

## **Edible Film Application from Red Ginger Starch as Seblak Seasoning Packaging**

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### **ABSTRACT**

*Edible film was a thin layer made from agricultural-based raw materials that was applied as a coating on food components and was directly consumable. Red ginger as a herbal plant contained polysaccharides that had the potential to serve as a starch source. This study aimed to obtain the best edible film formulation with the addition of red ginger starch, which was applied as packaging for seblak seasoning. The research was conducted experimentally using a completely randomized design (CRD) consisting of five treatments and three replications. The treatments included P1 with 0.5 g of red ginger starch, P2 with 1.0 g, P3 with 1.5 g, P4 with 2.0 g, and P5 with 2.5 g. The observed parameters were water vapor transmission rate, thickness, solubility, dissolution time in seblak seasoning, and moisture content of the edible film applied to the seasoning. Based on the results, the selected treatment was P1 (0.5 g red ginger starch), which produced a water vapor transmission rate of 4.58 g/m<sup>2</sup>•hour, a thickness of 0.18 mm, a solubility of 91.08%, a dissolution time of 1 minute 3 seconds in seblak seasoning, and a moisture index of 0.0711 g on the sixth day.*

**Keywords:** *Red ginger starch, Edible film, Seasoning packaging*

## **INTRODUCTION**

Plastic is a synthetic material that is difficult to degrade naturally, requiring hundreds or even thousands of years to decompose in the environment. According to Gozali et al. (2020), the negative impacts of plastic packaging can be minimized by using biodegradable packaging alternatives that are easily broken down by nature and safe for food products. The use of edible films offers a promising solution to reduce environmental pollution caused by plastic waste. Nurhakim et al. (2021) state that edible films are an environmentally friendly and biodegradable packaging innovation made from natural polymers such as polysaccharides, proteins, and lipids that are safe for consumption.

Polysaccharides that can be used to produce edible films include starch, pectin, carrageenan, agar, and other polysaccharide derivatives. Ginger is a herbal plant with strong potential as a starch source. There are three main varieties of ginger: *Zingiber officinale* var. *Amarum* (small ginger), *Zingiber officinale* var. *Roscoe* (elephant ginger), and *Zingiber officinale* var. *Rubrum* (red ginger). Red ginger contains a higher starch content (52.9%) compared to small ginger (41.48%) and elephant ginger (44.25%) (Herlinawati et al., 2023).

The production of edible film from red ginger starch can be applied to the packaging of seblak seasoning. Using edible film made from red ginger starch as packaging for seblak seasoning can reduce plastic waste. Edible films are effective for this purpose because they dissolve easily in hot water, making them practical for consumers while significantly reducing plastic packaging waste. Micro, Small, and Medium Enterprises (MSMEs), such as Cemilan Nana Pku, currently use various types of plastic packaging for seblak seasoning, resulting in large amounts of plastic waste for each product unit.

Therefore, this study aims to obtain the optimal formulation of edible film with the addition of red ginger starch for application as environmentally friendly packaging for seblak seasoning.

## **METHODS**

### **Materials and Equipment**

The materials used in this study were fresh red ginger, inorganic beef gelatin powder, glycerol, distilled water (aquadest), carboxymethyl cellulose (CMC), and seblak seasoning produced by the MSME Cemilan Nana PKU, located on Jalan Air Dingin, Marpoyan, Pekanbaru City.

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The equipment used included an analytical balance, hot plate, magnetic stirrer, oven, spatula, stirring rods, thermometer, blender, filter paper, graduated cylinder, 500 mL beaker glass, desiccator, sealer, and glass molds measuring 20 × 20 cm.

**Research Method**

This study employed an experimental method using a non-factorial Completely Randomized Design (CRD) consisting of five treatments with three replications, resulting in 15 experimental units. The treatments referred to Sutra et al. (2020), namely the preparation of edible films with the addition of red ginger starch applied as packaging for seblak seasoning, with starch concentrations of 0.5 g, 1.0 g, 1.5 g, 2.0 g, and 2.5 g.

**Preparation of Red Ginger Starch**

The preparation of red ginger starch followed the method of Sutra et al. (2020). The ginger rhizomes were peeled and washed under running water, cut into small pieces, and weighed (2 kg). The ginger was then blended with warm water at a ratio of 1:4 (w/v) until a slurry was obtained. The slurry was filtered to obtain ginger extract, which was then allowed to settle to form starch sediment. The sediment was dried for 24 hours to obtain red ginger starch. The dried starch was ground using a blender and sieved through a 100-mesh sieve. The yield obtained from 2 kg of ginger was 118 g of red ginger starch.

**Preparation of Edible Film**

The preparation of edible film also followed Sutra et al. (2020). First, 2 g of gelatin was dissolved in 100 mL of distilled water. Red ginger starch (according to the treatment level) and CMC were added to the solution. The mixture was homogenized using a magnetic stirrer and heated on a hot plate at 60 °C for 10 minutes, followed by the addition of 1 g of glycerol. The solution was then heated to 80 °C for 20 minutes until a gel formed. A volume of 85 mL of the solution was poured into a 20 × 20 cm glass mold and dried in an oven at 50 °C for 24 hours.

**Application of Edible Film to Seblak Seasoning**

The application followed Distantina et al. (2018). The edible film was cut into rectangular shapes and formed into small pouches. The edges were sealed using a sealer, leaving one side open to insert the seblak seasoning. After filling, the open side was sealed again.

**Observations**

Observations were divided into two parts: (1) properties of the edible film, including

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water vapor transmission rate (WVTR), thickness, and solubility; and (2) properties of edible film applied to seblak seasoning, including dissolution time and moisture of the seasoning inside the film.

**Water Vapor Transmission Rate (WVTR)**

WVTR was measured according to ASTM E96 (1997). Edible film samples were cut into circular shapes to fit the surface of porcelain cups. The cups containing 3 g of silica gel were weighed to obtain the initial weight. The film was then sealed onto the surface of the cup. The final weight was recorded, and the cups were placed in a desiccator containing distilled water. Every hour for 7 hours, the cups were removed and weighed.

$$\text{Water vapor transmission rate (g/m}^2\text{/ O'clock)} = \frac{\text{slope of increase in cup weight (g/O'clock)}}{\text{surface area (g)}}$$

**Film Thickness**

Film thickness was measured according to Wulandari et al. (2017) using a micrometer with 0.001 mm precision. Measurements were taken at five different points (four corners and the center) of each film sample, and the average value was calculated. Thickness was expressed in millimeters (mm).

**Film Solubility**

Film solubility was determined following Gontard et al. (1994). Samples were cut into 3 × 3 cm pieces. Before immersion, the edible film and porcelain cups were dried in an oven at 105 °C for 30 minutes. The dried films and cups were weighed separately. The film samples were then immersed in 50 mL of distilled water for 24 hours. The insoluble residues were dried again at 105 °C for 3 hours. Solubility was calculated using the formula:

$$\text{Solubility of edible film (\%)} = \frac{M1-M2}{M2} \times 100$$

Information:

M1 = initial weight

M2 = final weight

**Dissolution Time**

Dissolution time followed Distantina et al. (2018). Seblak seasoning packaged with edible film was placed into boiling water at 100 °C. The dissolution time was evaluated based on how long it took for the seasoning to be released from the film.

### Moisture of Seblak Seasoning in Edible Film

Moisture analysis also followed Distantina et al. (2018). Edible film pouches filled with seblak seasoning were sealed and left at room conditions for 7 days. Daily observations were made. The amount of moisture absorbed from the air was expressed as a hydration index calculated as:

$$\text{Hydration index (g)} = \frac{M_s - M_i}{M_i}$$

Description:

Ms: Weight after several days (g)

Mi: Initial weight (g)

### Data Analysis

The data obtained were statistically tested using the analysis of variance (ANOVA) test using IBM SPSS Statistics 25 software. If  $F_{\text{count}} \geq F_{\text{table}}$ , further testing was carried out using the Duncan's New Multiple Range Test (DNMRT) at the 5% level.

## RESULTS AND DISCUSSION

### Water Vapor Transmission Rate (WVTR)

Water vapor transmission rate is defined as the amount of water vapor that passes through a film per unit time divided by the surface area of the film. WVTR indicates the extent to which moisture migrates through a food packaging material. The WVTR values obtained in this study are presented in Table 1.

**Table 1.** Average Water Vapor Transmission Rate (WVTR)

Treatment	WVTR (g/m <sup>2</sup> /hour)
P1 = Addition of red ginger starch 0.5 g	4.58 <sup>d</sup>
P2 = Addition of red ginger starch 1.0 g	3.82 <sup>c</sup>
P3 = Addition of red ginger starch 1.5 g	3.60 <sup>bc</sup>
P4 = Addition of red ginger starch 2.0 g	3.52 <sup>b</sup>
P5 = Addition of red ginger starch 2.5 g	2.54 <sup>a</sup>

Note: Different lowercase letters indicate significant differences ( $P < 0.05$ ).

The data in Table 1 show that the WVTR values of the edible films ranged from 2.54 to 4.58 g/m<sup>2</sup>/hour. It can be observed that increasing the concentration of red ginger starch resulted in a decrease in the WVTR of the edible film. According to Wahyuningsih et al. (2019), a higher starch concentration increases amylose content, which enhances intermolecular bonding. This reduces the number of free hydroxyl groups available to bind

water molecules, thereby lowering the permeability of the film to water vapor.

Deden et al. (2020) stated that a good edible film is one that is not easily permeable to water vapor, meaning it should have a low WVTR value. Based on the Japan Industrial Standard (JIS, 1975), the maximum acceptable WVTR is 10 g/m<sup>2</sup>/hour. The smaller the WVTR value, the better the film's ability to protect food products and extend shelf life (Dewi et al., 2021).

### **Film Thickness**

Film thickness is an important parameter in determining the quality of edible films for food packaging, as it strongly affects physical and mechanical properties such as tensile strength, elongation, solubility in water, and water vapor transmission rate. The thickness values of the edible films produced in this study are presented in Table 2.

**Table 2.** Average Thickness of Edible Films

<b>Treatment</b>	<b>Thickness (mm)</b>
P1 = Addition of red ginger starch 0.5 g	0.18 <sup>a</sup>
P2 = Addition of red ginger starch 1.0 g	0.19 <sup>ab</sup>
P3 = Addition of red ginger starch 1.5 g	0.20 <sup>ab</sup>
P4 = Addition of red ginger starch 2.0 g	0.22 <sup>ab</sup>
P5 = Addition of red ginger starch 2.5 g	0.24 <sup>b</sup>

Note: Different lowercase letters indicate significant differences ( $P < 0.05$ ).

The data in Table 2 show that the thickness of the edible films ranged from 0.18 to 0.24 mm. An increase in red ginger starch concentration resulted in thicker edible films. This occurs because higher starch content increases the total solids in the film-forming solution, which leads to a thicker film after drying. This finding is consistent with Sutra et al. (2020), who reported that increasing starch concentration increases the total solids content and, consequently, film thickness.

Lestari et al. (2022) also reported that the composition of ingredients such as starch, glycerol, and gelatin influences film thickness. A higher amount of added components increases viscosity and dissolved solids in the film matrix, resulting in thicker films. Therefore, the greater the number of components used in film formulation, the thicker the edible film produced.

The average thickness of edible films in this study (0.18–0.24 mm) is still considered acceptable, as it is below the maximum limit set by the Japanese Industrial Standard (less than 0.25 mm). Films thicker than 0.25 mm tend to have lower flexibility and are less suitable for

food packaging applications.

### **Solubility of Edible Film**

The solubility of an edible film is an important indicator of its biodegradability and suitability as a food packaging material. The solubility test aims to determine the film's ability to dissolve in water and its interaction with moisture. The solubility values of the edible films produced in this study are presented in Table 3.

**Table 3.** Average Solubility of Edible Films

<b>Treatment</b>	<b>Solubility (%)</b>
P1 = Addition of red ginger starch 0.5 g	91.07 <sup>c</sup>
P2 = Addition of red ginger starch 1.0 g	85.56 <sup>bc</sup>
P3 = Addition of red ginger starch 1.5 g	87.54 <sup>bc</sup>
P4 = Addition of red ginger starch 2.0 g	74.64 <sup>b</sup>
P5 = Addition of red ginger starch 2.5 g	53.80 <sup>a</sup>

Note: Different lowercase letters indicate significant differences ( $P < 0.05$ ).

The data in Table 3 show that the average solubility of the edible films ranged from 53.80% to 91.07%. It can be observed that increasing the concentration of red ginger starch resulted in a decrease in film solubility. This reduction is influenced by the higher starch content, which increases the density of the film matrix and reduces the number of sites available for water penetration. This result is consistent with Sutra et al. (2020), who reported that lower starch concentrations produce edible films with higher solubility.

The solubility of edible films is strongly affected by the presence of hydrophilic components (Ali et al., 2017). Hydrophilic components are water-loving materials that readily interact with and dissolve in water. In this study, all formulation ingredients were hydrophilic, which contributed to the relatively high solubility of the films. Highly soluble edible films are particularly suitable for ready-to-eat food products because they dissolve easily during consumption. The edible films developed in this study are expected to have high solubility because they function as packaging that dissolves when hot water is added. According to Wijayani et al. (2021), edible films with high solubility are suitable for applications such as instant noodle wrappers, ready-to-eat food packaging, and candy wrappers.

### **Dissolution Time of Edible Film in Seblak Seasoning**

The dissolution of the edible film was evaluated based on the time required for the seblak seasoning to be released from the edible film into the boiling seasoning solution. The

results were recorded in minutes. The dissolution time of the edible film in seblak seasoning is presented in Table 4.

**Table 4.** Average Dissolution Time of Edible Film in Seblak Seasoning

Treatment	Dissolution Time (minutes)
P1 = Addition of red ginger starch 0.5 g	1.03 <sup>a</sup>
P2 = Addition of red ginger starch 1.0 g	1.39 <sup>b</sup>
P3 = Addition of red ginger starch 1.5 g	1.63 <sup>bc</sup>
P4 = Addition of red ginger starch 2.0 g	1.92 <sup>c</sup>
P5 = Addition of red ginger starch 2.5 g	2.45 <sup>d</sup>

Note: Different lowercase letters indicate significant differences ( $P < 0.05$ ).

The data in Table 4 show that the average dissolution time of edible films in seblak seasoning ranged from 1 minute 3 seconds to 2 minutes 45 seconds. It can be seen that increasing the concentration of red ginger starch led to a longer dissolution time. Higher starch concentrations produced thicker films, and thicker films generally have denser and more compact matrices. As a result, water penetration and film disintegration occur more slowly.

The dissolution time of the edible film pouch was approximately 2.5 minutes, which is faster than the typical brewing time of commercial instant noodles (about 3 minutes). This is advantageous because if the edible film pouch does not dissolve completely within the brewing time, it may negatively affect visual sensory acceptance. The variation in dissolution time can be influenced by differences in raw materials and formulation concentrations (Liu et al., 2020).

### Moisture Content of Seasoning in Edible Film

The moisture characteristics of the edible film were analyzed according to Distantina et al. (2018). Edible films filled with seblak seasoning were sealed using a heat sealer and then stored under open-air conditions. The amount of moisture absorbed from the surrounding air into the edible film was used as a parameter of moisture, expressed as the hydration index. The moisture values of the seasoning in edible films are presented in Table 5.

**Table 5.** Average Moisture (Hydration Index) of Seasoning in Edible Film

Treatment	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
P1 (0.5 g red ginger starch)	0.0021 <sup>a</sup>	0.0157 <sup>d</sup>	0.0231 <sup>c</sup>	0.0404 <sup>d</sup>	0.0513 <sup>d</sup>	0.0711 <sup>d</sup>
P2 (1.0 g red ginger starch)	0.0032 <sup>b</sup>	0.0118 <sup>cd</sup>	0.0222 <sup>c</sup>	0.0370 <sup>c</sup>	0.0467 <sup>c</sup>	0.0636 <sup>c</sup>
P3 (1.5 g red ginger starch)	0.0038 <sup>c</sup>	0.0109 <sup>c</sup>	0.0181 <sup>b</sup>	0.0380 <sup>c</sup>	0.0420 <sup>c</sup>	0.0516 <sup>c</sup>
P4 (2.0 g red ginger starch)	0.0040 <sup>d</sup>	0.0105 <sup>b</sup>	0.0171 <sup>b</sup>	0.0321 <sup>b</sup>	0.0421 <sup>b</sup>	0.0507 <sup>b</sup>
P5 (2.5 g red ginger starch)	0.0041 <sup>e</sup>	0.0101 <sup>a</sup>	0.0149 <sup>a</sup>	0.0303 <sup>a</sup>	0.0390 <sup>a</sup>	0.0491 <sup>a</sup>

Notes: Values followed by different lowercase letters in the same column indicate significant differences ( $P < 0.05$ ).

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The data in Table 5 indicate that the hydration index of seasoning packaged in edible films with different concentrations of red ginger starch showed significant differences over the storage period. On day 6, the highest hydration index was observed in treatment P1, while the lowest was found in treatment P5. Specifically, the highest average hydration index on day 6 occurred in P1 (0.5 g red ginger starch) with a value of 0.0711 g, whereas the lowest was observed in P5 (2.5 g red ginger starch) with a value of 0.0491 g.

These results demonstrate that increasing the concentration of red ginger starch improves the moisture barrier properties of the edible film, resulting in a lower hydration index. Higher starch concentrations produced thicker films, which in turn reduced the water vapor transmission rate. The increased polymer content promotes stronger intermolecular bonding and the formation of a denser matrix structure, thereby restricting the diffusion of water vapor through the film. Consequently, edible films with lower water vapor transmission rates are more effective in maintaining the moisture stability of the packaged product.

Distantina et al. (2018) reported that physical quality deterioration begins when the hydration index reaches 0.1. In this study, none of the treatments reached this critical value during the six-day observation period. Although P1 approached the threshold on day 6 (0.0711 g), it remained below the critical limit. Treatment P5 exhibited the lowest hydration index on day 6 (0.0491 g), indicating the best moisture resistance. Therefore, P5 can be considered the most effective treatment in terms of maintaining seasoning quality based on hydration stability.

**Recapitulation of the Selected Treatment**

The quality requirements used as references in this study were based on the Japanese Industrial Standard (JIS, 1975) for edible films. The analyses performed on the edible films included water vapor transmission rate, thickness, and solubility. Additional analyses conducted on edible films applied to seblak seasoning included dissolution time and moisture content.

The recapitulation of the analytical results is presented in Table 6.

**Table 6.** Recapitulation of Edible Film Characteristics with Red Ginger Starch Addition

Observation	Standard	P1 (0.5 g)	P2 (1.0 g)	P3 (1.5 g)	P4 (2.0 g)	P5 (2.5 g)
1. Edible film						
Water vapor transmission rate (g/m <sup>2</sup> ·h)	Max 10*	4.58 <sup>d</sup>	3.82 <sup>c</sup>	3.60 <sup>bc</sup>	3.52 <sup>b</sup>	2.54 <sup>a</sup>

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Thickness (mm)	Max 0.25*	0.18 <sup>a</sup>	0.19 <sup>ab</sup>	0.20 <sup>ab</sup>	0.22 <sup>ab</sup>	0.24 <sup>b</sup>
Solubility (%)	–	91.08 <sup>c</sup>	85.57 <sup>bc</sup>	87.55 <sup>bc</sup>	74.64 <sup>b</sup>	53.81 <sup>a</sup>
2. Seblak seasoning wrapped with edible film						
Dissolution time in boiling water (min)	–	1.03 <sup>a</sup>	1.39 <sup>b</sup>	1.63 <sup>bc</sup>	1.92 <sup>c</sup>	2.45 <sup>d</sup>
Moisture (hydration index) on day 6 (g)	0.1**	0.0711 <sup>d</sup>	0.0636 <sup>c</sup>	0.0516 <sup>c</sup>	0.0507 <sup>b</sup>	0.0491 <sup>a</sup>

Notes:

Values followed by different lowercase letters in the same row indicate significant differences ( $P < 0.05$ ). Bold values in the same row indicate results that comply with the Japanese Industrial Standard (JIS, 1975) and the criteria reported by Distantina et al. (2018).

\*Japanese Industrial Standard (JIS, 1975).

\*\*Distantina et al. (2018).

The summary data show that increasing the concentration of red ginger starch significantly affected water vapor transmission rate, thickness, solubility, dissolution time in seblak seasoning, and the moisture content of the seasoning. According to JIS criteria, a good edible film should have low water vapor permeability, acceptable thickness ( $<0.25$  mm), and appropriate solubility.

Based on the recapitulation results, treatment P1 (0.5 g red ginger starch) was selected as the primary treatment because it meets the JIS requirements and is suitable for instant seasoning packaging, which requires rapid dissolution. P1 produced an edible film with a water vapor transmission rate of  $4.58 \text{ g/m}^2\cdot\text{h}$ , a thickness of 0.18 mm, high solubility (91.08%), and a fast dissolution time of 1 minute 3 seconds. The hydration index of the seasoning on day 6 (0.0711 g) remained below the critical value of 0.1.

However, treatment P5 (2.5 g red ginger starch) was also considered a selected treatment because it showed the lowest water vapor transmission rate ( $2.54 \text{ g/m}^2\cdot\text{h}$ ) and the best moisture resistance, with the lowest hydration index (0.0491 g). Therefore, P1 is recommended for applications requiring rapid dissolution, while P5 is more suitable for applications requiring stronger moisture protection.

### CONCLUSION AND IMPLICATIONS

Based on the results of this study, it can be concluded that the addition of red ginger starch at different concentrations in the production of edible film for seblak seasoning

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significantly affected the water vapor transmission rate, film thickness, solubility, dissolution time of the edible film in seblak seasoning, and the moisture content of the seasoning packaged in the edible film. The best treatment based on the experimental results was P1 (addition of 0.5 g red ginger starch), which showed a water vapor transmission rate of 4.58 g/m<sup>2</sup>-h, film thickness of 0.18 mm, solubility of 91.08%, dissolution time of the edible film in seblak seasoning of 1 minute and 3 seconds, and a hydration index of 0.0711 g for seasoning moisture on day six. The edible film produced with red ginger starch requires further investigation using an optimization approach such as Response Surface Methodology (RSM) to determine the optimal formulation conditions and to obtain the best overall treatment for future development.

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