red ginger starch and white ginger starch) and 3 replications. A better film characteristic for *galamai* packaging was obtained from temulawak compared to other treatments. Its film properties were: thickness of 0.30 mm, water content of 13.07%, water activity 0.587, water evaporation 0.43 g/m^2.h, and antimicrobial activity against microorganisms on *galamai* of 2.4 mm (clear zone), and perfectly spread film under microscopic observation.**

***Keywords*— starch film; *Zingiberaceae*; packaging; *galamai*.**

I. Introduction

Galamai is a traditional food of West Sumatera, Indonesia. It is made of rice flour, palm sugar, and coconut milk. The materials are mixed and cooked on a high temperature until the dark brown dough are formed. *Galamai* has a sweet taste with chewy texture, suitable to present as a snack. Due to its ingredients, *galamai* is prone to deterioration. Thus, it has a short shelf life, despite of plastic packaging. A degraded *galamai* has a characteristic of unpleasant smell and white powder-like surface. A peculiar taste of *galamai* and its limited shelf life create a specific challenge in innovative packaging such as antimicrobial edible films and edible coatings.

Most microorganisms on *galamai* were gram negative bacteria, and fungi. Its succession respectively; bacteria grew up first followed by fungi [1]. Common microorganisms contaminated the type of food with a high fat content. Antimicrobial edible films and coatings has been suggested as an innovative approach that is used to extend the shelf life of the products are ready to eat during storage, in order to avoid undesirable microorganisms [2].

Edible films serve as a barrier to prevent water loss and change in color or flavor in food products, by cutting off access to the atmospheric oxygen. So it can be used to improve the quality of fresh and processed food products. Besides, edible films are also used to extend their shelf life, by inhibiting the growth of microorganisms selected [3]. Edible films and coatings enhance the quality of food products, by giving protection from physical, chemical, and biological deterioration [4].

The main film materials are biopolymers, such as proteins, polysaccharides, lipids and the combinations. As a general rule, fat are used to reduce water transmission; polysaccharides are used to control oxygen and other gas transmission; while protein provides mechanical stability [5]. Polysaccharide film are made of materials such as starch, non-starch, carbohydrates, gums and fibers [2].

Zingiberaceae family; such as ginger, temulawak, ginger and turmeric place its energy storage in its rhizome. As in tuber, it is also contains starch. Starch is the main polysaccharide energy storage material in the plant kingdom [6]. It is mixture of two polymers, amylosa and amylopectin. Amylose has a predominant linear nature, so it is closely associated with the ability to form a film. A film can be made of any type of starch, since it contains amylose. Amylose fractions have also been used to make the film. Starch content of *zingiberaceae* (temulawak, turmeric, white ginger and red ginger), respectively; 41.45% [7], 40-50% [8], 44.25% and 52.9% [9]. It showed the potential to be used as raw material in the manufacture of edible film [10].

Antimicrobial films for packaging is able to act as a coating and also able to deter and suppress the growth of microorganisms. Some natural anti-microbial compounds that are easily found are a group of essential oils, flavonoids, oleoresin and its derivatives such as phenol, curcuminoid, alkaloids, terpenoids, tannins, flavanoids and so on [11]. Several specific compounds derived from it were *Zingeberon* in ginger, *Xanthorizol* in temulawak, and *Curcuminoid* in turmeric. Temulawak, ginger and turmeric, can used as raw material for medicine and food preservatives [10]. Reported an increasing addition of ginger essensial oil into uwi starch film, zone inhibition also increased towards gram negative bacteria (*Escherichia coli*) [12]. Therefore, this research was aimed to determine the characters of edible films from *Zingiberaceae* starch for *galamai* packaging.

II. Materials and Methods

A. Materials

The *Zingiberaceae* (temulawak, turmeric, red ginger and white ginger) starch and cassava starch derived from juice extraction and 2 hours precipitation, respectively. Other materials were glycerol and water distillate.

B. Edible Film Preparation

Film was prepared from *Zingiberaceae* (temulawak, ginger, turmeric, red ginger and white ginger) and cassava starch (control). 8 % (g/v) of starch was mixed with 150 ml of water distillate. Then, it was heated and homogenized (70-85^{0}C, 20 minute). 4 % of glycerol was added subsequently. The mixture was poured to a glass plate for printing prior dried in 50^{0}C for 20 hours. [13]

C. Microbial Isolation

The microorganism were isolated from contaminated *galamai* and transferred to Potato Dextrose Agar (PDA). Potato Dextrose Broth (PDB) was used as a growth medium for antimicrobial activity test.

D. Analysis

1) Moisture Content (Gravimetric). Approximately 2 gram of samples on the porcelain cups were dried on an oven with the temperature of 100-105^{o}C until a constant weight was reached. Subsequently it was stabilized in desiccator. Water content was calculated on wet basis. [14]

2) Thickness. Samples were measured with a micrometer (vernier caliper 0-150 mm x 0.05, Shanghai-China) at five different area. An average value was calculated in mm.

3) Water Vapor Transmission. Edible films were cut 5 cm in diameter and placed between two containers (beverage cups). A first container filled with water and a second container containing silica gel with a known weight. It then allowed to stand for an hour and water vapor transmission was measured.

4) Water Activity (Aw). Water activity of samples was analyzed with Novasina Labmaster AW. 5 gram of edible film was placed in a sample container. Wait until the tool read the value of existing Aw.

5) *Microscopic Observation of the Film Surface.* Edible films were cut to the required size and placed on glass object then observed by microscope with 40 x magnification.

6) Antimicrobial Activity. A 6 mm in diameter of film sample was dried and placed on the surface of the previously inoculated PDA plates. Plates were incubated for 24 h at 30 ^{0}C prior examination. Growth zone width indicated by halos around (clear zone) the disk was measured. [15]

7) *Experimental Design.* Complete Random Design (CRD) was used with 3 replications. The treatment were A = Cassava starch (control), B = Temulawak starch C = Turmeric starch, D = Red ginger starch and E = White ginger starch.

III. Result and Discussion

Edible film is defined as a material used for wrapping various food to extend shelf life of product that may be eaten together with food or without further removal [5]. Moreover, the objective of packaging is to protect food from physical, chemical and microbiological deterioration. Thus, several characteristics had been chosen as the critical factor to indicate the ability of film to prolong the shelf life of product. The characters of edible films were shown on table 1.

TABLE I
Several Characteristics Of Edible Film Product

Starch	Thickness (mm)	Water Content (%)	Aw	Water Vapor Transmission (g/m^2.h)	Clear zone (mm)
Cassava	0.36	12.35	0.58	0.22	0
Temulawak	0.30	13.67	0.58	0.43	2.40
Turmeric	0.22	23.87	0.71	0.81	1.78
Red ginger	0.25	22.52	0.63	0.60	1.92
White ginger	0.16	18.67	0.66	0.79	1.58

A. Thickness

Edible films act as coating and or fortification of natural layers to prevent moisture losses, while selectively allowing for controlled exchange of important gases (oxygen, carbon dioxide), in respiration processes. A film can also provide surface sterility and prevent loss of important component [5]. Edible film protect packaged food products from physical damage (including; physical impact, pressure, vibrations), and mechanical factors [4]. Standardized examinations of commercial film structures are also applied to evaluate the structural strength of edible films. Such tests may include thickness. The samples thickness was ranged from 0.16 to 0.30 mm, while edible film from cassava starch thickness was 0.36 mm (control). Classified that edible films thickness is less than 0.3 mm in general [5]. Based on the criteria of thickness, edible film from *Zingiberaceae* starch had met the requirement, while there were significant differences between each treatment, as shown on Figure 1.

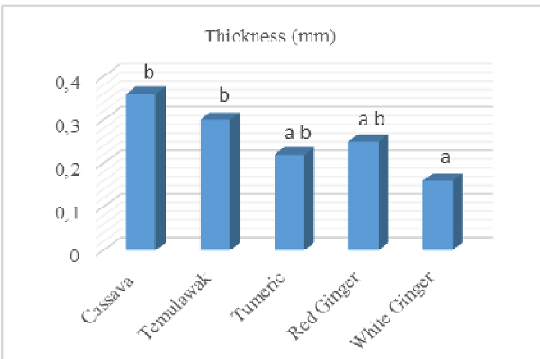

Fig 1. Edible Film thickness

B. Moisture Content

The water content is very prominent in determining the shelf life of food. High moisture had linked to a high microorganism activity. Drying is one of the methods to minimize the moisture content and extend the shelf life of food. Moisture content of edible film also has the influence to the product that is wrapped by it.

Water content can be distinguished to free water and bound water contained in the material woven network. The drying process begins with the evaporation of free water that requires less energy because the process occurs more quickly and easily. If all free water is drained, the moisture content of the material usually reaches 12 to 25% [16].

The decrease of water content will increase the total solid. Starch is the main contributor to the total solid in edible films. With substantial amount of hydroxyl bond, starch is able to bind water on its matrix [1]. Hydrogen bonds play the most significant role in films formation and characterization due to large numbers of hydroxyl groups and or other hydrophilic bond on neutral carbohydrate structure [4].

The result had shown a significant difference of moisture content on every treatment. Thus, not every treatment was suitable as a packaging. Edible film from turmeric, red ginger and white ginger starch had high moisture but low total solid. Therefore, the edible films were not formed well and rent easily. The water content of treatments could be seen on Figure 2.

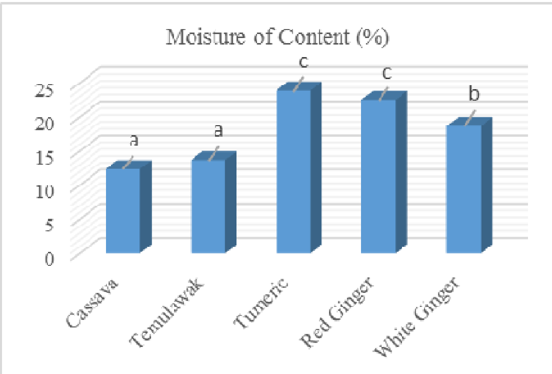

Fig 2. Moisture of Content Edible Film

C. Water activity (Aw)

Aw of treatments ranged from 0.58 to 0.71. Water activity (Aw) is amount of water on food product that can be used by microorganism for its growth. Bacterium is able to grow optimally at Aw of 0.90-0.97, while yeast at Aw of 0.87-0.91, and mold at Aw 0.80-0.91 [1]. Aw of samples were belou the optimum level for microorganism.

Food shelf life is affected by moisture content. While moisture content of the environment is involved in the change of moisture content of food. Food packaging has the main influence to food. Packaging with low Aw is able to shield *galamai* from deterioration caused by microorganism. Hence *galamai* is possible to store longer. Aw value of treatments were significantly different (α = 5 %). The difference was affected by moisture content of starch and drying films. Mechanical character of food is influenced by its drying process [17]. The amount of water evaporated is affected by the period of drying, albeit not all water in food is vaporized. Subsequently, Aw will decrease. Aw difference is between products are illustrated on figure 3.

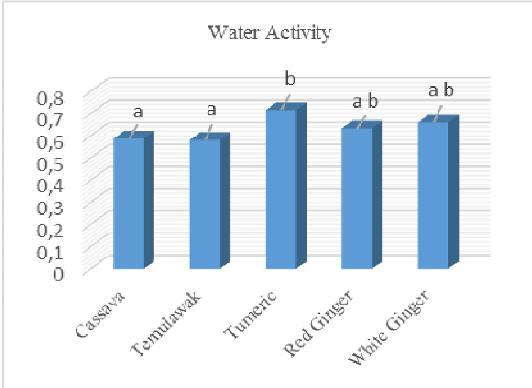

Fig 3. Aw of edible films

D. Water Vapor Transmission

One of the main functions of edible film are to reduce water vapor migration and to decrease water vapor permeability as low as possible [1]. Value of the water vapor transmission rate can be used to determine the shelf life of the product. If the water vapor transmission rate can be retained, then the product shelf life can be extended [18]. The water vapor migration is relativelly lower, which is the better properties of edible film to maintain the shelf life of product.

Water vapor transmission is a vital character of edible films. The quality of edible film is affected by basic material, temperature and period of drying [17]. Starch from rhizomes had a diverse temperature of gelatinization. Thus, there were differences in time and temperature of drying for production of edible films. Moreover, it was the cause in water vapor transmission difference of treatments as could be seen in figure 4.

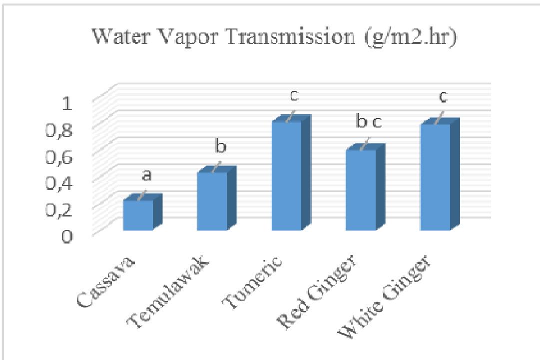

Fig 4. Water Vapor Transmission of Edible Films

E. Antimicrobial Activity

Method used to evaluate the effectiveness of food related antimicrobials was agar diffusion. The agar diffusion method has probably been the most widely used method for determination activity throughout history. In this test, antimicrobial compound was added to an agar plate on a paper disk or in a well. Compound diffused through the agar, resulting in a concentration gradient that was inversely proportional to the distance from the disk or well [19]. The degree of inhibition, which is indicated by a clear zone around the disk or well, are depend on the rate of diffusion of the compound and cell growth. Therefore, the antimicrobial evaluated should not be highly hydrophobic because the compound will not diffuse and low or no inhibition will be detected.

Antimicrobial activities of treatments were 1.58 to 2.4 mm (Fig. 5). These antimicrobial activities were relatively low. Microorganisms are termed susceptible when the zone is > 30 to 35 mm in diameter, intermediate with a zone of 20 to 30 mm, or resistant with a zone of < 15 to 20 mm [15]. A low antimicrobial activity was affected by a low concentration of antimicrobial substances of starch derived from the rhizome of *Zingiberaceae*. It was also due to extraction process.

Antimicrobial activity of treatments were significantly different since the variety in antimicrobial substances in rhizome starch. Furthermore, antimicrobial capability of various antimicrobial substances was also diverse. Antimicrobial substances lost during heating and drying were also corresponded to the low antimicrobial activity in edible films.

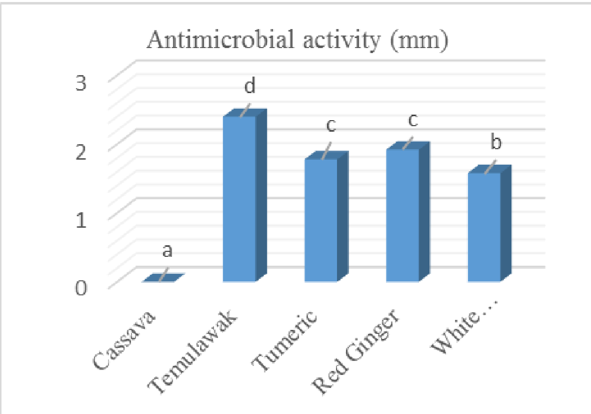

Fig. 5. Clear Zone of Edible Films

F. *Microscopic Observation*

The surface contour is an important parameter which is correlated with moisture content, water vapor and oxygen transmission. Those parameters contribute to rapid food deterioration. Thus, it is important to be a parameter for choosing edible films as a packaging.

The surface of edible films from *Zingiberaceae* was described as perfectly spread or not perfectly spread under microscopic observation. A perfectly spread surface means its support in reducing water vapor and oxygen transmission as a fine packaging. The exterior of edible films were corresponded to its moisture content.

Moisture content was influenced by temperature and period of drying. The longer period of drying and the higher the temperature used, the moisture content of edible film will decrease. An edible film with low moisture content had a compact pores and perfectly spread surface. Besides, glycerol addition also contributed to edible film surface formation. A long period of drying and glycerol addition will lower internal hydrogen bonds and generated a film with a compact pores, subsequently [15]. Moreover, water vapor and oxygen transmission will be decelerated. Microscopic observations were shown in figure 6.

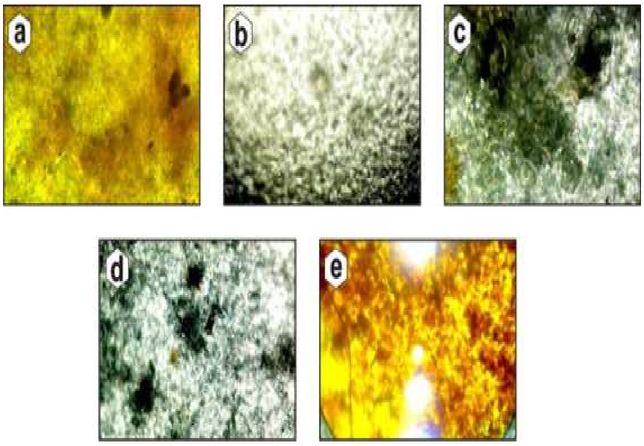

Fig. 6. Microscopic observations of films. a). Temulawak starch films, b). Cassava starch films, c). White ginger starch films, d). Red ginger starch films and e). Turmeric starch films

IV. Conclusions

The use of starch from the rhizomes of *Zingiberaceae* family were statistically shown significant difference in thickness, moisture content, Aw, water vapor transmission and antimicrobial activity. The best treatment was film made of starch from temulawak. The characteristics of the film were: thickness of 0.30 mm, moisture content of 13.07%, water activity of 0.587, water vapor transmission of 0.43 g/m^2.h, antimicrobial activity towards microorganism on *galamai* of 2.4 mm and description of microscopic observation of the film surface as perfectly spread.

Acknowledgment

The author expressed a great acknowledge for financial support from Hibah Bersaing National Competitive from Directorate General of Higher Education Republic of Indonesia.

References

[1] Murtius, W. S., I. D. Rahmi and Neswati. 2015. Antimicrobial Activity of Jackfruit's Straws Films Which has been enriched by Temulawak (Curcuma Xanthorrhizza, ROXB.) toward Microorganism on Galamai. GSTF Journal of BioSciences (JBio) Vol.3 No.2, August 2015.

[2] Lee, H., S.C, Min. 2013. Antimicrobial Edible Defatted Soybean Meal-Based Films Incorporating the Lactoperoxidase System. LWT-Food Science and Technology 54 (42-50)

[3] Aldana, D. S., Sergio, A.O., Cristobal, N. A., Juan, C. C.E., Guadalupe, V. N. M. 2015. Antibacterial Activity of Pectic-Based Edible Films Incorporated with Mwxican Lime Essential Oil. Elsevier Ltd. Food Control 50. 907-912

[4] Han, J.H. 2014. Edible Films and Coatings: A Review. Pepsico Inc. Plano, Texas, USA.

[5] Attila, P. E and W. Orts. 2009. Edible Film and Coatings: Why, What and How? Springer Dordrecht Heidelberg London New York.

[6] Kramer, M.E. 2009. Structure and Function of Starch Based Edible Films and Coatings. Springer Dordrecht Heidelberg London New York.

[7] Hayani, E. 2006. Analysis of the Chemical Constituents of Ginger Rhizome. Research Institute for Spices and Medicinal Plants. Technical Meeting of the National Power Functional Agriculture. Bogor. (Text in Indonesia)

[8] Atmaja, D.A. 2008. Effect of Extract Turmeric (Curcuma domestica) Microscopic Description Againts Gastric Mucosal Mice Balb the Given Paracetamol. Medicine Faculty. Diponegoro University. (Text in Indonesia)

[9] Winarti.C dan Hernani. 2012. Active Ingredients Ginger and Utilization in the Health Sector. Indonesian Center for Agricultural Postharvest Research and Development. Bogor (Text in Indonesia)

[10] Murtius, W.S and Hari, P.D. 2015. Potential Starch Zingiberaceae as Raw Material Films as Galamai Packaging. Proceding National Seminar. Politeknik Pertanian Payakumbuh.

[11] Sylvester, W.S., Son, R., Lew, K.F and Rukayadi, Y. 2015. Antimicrobial Activity of Java Turmeric (Curcuma xanthorriza, Roxb). Extract against Klebsiella pneumoniae Isolated from Several Vegetables. International Food Research Journal. Vol. 22. No. 5. pp. 1770-1776.

[12] Miksusanti, Herlina and K.I. Masril. 2013. Antimicrobial and Antioxidant of Uwi (Dioscorea alata, L) Starch Edible Film Incorporated with Ginger Essential Oil International Journal of Bioscience, Biochemystry and Bioinformatics. Vol. 3, No. 4.

[13] Mardiana, K. 2008. Utilization of Aloe Vera Gel as Edible Coatings Sweet Fruit Starfruit (Carambola averrhoa, L). Essay. Bogor gricultural Institute. Bogor. (Text in Indonesia)

[14] Sudarmadji, S., B. Haryono, dan Suhardi. 1997. Procedure Analysis of Food and Agriculture. Liberty, Yogyakarta. 172 hal. . (Text in Indonesia)

[15] Davidson, P.M., J.N, Sofos., A.L, Branen. 2013. Antimicrobial in Food. Third Eddition. CRC Press, Boca Raton

[16] Neswati., W.S, Murtius., A. Prastica. 2015. Characteristics of Jackfruit Straw's Edible Film Enriching byGingers Red (Zingiber officinale, Rosc.). Ijaseit. Vol 5 (2015) No. 2

[17] Sudaryati, H.P., Tri, M.S., Egha, R.H. 2010. Physical and Mechanical Properties of Edible Film from Porang (Amorphopallus oncophyllus) Flour and Corboxymethycellulose. J. Teknologi Pertanian. Vol. 11 No. 3 (196-201)

[18] Vigil, A.L.M., E. Palou., M.E. Parish and P.M. Davidson. 2013. Methods for Activity Assay and Evaluation of Results. CRC Press, Boca Raton.

[19] Krochta, J.M., E.A. Baldwin and M. Nisperos-Carriedo. 1994. Edible Coating and Film to Improve Food Quality. Technomic Publishing Co. Inc. Landcaster. Basel