Application of Edible Coating Derived from Salacca Seed and Glucomannan on Red Chili (*Capsicum annuum* L.)

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ABSTRACT

Chili is a significant commodity in Indonesia, but its short shelf life often leads to supply shortages and price fluctuations. To address this, post-harvest processing techniques, such as applying edible coating, are employed. This coating forms a thin plastic-like layer on the surface of the product, inhibiting metabolism while ensuring safety for consumption. Therefore, this research aimed to assess the effect of edible coating comprised of salacca seed flour and glucomannan, both at room temperature and under cold storage conditions, on weight loss, hardness, and color, ultimately extending the shelf life of chili. Edible coating procedure involved using salacca sourced from the Sleman market, porang tuber from Gunung Kidul farmer, as well as aqua dest, glycerol, and 96% ethanol. Various concentrations of coating layers were tested, including 1% salacca seed flour, 5% salacca seed flour, 10% salacca seed flour, 0.4% glucomannan, and a non-coated control group. The result showed that the optimal treatment during storage at room and the cold temperature was achieved with a 0.4% glucomannan coating layer and 1% salacca seed flour coating layer. Based on evaluations of weight loss, hardness, and color, it could be concluded that both salacca seed flour and glucomannan can extend the shelf life of chili.

Keywords: Chili; edible coating; glucomannan; salacca seed powder; storage life

INTRODUCTION

Edible coating is a thin layer consisting of safe-to-consume materials that functions as a protective barrier on food items, thereby preventing moisture loss. This layer also exhibits permeability to specific gases while regulating the movement of water-soluble components that might lead to alterations in the pigments and nutritional content of vegetables (Widaningrum, 2015). Observably, this method is primarily used to extend the shelf life of agricultural products such as fruits and vegetables. This edible coating is typically composed of three groups, including hydrocolloids, lipids, and composites. Hydrocolloids can be derived

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from various plant parts, such as roots, seed, fruits, and tubers (Herawati, 2018). Among the hydrocolloids, glucomannan stands out as a hydrocolloid polysaccharide formed from D-mannose and D-glucose (Yoga Prabowo et al., 2014). This substance finds its origins in several indigenous plants such as salacca and porang, thereby showing its versatility (Winarti et al, 2012).

In the context of salacca, various components apart from the fruit flesh are discarded as waste, including seed containing glucomannan content. These seed offer substantial advantages, as evidenced by Anggrahini et al., (2017), who indicated their potential for processing into flour with properties similar to standard Carboxymethyl Cellulose (CMC). The ability of CMC to form films arises from its polymer chain structure and relatively high molecular weight (Putri et al., 2018). Furthermore, it is noteworthy that CMC boasts attributes such as biodegradable, non-toxic, and water-soluble. This shows the use of salacca seed flour as a viable edible coating material comes into focus. Regrettably, existing research on harnessing salacca seed to extend the shelf life of agricultural products remains limited.

Beyond the use of salacca seed, another promising avenue lies in the use of porang tubers as a potential edible coating material. The porang plant (*Amorphophallus onchophyllus*) thrives in Indonesia and has garnered attention due to its facile cultivation and significant economic value as glucomannan source. Positioned between cellulose and galactomannan, glucomannan exhibits unique attributes, including the capacity to crystallize and create intricate fiber structures. Additionally, this substance can generate an elastic gel, rendering it ideal for crafting edible coating that can be dissolved in water to form film-like structures (Hatmi et al., 2020; Yanuriati et al., 2017).

Edible coating finds its application across diverse horticultural plants, such as chili, a produce renowned for its fiery flavor attributed to capsaicin content. Typically, chilies are harvested within the span of 2 to 3 months from the planting phase. Fully ripe red chilies exhibit ripeness levels ranging between 80% and 100%, signifying optimal maturity without overripeness (Priyono, 2017). After harvesting, the quality of chili peppers can degrade due to factors such as transpiration, respiration, and ethylene production. To preserve the quality of the harvest, post-harvest processes are indispensable, serving to curb respiration and transpiration rates in the plant. The post-harvest processes are crucial, particularly considering that red chili is a commodity susceptible to price fluctuations. These price fluctuations are intrinsically tied to the interplay of supply and demand dynamics. An abundance in supply tends to exert downward pressure on prices, while a shortage results in price hikes. The volatile nature of red chili prices poses considerable challenges in terms of prediction and management (Sukmawati, 2017).

METHODS

Materials

This research used mature and large red chili obtained from the market as the primary material to ensure distinct observations of color changes. Coating materials consisted of salacca seed procured from the market, porang tubers sourced from Gunung Kidul farmers, as well as distilled water (aquadest), glycerol, and 96% ethanol. A total of 4 variations of coating layer concentrations, including 1% salacca seed flour, 5% salacca seed flour, 10% salacca seed flour, 0.4% glucomannan, and a non-coated control group were employed.

Research Procedure

The research commenced with the preparation of salacca seed flour and glucomannan extract. To produce the flour, seed were separated from the fruit flesh, washed with running water, and soaked for 8 hours. This soaking procedure aimed to eliminate any adhering dirt on salacca seed, which were later dried in an oven for 48 hours. Once dried, seed were ground using a grinder blender machine to create flour and sieved to achieve the desired granule size. In contrast, porang tubers were extracted by blending 5 kg of fresh porang tubers with a 1:1 (w/v) solution of 96% ethanol, thereby serving as a washing process to dissolve impurities. The resulting mixture underwent filtration and was further washed using 70% ethanol in a 1:1 ratio before undergoing another filtration step. This washing step was repeated three times using a 50% ethanol solution in a 1:1 ratio. Following five rounds of washing, the filtered particles were dried using a cabinet dryer at a designated temperature for 5 hours in a cabinet dryer. The resulting dried material was subsequently ground to obtain the desired glucomannan extract.

After obtaining salacca seed flour and glucomannan extract, coating process was performed with the following variations, including 1% salacca seed flour, 5% salacca seed flour, 10% salacca seed flour, 0.4% glucomannan, and a non-coated control group. Each treatment was stored under two conditions, involving cold storage and room temperature. The cold storage environment was maintained at a constant temperature of 12 °C and a humidity level of 95%. Meanwhile, the

room temperature storage took place within a typical room environment with a temperature of 31 °C and a humidity of 58%.

Hardness Test and Color Evaluation of Coated Red Chili During Storage

The hardness value of the product (P) held significant importance in the food preservation process using edible coating. This observed value, measured in grams (g), was converted to kilograms (kg) and subsequently integrated into Equation 1.

$$p(kg/m^3) = \frac{hardness\ value\ on\ penetrometer\ (kg)}{surface\ area\ of\ penetrometer\ (m^2)} \quad (1)$$

The surface area of the penetrometer tip (A) could be readily calculated using Equation 2.

$$A = \frac{1}{2}\ DS \quad (2)$$

D =1.21 cm
S = 1.10 cm
A = (1.21 cm) (1.1 cm) = 2.08967 = 0.0208967

To analyze the hardness value of each treatment, an average was derived and plotted in a unified graph, showcasing the average P (kg/) vs. t (day) for each treatment.

The color evaluation of the product is evaluated using the comparison of the chilli's sample photos during the storage

Weight Loss Test of Coated Red Chili During Storage

Weight loss was regarded as a crucial parameter in the realm of food preservation. The evaluation of weight loss was undertaken using Equation 3

$$weight\ loss\ (\%) = \frac{(mass\ at\ day\ 0) - (mass\ at\ day\ n)}{mass\ at\ day\ 0} \times 100\% \quad (3)$$

An illustrative graph was generated, showing the average weight loss (%) over a span of days. Each plotted line was accompanied by the equation of the corresponding line, denoted as y = mx.

Kinetic Analysis

The domain of kinetic analysis found its application in various aspects of biosynthesis, such as the reaction rate and the prediction of reactant or product concentrations. In the context of this experiment, the application of zero-order kinetic analysis was apparent, as shown in Equation 4. Additionally, first-order kinetic analysis was employed, as expressed in Equation 5.

$$\frac{dC}{dt} = \pm k.C^n$$

$$\frac{dC}{dt} = \pm k.C^0 dC = \pm k\ dt \int_0^t dC = \pm k \int_0^t dt$$

$$C_t - C_0 = \pm kt \quad (4)$$

$$\frac{dC}{dt} = \pm k \cdot C$$

$$\frac{dC}{C} = \pm k \cdot dt$$

$$\int_{C_0}^{C_{(t)}} \frac{dC}{C} = \pm k \cdot \int_{t_0}^{t_{(t)}} dt$$

$$ln\ (C_t) - ln\ (C_0) = \pm k(t_{(t)} - t_0)$$

$$ln\ (\frac{C_t}{C_0}) = \pm k(t_{(t)} - t_0) \quad (5)$$

where = chili concentration at time t = t; = initial concentration of chili at time t = 0; k = kinetic rate constant (); and t = time (minutes).

RESULTS AND DISCUSSION

Change in Hardness Values

The experiment aimed to assess the impact of different coating treatments on storage of chili over a 10-day period, including both room temperature and cold storage conditions. This edible coating comprised a 0.4% glucomannan solution and solutions of 1%, 5%, and 10% salacca seed flour (TBS). An essential parameter for determining the efficacy of edible coating in food preservation was regarded as the hardness value of agricultural products. The degradation of hemicellulose and protopectin has the potential to contribute to a decrease in hardness value (Muchtadi et al., 2010). Product hardness was quantified by establishing a ratio between the hardness value of the penetrometer and its surface area. Control treatments were also implemented for comparison, without the application of edible coating, both under room temperature and cold storage conditions (Table 1 and Table 2). Upon analysis, it was evident that changes in hardness value were more pronounced at room temperature compared to cold storage. The efficacy of cold storage lay in its ability to maintain lower temperatures coupled with higher humidity, resulting in superior chili preservation throughout storage (Table 2). Furthermore, the alteration in hardness at room temperature was denoted as a percentage change per day. The control treatment exhibited the highest rate of change, while the 5% TBS treatment showed the lowest, closely followed by the 0.4% glucomannan treatment. The hardness change rates observed at

Table 1. The rate of change of hardness value at room temperature

Treatment	Rate (%/day)
TBS 1%	0.0443
TBS 5%	0.0417
TBS 10%	0.0452
GL 0.4%	0.0433
Control	0.0586

Table 2. The rate of change of hardness value at *cold storage*

Treatment	Rate (%/day)
TBS 1%	0.0048
TBS 5%	0.0121
TBS 10%	0.0012
GL 0.4%	0.0033
Control	0.0107

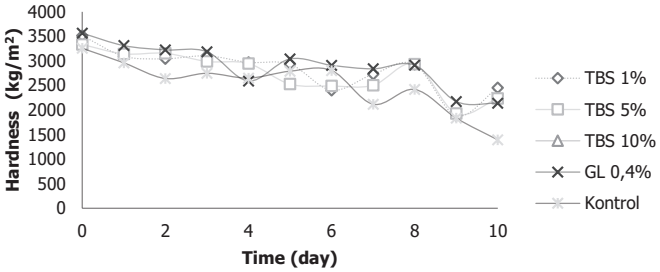

Figure 1. Change in hardness value at room temperature

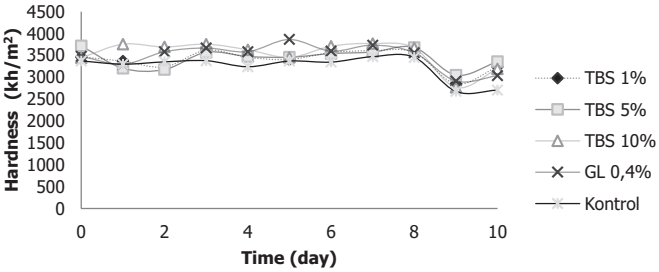

Figure 2. Change in hardness value at cold storage

room temperature and cold storage were presented in Tables 1 and 2, and, the graphical representations of these changes were provided in Figures 1 and 2.

Color Change

The analysis of color change included the evaluation of lightness, chroma, and hue parameters. Chroma and hue values were derived from the a and b values, with the assessment carried out for 10 days using a colormeter. The results showed that chilies stored at room temperature exhibited more rapid color alterations in comparison to those stored under cold storage conditions. Cold storage, characterized by an average temperature range of 10-12 °C and humidity levels ranging from 90-95%, contributed significantly to the preservation of red color. Conversely, storing chilies at room temperature resulted in a slight darkening of their color. These observations aligned with the results from Sulistyaningrum & Marendra Kiloes, (2020), indicating that chilies stored at room temperature experienced progressive color changes over time, leading to a darker brown hue. Comprehensive differences in color between the initial and concluding stages of the experiment were presented in Table 3.

Changes in Weight Loss Value

Weight loss values served as a pivotal parameter for the preservation of agricultural food. These values gauged alterations in moisture content during storage, wherein a decline in weight loss signified reduced moisture levels. The assessment of weight loss was conducted over a 10-day period, including both cold storage and room temperature conditions. Solutions comprising 0.4% glucomannan and salacca seed flour at concentrations of 1%, 5%, and 10% were employed for storage treatments. The results indicated that within cold storage conditions, the 10% TBS treatment exhibited the swiftest rate of weight loss change, while the most gradual rate was observed in the 1% salacca seed flour treatment. For room temperature storage, the treatment employing a 10% salacca seed flour concentration experienced the most rapid rate of weight loss alteration. However, the differences among each treatment remained relatively minor, and the longest duration of weight loss change was observed in conjunction with the 0.4% glucomannan solution. This aligned with the results of (Mita & Ayuluthfi, 2012), who indicated that thicker coating layers could lead to heightened weight loss due to reduced oxygen availability, subsequently triggering anaerobic respiration (Basuki et al., 2010). This notion was further supported by the understanding that edible coating could curtail respiration, and in cold storage settings, humidity levels were inherently elevated. Excessive moisture content could potentially contribute

Table 3. Differences in chilies at the beginning and end of the experiment

	Day-	TBS 1%	TBS 5%	TBS 10%	GL 0.4%	Control
Cold storage	0					
	10					
Room temperature	0					
	10					

Table 4. The rate of change in weight loss at room temperature

Treatment	Rate (%/day)
TBS 1%	6.7848
TBS 5%	6.7801
TBS 10%	6.9463
GL 0.4%	6.6183
Control	7.0435

Table 5. The rate of change in weight loss at cold storage

Treatment	Rate (%/day)
TBS 1%	1.3764
TBS 5%	1.4819
TBS 10%	1.5143
GL 0.4%	1.4338
Control	1.4026

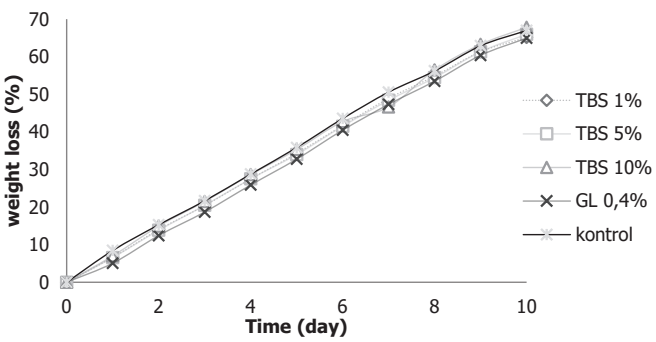

Figure 3. Change in weight loss at room temperature

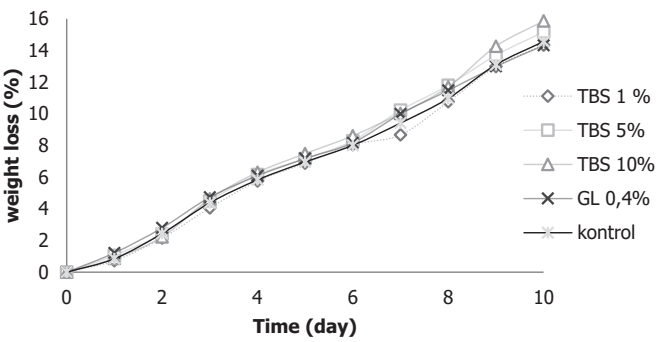

Figure 4. Change in weight loss at cold storage

to the deterioration of chili. The results of the weight loss change in chili were presented in Tables 4 and 5, as well as in Figures 3 and 4.

CONCLUSION

In conclusion, based on the experimental results, the assessment of the hardness test at room temperature indicated that the control treatment yielded the highest value. The 5% TBS treatment showed the lowest value, followed by the 0.4% glucomannan treatment. In cold storage conditions, the 5% TBS treatment exhibited the most significant decrease in hardness, whereas the 10% TBS treatment displayed the least reduction. Cold storage effectively preserved red color of chili, while storage at room temperature led to a minor darkening of the color. Moreover, weight loss measurements conducted under cold storage conditions showcased the most rapid reduction in weight loss within the 10% TBS treatment, and the slowest reduction occurred in the 1% salacca seed flour (TBS) treatment. For room temperature storage, the treatment involving a 10% salacca seed flour concentration experienced the fastest reduction in weight loss. The 0.4% glucomannan solution exhibited the lengthiest alteration in weight loss. In summary, optimal coating performance was observed at room temperature with glucomannan and 5% salacca seed flour coating, while in cold storage, the most effective performance was achieved through glucomannan and 1% salacca seed flour coating.

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CONFLICT OF INTEREST

The authors affirm that there are no conflicts of interest involving any relevant parties.

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