Application of Alkali Treatment Rice Husk – CaCl₂ as Moisture Absorber of Coconut Palm Sugar Granule

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Abstract. Rice husk is high fiber agricultural wastes and with CaCl₂ impregnated, it would be potential to develop as a composite moisture absorber. In this case, the rice husk – CaCl₂ composite can absorb and control the moisture in headspace of packaging to stabilize the water activity of the product. This study was aimed to develop moisture absorber from rice husk – CaCl₂ and apply the sachet of moisture absorber into the package of coconut palm sugar granule (CSG). Moisture absorber was prepared by impregnated the surface of modified rice husk using sodium hydroxide (5% w/v) and CaCl₂ with the concentration of 5, 10 and 15 % w/v. Physical parameters of CSG were analyzed. Rice husk – CaCl₂ 15% has the highest moisture absorption. Meanwhile, the using of rice husk - CaCl₂ as moisture absorber was able to maintain the moisture content of CSG during storage at the condition as about 2% with RH 70%.

1. Introduction

Moisture can cause food deterioration such as moistening, caking, and softening for hygroscopic, powdered, and crisp food [1]. The other effect of excess moisture in the packaging decreases the shelf life of the product. Excess moisture comes from product activity or an environment. The moisture will insert into packaging with high permeable packaging material. Water activity is a critical point for powdered food quality during storage. For this reason, moisture in the headspace of product packaging needs to be controlled using of packaging technology that actively interacts in the packaging headspace. Active packaging like moisture absorber has functioned as a desiccant. It can absorb and control moisture in the packaging headspace so it will prevent the caking of powdered food and water activity will be preserved [2].

Palm sugar has varied mineral composition, the packaging, distribution, and transportation is easier than coconut sugar block handling [3]. Farmers use wet granulation method to produce palm sugar granules from the sap. The other granulation method is dry granulation which use palm sugar blocks as raw material to produce palm sugar [4]. Coconut sugar has a short shelf life, approximately 2 - 4 weeks, and if it process as palm sugar it would increase the shelf life until 627 days using metalized plastic [5]. On the other hand, palm sugar have difficulties. It was hygroscopic because of the reduction sugar composition [6]. The moisture sorption rate is about 0,039 gram/1,98 gram per minute or 1,99% (weight per weight) per minute in RH 100% [7] and it will cause the caking of palm sugar. Caking, stickiness of palm sugar can be prevented by use of anticaking [8], moisture absorber or packaging
that suitable for the product [5]. Moisture absorber from green desiccant from alkali treatment rice husk has a possibility to use and replacing common moisture absorber like silica gel [9].

Alkali Treatment Rice Husk-CaCl₂ for coconut palm sugar (CSG) moisture absorber be a focused research in this paper. Safety, cheap and environmental friendly of moisture absorber have an opportunity to research. Treated rice husk has the possibility as a green desiccant [10]. CaCl₂ has the hygroscopic characteristic, it commonly used as a desiccant because of the higher sorption capacity, fast sorption rate, cheap and no toxic. The moisture sorption of CaCl₂ can do in lower relative humidity (<30°C) and varied temperature between 10 – 45 °C [13]. On the other hand, CaCl₂ will adsorb moisture until equilibrium to makes a solution, is named deliquesence phenomenon [14]. Mixing CaCl₂ with alkali treated rice husk has a possibility as a green desiccant. Performance and adsorption rate of alkali treated rice husk- CaCl₂ as moisture absorber to keep the quality of CSG need to analyze. This study was aimed to develop moisture absorber from rice husk – CaCl₂ and apply the sachet of moisture absorber into the package of coconut palm sugar granule (CSG).

2. Materials and Methods

2.1. Materials and apparatus

Rice husk was purchased in the local market. The rice husk treatment was washing, drying and grinding to make a powder rice husk (60 mesh). CaCl₂ analytical grade was prepared from Merck. Coconut palm sugar granule was gathered from the industry at Bogor. Analytical balance, aluminium and glass equipment, oven, incubator, desiccator, hermetic jars were used as apparatus the research.

2.2. Alkali Treatment and Moisture Absorber Preparation

Rice husk was treatment using sodium hydroxide 5% w/v for 2 hours and then filtered, dried in oven 105 °C until constant weight. CaCl₂ with concentration 5, 10 and 15% w/v was impregnated into treated rice husk for two hours, then filtered and dried until constant weight. Moisture absorber treated rice husk- CaCl₂ was ready to use. Measurement moisture absorption capacity was calculated by gravimetric method [15]. One gram of moisture absorber was prepared on a small plate. Moisture absorber was stored in a hermetic glass which contained a quarter of water volume. The hermetic glass were placed in storage room and were weighed every day until constant weight was reached. LiCl and MgCl₂ saturated solution were used to get isotherm sorption of the highest moisture absorption capacity of treated rice husk and CaCl₂.

2.3. Application of Moisture Absorber

30 gram coconut palm sugar granule (CSG) in LDPE plastics was stored in incubator 30 °C with 95% ± 3 relative humidity. The moisture content of CSG was calculated in 7 days. One gram moisture absorber from treated rice husk and CaCl₂ in LDPE sachet package inserted in CSG packaging. Performance of CSG with moisture absorber including weight gain, moisture content, and color appearance. Chromameter was used to get L, a*, b* scale. Besides that, the moisture content of moisture absorber during storage was also calculated. As a result, the relationship between moisture content of CSG and moisture absorber will be known.

3. Results and Discussions

3.1. Treated Rice Husk-CaCl₂ Moisture Sorption

Alkali treatment rice husk with a higher concentration of CaCl₂ showed higher moisture sorption capacity in relative humidity 97% (figure 1.). The maximum moisture sorption capacity was 50,4% for treated rice husk (15% CaCl₂) in 14 days storage. The first day of storage shown the higher moisture sorption rate. This is due to the fact that CaCl₂ has fast absorbing of moisture [14], and greater moisture capacity than silica gel [13]. The moisture capacity of moisture absorber from treated rice husk and CaCl₂ is less than pure CaCl₂ or silica gel sorption. Silica gel has 22,41% moisture absorption in 24 hours with RH 75% using saturated NaCl solution [11]. Raw rice husk has 18,52% moisture absorption in RH 75%, 28 ± 2°C. Alkali treatment of rice husk using KOH has 18,875% sorption capacity in RH
75% for 24 hours in the first day [11]. The adsorption rate of treated rice husk-CaCl$_2$ in varied concentration showed the same decrease pattern until constant weight reached. The treated rice husk – CaCl$_2$ 15% showed the highest adsorption rate in the first day with the adsorption rate was 0.530 gH$_2$O/g sample/days. Based on this, treated rice husk-CaCl$_2$ 15% is used as moisture absorber for coconut palm sugar packaging. The analysis of sorption isotherm in temperature 30 °C, treated rice husk-CaCl$_2$ 15% has equilibrium moisture content 6% (Aw 0.1) and 11% (Aw 0.2). Hemicellulose, lignin and part of crude fibers in rice husk is reduced by alkali treatment. Alkali treatment is also created a cavity of rice husk structure. Besides that, the hydroxyl group in the chain of cellulosic material on surface rice husk is important in chemisorption of moisture [11].

Figure 1. Moisture sorption capacity of treated rice husk + CaCl$_2$

3.2. Application in Coconut Palm Sugar

3.2.1. Moisture Content

Coconut palm sugar that used in this research has moisture content 1.69 % w.b. The moisture content of coconut palm sugar in LDPE plastic packaging during storage in 30±1°C, RH 95% was shown in figure.2. The moisture content of coconut palm sugar increase during storage. The moisture content of CSG without moisture absorber increase more higher than with moisture absorber (treated RH and CaCl$_2$ 15%). Water vapor transmission rate (WVTR) of coconut palm sugar packaging (LDPE) caused the change of moisture content. LDPE has higher WVTR than polypropylene, so it makes moisture more easy to pass the packaging.

Figure 2. Moisture content of coconut palm sugar with moisture absorber treated Rice Husk + CaCl$_2$

Moisture content of coconut palm sugar will effect on the glass transition temperature (Tg) and sticky point temperature (Tsc) [8]. Coconut palm sugar hygroscopicity effected by pH of coconut palm
sugar block. When pH of raw material is too low pH, it would form the reduction sugar, and OH- in reduction sugar will absorb more moisture [9]. Free flowing ability is important parameters for powdered quality. On the other hand, coconut palm sugar has hygroscopic characteristics, because the high percentage of component is sugar, and it could cause caking and sticky. Bulky cake will occurred when the free flowing single particles of sugar has stickiness on particles surface [10].

Treated rice husk and CaCl$_2$ 15% in sachet packaging has increase in moisture content. The moisture absorber can working used LDPE sachet with the thickness of 0,3mm. Fresh product with higher water activity need moisture absorber with high water holding capacity [14]. For this condition, porous sachet or perforated water vapor barrier plastic is suitable for sachet of moisture absorber [12]. The end of storage, the moisture content of moisture absorber that used in CSG packaging was 8,46% wb. It means moisture absorber has sorption the moisture from environment and keep the moisture content of coconut palm sugar.

### 3.2.2. Color

Coconut palm sugar mostly consists of 91,4% sugars, that is glucose, fructose and sucrose. The formation of brown color is caused by maillard reaction during process production palm sugar [9]. L value is higher on 7$^{th}$ days storage of coconut palm sugar. The color is more brighter on CSG without moisture absorber (Table 1).

| Table 1. L* a* b* scale of coconut palm sugar granule |
|-------------------------------------------------------|
| Days | L   | a    | b*  | c*  | h*  |
|------|-----|------|-----|-----|-----|
| Without MA$^a$ | 0   | 57,31| 15,69| 30,11| 33,96| 62,47 |
| 3    | 53,10| 15,33| 27,005| 31,05| 60,42 |
| 7    | 62,84| 18,28| 32,61| 37,38| 60,72 |
| With MA$^b$ | 3   | 55,14| 15,28| 27,56| 31,50| 61,01 |
| 7    | 56,7 | 15,5 | 28,7 | 32,66| 61,67 |

$^a$ Without moisture absorber  
$^b$ With moisture absorber

### 3.2.3. Weight

Figure 3 was shown that weight gain of coconut palm sugar without moisture absorber more higher than CSG without moisture absorber. The difference of weight gain until 7$^{th}$ days storage is 0,31 g for CSG with moisture absorber, and 0,91 g for CSG without moisture absorber.
4. Conclusion
The mixing of alkali treatment with CaCl₂ 15% w/v, can be applied as moisture absorber of coconut palm sugar granule. Moisture absorber from treated Rice Husk and CaCl₂ 15% has slow rate adsorption than chemical desiccant. Application treated RH and CaCl₂ should be the next research for product with higher water activity and higher relative humidity.

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