

Characteristics of Jackfruit Straw's Edible Film Enriching by Gingers Red (*Zingiber officinale*, Rosc.)

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Abstract— This research was aimed to determine the effect of the addition red ginger's (*Zingiber officinale*, Rosc.) concentrate toward physicochemical, and sensory evaluation of edible film from jackfruit straw's. Using design is Completely Randomized Designed (CRD) consist of 5 treatments (The addition of red ginger's concentrate 2%, 4%, 6%, 8%, and 10%) and 3 replications. Data was analysed statistically with ANOVA and were continued with Duncan's New Multiple Range Test (DNMRT) at 5% significance level. This research determined the addition of red ginger's concentrate significantly affected toward aw, thickness and water vapor transmission rate, but not significantly affected toward water content. The best edible film were determined based on sensory evaluation on packaging of galamai, showed Treatment B as the best product with panelist preferences at color (3,70), flavor (3,80), taste (3,75), and texture (3,50). For physical and chemical characteristic water content 12,6711%, aw 0,4263, thickness 0,0929 mm, water vapor transmission rate 0,0635 g/m².jam.

Keywords— Edible film; Jackfruit straw's; gingers red

I. INTRODUCTION

Edible films is produced from edible biopolymers and food-grade [1]. The use of edible films as primary packaging can potentially replace conventional packaging materials, partially or totally, which can reduce the overall utilization of synthetic materials [2],[3].

Film-forming biopolymers can be proteins, polysaccharides (carbohydrates and gums), lipids, or a mixture of these [4]. The raw material of the potential of edible film developed is jackfruit straw.

Jackfruit straw is a waste jackfruit having taken flesh and not including the skin and seeds. According [5], 40-50% of waste is jackfruit straw. It contain carbohydrates that consists of glucose, fructose, sucrose, starch, pectin and also contain cellulose which is quite high. Renewable sources for biopolymers include polysaccharides such as pectin, a naturally occurring, hydrophilic polysaccharide found in plant cell walls which has good film forming properties [6].

Using of red ginger can improve the functional properties of jackfruit straw's edible film. Red Ginger contains essential oils (especially gingerol) which function as antimicrobial. Besides antimicrobial properties, EO- or OC-containing edible films may have improved barrier [7], antioxidative, sensory [8],[9], mechanical properties [10].

Applications of edible films containing essential oils (EOs) of red ginger may be affect sensory of *galamai*. Galamai is a traditional food of West Sumatra (derived from Payakumbuh) which is made from glutinous rice flour and coconut milk cooked with sugar dissolved in it. Galamai are packed with edible films containing Essential oil of red ginger will affect sensory properties. This study aims to investigate the characteristics of edible films containing red ginger essential oil and its influence on the sensory properties galamai.

II. MATERIALS AND METHODS

A. Materials

The main raw material used in this study is jackfruit straw and red ginger that has been aged 7-8 months, distilled water, glycerol and CMC, and galamai for packaging applications the use of edible film produced and other chemicals for analysis.

B. Extraction of Red Ginger

Taken ginger rhizome is the part that is still fresh. Cleaned and peeled ginger and wash with distilled water. Red ginger crushed using a juicer and red ginger rhizome extract obtained.

C. Making of Edible Film

Jackfruit straw has destroyed and taken the filtrate 100 ml, then added with 5% glycerol plasticizer and (w/v), stirring evenly, CMC 1% which has been previously dissolved, while continuing to be heated. The mixture is stirred with a magnetic stirrer and heated to 70 ° C with a hotplate. Allow approximately up to a temperature of 45 ° C and then add red ginger rhizome extract (2%, 4%, 6%, 8% and 10%). Printing is done by pouring a solution of the film into the glass plate with a size of 20 cm x 20 cm x 2 mm [11].

The next stage is drying by using an oven at 60°C for 24 hours. Let stand for 10 minutes at room temperature, the film then removed from the glass plate.

D. Application of Edible Film on the Galamai

The film is formed on each treatment is cut to size and made packaging to galamai. Galamai are packed with plastic packaging used as controls. Then galamai already packed with edible films containing red ginger extract and do sensory test.

E. Water Content

Samples 1-2 g dried in an oven at 100 ° C for 3-5 hours, depending on the material [12]. After the sample is inserted in a desiccator and weigh. The water content was calculated by the formula:

$$\text{Water content} = \frac{a-b}{a} \times 100 \% \quad (1)$$

a = Initial weight of the sample;

b = Weight after drying of the sample

F. Water Activity (a_w)

Measurement of water activity carried out by using a_w meter. Edible films are cut into small pieces weighing 1-3 grams and placed in the measuring cup a_w . The recording was made of the value of a_w .

G. Thickness

The resulting of film thickness was measured using a micrometer with an accuracy of 0.001 mm [13]. Measurements were taken at five different places. The measurement results were averaged as a result of the film thickness and expressed in mm.

H. Water Vapor Transmission Rate

Edible films cut 5 cm in diameter and placed between two containers (glass beverage) [14]. The first container filled water and the second container filled which known its weight. Then allowed to stand for 1 hour and water vapor transmission is calculated by the formula:

$$\text{Water Vapor Transmission Rate} = \frac{W}{A} \quad (2)$$

W = weight change;

A = area of the film (m²)

I. Sensory Evaluation

The sensory quality of *galamai* sample was evaluated by a 20 member panel from the laboratory [15]. The *galamai*

samples of the different treatments were individually presented in covered small porcelain dishes to each panelist. The samples were blind-coded with 3-digit random numbers. Panel scored for sensory characteristics, such as color, odor, taste and texture using a five point hedonic scale (1 = dislike (DL), 2 = less like (LL), 3 = regular (R), 4 = like (L), 5 = very like (VL)).

J. Statistical Analysis

The design used in this study is completely randomized design with five treatments and three replications. If the result shows a difference due to the treatment, then Followed by test Dunncan's New Multiple Range Test (DNMRT) at the 5% significance level.

III. RESULT AND DISCUSSION

A. Water Content

The water content is very influential in determining the shelf life of food products. Results of analysis of variance showed that the addition of red ginger extract is no significant on the moisture content of edible film of jackfruit straw. Moisture content of edible film can be seen in Figure 1.

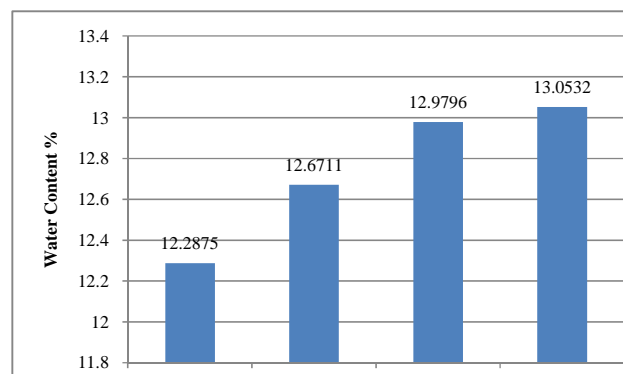


Fig 1. Water content of edible film of jackfruit straw with addition red ginger extract (*Zingiber officinale*, Rosc.)

Water content can be distinguished on the 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 the free water is drained, the moisture content of the material reaches 12 to 25% [16]. Subsequent drying process is the evaporation of water bound which require greater energy. If the bound water is removed entirely, then the moisture content of the material will range from 3 to 7% and optimum stability will be achieved [17].

B. Water Activity (a_w)

Water activity (a_w) was very influential in determining the shelf life of food products. Results of analysis of variance showed that the addition of red ginger extract significantly different with a water activity (a_w) jackfruit straw's edible film. Results DNMRT test (Duncan's New Multiple Range Test) can be seen in Figure 2.

Increasing the concentration of red ginger extract showed significant difference at 5% level. This is caused by the increasing number of additions of red ginger extract, then the free water content in the sample increased so that the value

of a_w is also increasing. [18] stated moisture content and a_w relationship shown by the tendency that the higher the water content the higher the value of a_w , where water levels are expressed in percent (%) in the 0-100 scale, while the a_w value expressed in decimal number in the range 0-1.0 scale.

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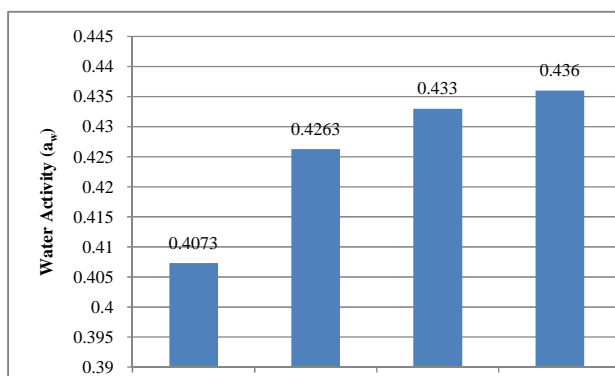


Fig 2. Water activity of edible film of jackfruit straw with addition red ginger extract (Zingiber officinale, Rosc.)

Water activity (a_w) is the amount of water available in groceries that determine the processes of decay of food. Test the water activity (a_w) is intended to calculate the amount of free water in the sample edible film. The term used to describe the water activity of water that is not bound or free in a system that can support biological and chemical reactions. Various microorganisms have a minimum a_w for growth, such as bacteria a_w 0.90, 0.80-0.90 a_w of yeasts, and molds a_w of 0.60-0.70 [19].

According to [19] that the value (a_w) from 0.20 to 0.50 is the range of values (a_w) which microorganisms can not grow in fertile. The value of water activity (a_w) was measured to determine the possibility of product contamination by microbial growth. Based on the value obtained, it can be concluded that the edible film safe from microbial growth.

Requirements for the a_w value of edible film yet, but when compared with studies [20] states that the tapioca starch's edible films have a_w value of 0.456. So also with the research [21] a_w value of edible film surimi eel with tapioca is 0:27 to 0:41. This result is not much different from the a_w value 0.4073-0.4373.

C. Thickness

Thickness is an important parameter that affects the use of films on the products. The thickness of the edible film to be adapted to the product [22]. Results of analysis of variance showed that the addition of red ginger extract significantly different with edible film thickness jackfruit straw. Results DNMRT test (Duncan's New Multiple Range Test) can be seen in Figure 3.

Based on Figure 3 noted that edible film thickness ranged between 0.0929-0.1219 mm. The value of the film thickness meets the standards of JIS 1975, ie a maximum of 0.25 mm. Increasing the concentration of red ginger extract showed significant difference at 5% level. The more the addition of red ginger extract on edible film, the thickness will also be higher. This is because red ginger juice still contain dissolved solids, such as starch. According to [23], red ginger has a starch content of 52.9%. The more the ginger juice is added, the more amylose in the film matrix. [11] states that the composition of the molecular structure of amylose is straight and unbranched with 1.4 α - glycosidic bond, thus the more there is accumulation of amylose and the resulting film is getting tight and thick. [24] explained that the amylose molecules are most responsible for the formation of edible film.

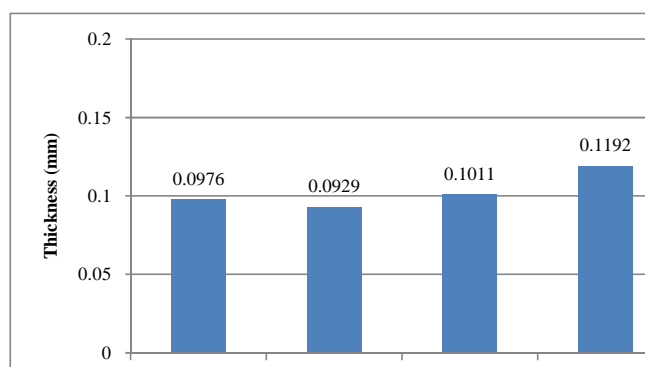


Fig. 3. Thickness Of Edible Film Of Jackfruit Straw With Addition Red Ginger Extract (Zingiber Officinale, Rosc.)

Amaliya *et al* [25] also stated that the higher the concentration of white turmeric cause edible film thickness will increase. Allegedly the addition of white turmeric filtrate in large numbers would increase the total amount of solids so that the film thickness increases. The film thickness obtained ranges 0.080-0.240 mm. In a study of [26], thickness derived from corn starch edible films incorporated with the juice of *chinese ginger* is 0.061-0.170 mm. This result is not much different when compared to the film thickness obtained by the 0.092-0.121 mm.

D. Water Vapor Transmission Rate

One of the main functions of edible film is to hold water vapor migration, the permeability to water vapor should be as low as possible [14]. Results of analysis of variance showed that the addition of red ginger extract significantly different with the water vapor transmission rate of jackfruit straw's edible film. Results DNMRT test (Duncan's New Multiple Range Test) can be seen in Figure 4.

Increasing the concentration of red ginger extract showed significant difference at 5% level. The Addition of red ginger extract is higher cause the water vapor transmission rate is smaller. According to [23], red ginger content essential oils 3.9%. Components of essential oils of red ginger are hydrophobic substances (e.g. gingerol) which can inhibit the penetration of water from the environment to *galamai*. [27] adding hydrophobic substances (e.g., cinnamaldehyde) is expected to improve the moisture barrier properties of a film.

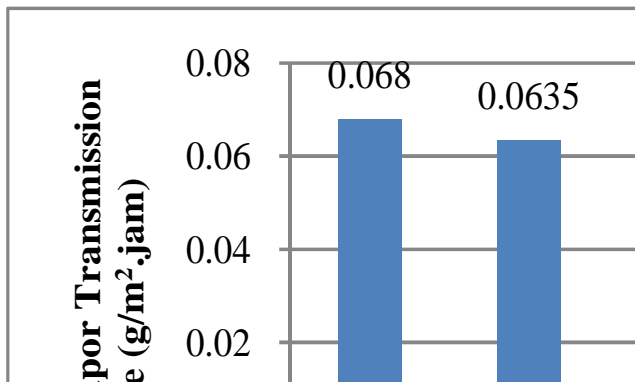


Fig. 4. Water vapour transmission rate of edible film of Jackfruit Straw With Addition Red Ginger Extract (*Zingiber officinale*, Rosc.)

The water vapor transmission rate is also influenced by the film thickness, the thicker films produced then diminishing its ability to absorb moisture. This is corroborated by a study [26], the high concentration of corn starch will increase the amount of film-forming polymer, while the increase in the juice of *chinese ginger* also increase the total solids, so it can form a thick edible film. Increasing the amount of polymer, will minimize the cavity formed in the gel. The thicker and dense matrix formed films can reduce the water vapor transmission rate because it is difficult to penetrate the water vapor.

Siswanti [28] also mentions in his research, that the increasing concentration of glucomannan, it can lower the water vapor transmission rate. This is due to the increased molecules of solution cause the structure of the film is more strong and compact, so that the film can hold water vapor transmission rate.

Krochta [29] states that the 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. The water vapor migration is smaller which is the better properties of edible film in maintaining the shelf life of products.

E. Sensory Evaluation

Sensory evaluation was conducted to determine panelists assessment of the product. Methode of the sensory evaluation is hedonic test for color, aroma, flavor, and texture resulting from each treatment.

1) *Color*: Color is a very important component to determine the quality of food. Determining the quality of a food is generally dependent on the color, because color appears first [17].

TABLE I
AVERAGE OF COLOR OF GALAMAI WHICH HAS BEEN WRAPPED EDIBLE FILM OF JACKFRUIT STRAW WITH ADDITION RED GINGER EXTRACT (*ZINGIBER OFFICINALE*, ROSC.)

Treatments	Color
Galamai + Extract of red ginger 2 %	3.75
Galamai + Extract of red ginger 4 %	3.70
Galamai + Extract of red ginger 6 %	3.50
Galamai + Extract of red ginger 8 %	3.55
Galamai + Extract of red ginger 10 %	3.45

1 = dislike (DL), 2 = less like (LL), 3 = regular (R), 4 = like (L), 5 = very like (VL).

Table I showed that the most preferred color is *galamai* + extract of red ginger 2%. Color of *galamai* which wrapped edible film of jackfruit straw with the addition of red ginger extract is visually not affect the *galamai* original color is dark brown. This is because the color of *galamai* is more dominant than the color of its edible film (brownish yellow), so the color of the edible film covered by *galamai* color (dark brown). This causes the panelists difficult to compare the differences in color on *galamai* wrapped edible film for each treatment.

2) *Aroma*: According to [17], each fruit has a distinctive aroma and additions to a particular material in a processing can affect the taste and aroma.

TABLE II
AVERAGE OF AROMA OF GALAMAI WHICH HAS BEEN WRAPPED EDIBLE FILM OF JACKFRUIT STRAW WITH ADDITION RED GINGER EXTRACT (*ZINGIBER OFFICINALE*, ROSC.)

Treatments	Aroma
Galamai + Extract of red ginger 2 %	3.50
Galamai + Extract of red ginger 4 %	3.80
Galamai + Extract of red ginger 6 %	3.50
Galamai + Extract of red ginger 8 %	3.40
Galamai + Extract of red ginger 10 %	3.40

1 = dislike (DL), 2 = less like (LL), 3 = regular (R), 4 = like (L), 5 = very like (VL).

Table II showed that the most preferred aroma is *galamai* + extract of red ginger 4% because ginger aroma that is not overly dominant. According to [30], red ginger has the smallest size and highest level of spiciness than the other two types of ginger. The aroma of the red ginger is highly dependent on essential oil content (1-3%).

3) *Taste*: According to [17], the taste of food can affect customer preference with food. Taste is an important factor for determining the admissibility of a food or food ingredient.

TABLE III
AVERAGE OF TASTE OF GALAMAI WHICH HAS BEEN WRAPPED EDIBLE FILM OF JACKFRUIT STRAW WITH ADDITION RED GINGER EXTRACT (*ZINGIBER OFFICINALE*, ROSC.)

Treatments	Taste
Galamai + Extract of red ginger 2 %	3.65
Galamai + Extract of red ginger 4 %	3.75
Galamai + Extract of red ginger 6 %	3.35
Galamai + Extract of red ginger 8 %	3.40
Galamai + Extract of red ginger 10 %	3.45

1 = dislike (DL), 2 = less like (LL), 3 = regular (R), 4 = like (L), 5 = very like (VL).

Table III showed that The most preferred flavor is *galamai* + extract of red ginger 4%. Taste in *galamai* wrapped edible film of jackfruit straw with the addition of extract of red ginger produced which is a blend of sweet and spicy taste. The taste of spicy derived from extract of red ginger.

4) *Texture*: Texture is a sensation of pressure that can be felt by mouth (at the time bitten, chewed, and swallowed) or using palpation with the finger [15]. Table IV showed that the most texture preferred is *galamai*+ extract of red ginger 8%.

TABLE IV
AVERAGE OF TEXTURE OF GALAMAI WHICH HAS BEEN WRAPPED EDIBLE
FILM OF JACKFRUIT STRAW WITH ADDITION RED GINGER EXTRACT
(ZINGIBER OFFICINALE, ROSC.)

Treatments	Texture
Galamai + Extract of red ginger 2 %	3.40
Galamai + Extract of red ginger 4 %	3.50
Galamai + Extract of red ginger 6 %	3.45
Galamai + Extract of red ginger 8 %	3.70
Galamai + Extract of red ginger 10 %	3.60

1 = dislike (DL), 2 = less like (LL), 3 = regular (R), 4 = like (L), 5 = very like (VL).

IV. CONCLUSIONS

The addition of extract of red ginger effect on water activity (a_w), thickness, and water vapor transmission rate of edible film of jackfruit straw. The best treatment is extract of red ginger 4% with characteristics of color 3.70, aroma 3.80, flavor 3.50 and texture 3.75, water content 12.6711%, a_w 0.4263, thickness 0.0929 mm, and water vapor transmission rate 0.0635 g / m².jam.

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