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Characterization of Durian Seed Flour (*Durio zibhetinuss l.*) and Estimation of its Self Life with Accelerated Self Life Testing (ASLT) Moisture Critical Method

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Abstract. The content of starch in the seeds of durian is high enough so that they can be processed into flour which has a high economic value and becomes a potential product diversification of wheat flour. Durian seed flour has a yellowish white color, a smooth texture, a slightly acidic odor due to a 2day deposition process that will produce a sour aroma from separate mucus. Durian seed flour has 13.42% moisture, 4.44%, ash, 9.08% protein, 0.55% fat and 72.49% carbohydrate. Its microbiological characteristics include 6.4×10^3 colony/gram total plate count, 5.0×10 colony/gram mold, <3 APM/gram *Eschericia coli*, and <100 colony/gram *Bacillus cereus*. For shelf life testing, the moisture initial is 0.1213% and moisture critical is 0.1607% with slope isothermal moisture sorption curve of 0.255. From BET (Brunaurer-Enmet-Teller) curve the moisture content which gives maximum shelf life is 2.80%. The shelf life of durian seed flour in LDPE plastic packaging is 134 days, in HDPE plastic packaging 230 days, and PP plastic packaging 536 days.

Keywords: Durian seed flour, ASLT, Shelf life, Isothermal Moisture Sorption

1.Introduction

The import of wheat flour is very high because wheat flour produced by local producers is not enough to meet the needs of wheat flour in Indonesia. Durian seed carbohydrate content is very high so it can be processed into flour with a high economic value and a potential as raw material of flour diversified products [1,2,3,4]. So far, the utilization of durian seeds has only been limited as raw material of chips with a relatively low market share, so it is expected that the waste of durian seeds can be processed into flour and various products and also increase the economic value of the durian seeds.

Prior to consumption, durian seed flour should go through a series of tests to ensure quality and feasibility as a flour diversified product. The parameters tested are physical, chemical and microbiological properties and also shelf life of durian seed flour. The inclusion of the expiry date gives consumers the information about the time limit of the use of the product. Manufacturers and product distributors also benefit from the availability of information about shelf life [5].

One way to find out the level of product durability during the storage period is through the determination of shelf life so it can be known how long a product can be stored before going down to its critical point. The shelf life of food products can be predicted and then the expiry date can be set by using two concepts of food storage product study, namely the Extended Storage Studies (ESS) and the Accelerated Storage Studies (ASS). Assessment of shelf life can be done in Accelerated Shelf Life Testing which can then predict the actual shelf life [6]. The determination of shelf life with the accelerated conditions most commonly used in the food industry is the Arrhenius method and the critical water content method. The determination of shelf life of critical moisture content method can be done by the assessment of isotherm of water sorption (ISA) that is the curve of relation between air storage RH and equilibrium moisture content at a product that is allowed to reach equilibrium during storage. Air storage RH can be arranged by balancing air using a suitable saturated salt solution [7]. The critical moisture method is generally used for food products with tipping point, congestion, and food damage based on their water activity. One of the most important determinants of product shelf life is product packaging. This research, therefore, performs physical n, chemical and microbiological characterization

of durian seed flour as well as the determination of its shelf life with some types of plastic packaging such as high density polyethylene (HDPE), low density polyethylene (LDPE), and Polypropylene (PP) by ASLT method.

2. Materials and Methods
2.1. Durian Seeds
Durian seeds are obtained from local cultivars in sub district Jasinga, Bogor, West Java and Sibolga area, North Sumatra.

2.2. The Making of Durian Seed Flour and its Characteristics
The durian samples are determined and then the durian seeds are collected for sorting. The process of durian seed flour making is with a wet method started by the separation of durian seed starch. It is then analyzed physically (color, taste and odor) and chemically, including water content (SNI 3751-2009), ash content (SNI 3751-2009), protein content (SNI 3751-2009), fat content (AOAC, 2005), carbohydrate content (AOAC, 2005), Total Plate Count (SNI 3751-2009), Coliform and *Escherichia coli* contamination (SNI 3751-2009), molds (SNI 3751-2009) and *Bacillus cereus* (SNI 3751-2009).

2.3. Shelf Life Estimation of Durian Seed Flour With ASLT Method
The determination of shelf life of durian seed flour by ASLT method uses critical moisture content (Labuza) method with different plastic packs: high density polyethylene (HDPE), low density polyethylene (LDPE), and polypropylene (PP) through various stages including the measurement of moisture initial (Mi), moisture critical (Mc), moisture equilibrium (Me) and the determination of isothermal sorption model, permeability of packaging to moisture and BET moisture content.

The moisture equilibrium (Me) and Aw values are included in the isothermal sorption equation models of Chen Clayton, Henderson, Hasley, Caurie, and Oswin. The five models are then evaluated for the Mean Relative Deviation (MRD) values. If the MRD value is <5 then the isothermal sorption model can describe the actual or very precise state. If it is 5 <MRD <10 then the model is rather precise to describe the actual state and if MRD is > 10 then the model does not exactly describe the actual condition.

Silica gel is inserted in a WVP cup and then it is sealed with a package of which its moisture permeability will be determined. The silica gel and the cup which has been covered by a packaging are weighed and put in a closed jar containing the NaCl solution. The determination of the permeability of the packaging is carried out at a temperature of $28°C$ and 75.62% RH. To adjust the room RH in the jar to reach 75.62% NaCl solution is then used. The permeability of the packaging is determined by the formula [8]: data obtained from the determination of the ISL curve is aw and moisture equilibrium. While the Mo BET requires aw / (1-aw) data M. Next, the linear regression curve is made with aw as the X-axis and aw / (1-aw) M as the Y-axis, so that a linear equation is obtained.

3. Results and Discussion
3.1. Characteristics of Durian Seed Flour
Durian seed flour has a yellowish white color, a smooth texture, a slightly acidic odor due to a 2day deposition process that will produce a sour aroma from separate mucus. Durian seed flour has 13.42% moisture, 4.44%, ash, 9.08% protein, 0.55% fat and 72.49% carbohydrate. Compared to other types of flour, namely cassava flour, protein content in durian seed flour is higher. Proteins contribute significantly to the physical properties of the food through its ability to make and stabilize gels, foam, emulsions, and fibril structures [9]. Fat content of more than 0.5% can be caused by residual malvalic acid that is carcinogenic cyclopropene fatty acid which exists between the outer skin and the epidermis of durian seeds. Therefore, the process of washing, soaking, and drying is essential to make durian seed flour a commodity for consumption and a substitution of wheat flour [10]. Moreover, microbiological characterization is performed to determine the level of hygiene in food product manufacturing as an indicator of food sanitation, and to estimate its shelf life according to SNI 01-

3751-2009. Its microbiological characteristics include 6.4×10^3 colony/gram total plate count, 5.0 x 10 colony/gram mold, <3 APM/gram *Eschericia coli*, and <100 colony/gram *Bacillus cereus*.

Table 1. Characteristics of Durian Seed Flour

Parameter	Unit	Durian Seed Flour	01-3751-2009 SNI Wheat
Rendement	%	26,23	-
Color		yellowish white	White
Texture		smooth texture	Powder
Odor		slightly acidic	Normal
Water	%	13.42	Maximum 14.5
Ash	%	4.44	Maximum 0.70
Protein	%	9.08	Minimum 7.0
Fat	%	0.55	-
Carbohydrate	%	72.49	-
Total Plate Count	colony/g	6.4×10^3	Maximum 1×10^6
Molds	colony/g	5.0×10	Maximum 1×10^4
Eschericia coli	APM/ g	3	Maximum 10
Bacillus cereus	colony/g	<100	

3.2. Estimation of Durian Seed Four Shelf Life with ASLT Method
The estimation of shelf life of durian seed flour products is calculated through the Labuza equation (1985) that is the shelf life at 78% RH storage [8]. Moisture content in food products determines acceptability, freshness, texture, resistance to microorganisms, and shelf life of the products. In dry food products such as flour, moisture content is a critical characteristic that affects consumer acceptance because it determines textures (clumping and wet). Durian seed flour is slightly hygroscopic (easy to clot) so it needs to determine the point of damage based on critical moisture content (Mc).

Table 2. *Moisture Initial (Mi) and Moisture Critical (Mc)*

Parameter	Unit	Results
Moisture initial (Mi)	% (dry based)	0.1213
Moisture critical (Mc)	% (dry based)	0.1607

Moisture equilibrium is required to obtain the isothermal sorption curve of the product, by conditioning the durian seed flour in some type of saturated salt solution with different relative humidity. The achievement of equilibrium conditions between samples and the environment is characterized by constant sample weights. A constant weight is shown by the difference of consecutive weighing of not more than 2 mg / g of samples stored at RH below 90% and not more than 10 mg / g of samples stored at RH above 90% [11].

Table 3. Equilibrium Moisture Content in Different Conditions of Aw

Saturated Salt RH	Aw		Moisture Content (% wet based)	Moisture Content (% dry based)
NaOH	6.9	0.069	4.4382	0.0464
MgCl2	32.4	0.324	7.4843	0.0809
KI	69	0.690	11.3943	0.1286
NaCl	75.5	0.755	13.8462	0.1607
KCl	84	0.840	18.5341	0.2275
BaCl2	90.3	0.903	23.4764	0.3068

The equilibrium weight starts to be gained on the 5th storage day for samples stored under low RH conditions, as in RH 7-69 storage. The higher the relative humidity value of storage, the longer it takes to reach a state of equilibrium with the environment. The equilibrium weight of the durian seed flour samples shows the phenomenon of weight gain except in low storage RH that is at a condition of 6.9% RH. In the flour stored at a relative humidity condition of 6.9%, the process that occurs is the release of water vapor from samples to the environment (desorption phenomenon), this is because the samples under low RH conditions have a higher aw than the relative humidity, reaching the equilibrium of durian seed flour will release moisture. While the durian seed flour stored in the relative humidity of 32%, 69%, 76%, 84% and 90% increase weights (adsorption phenomenon) because of the lower aw than the relative humidity.
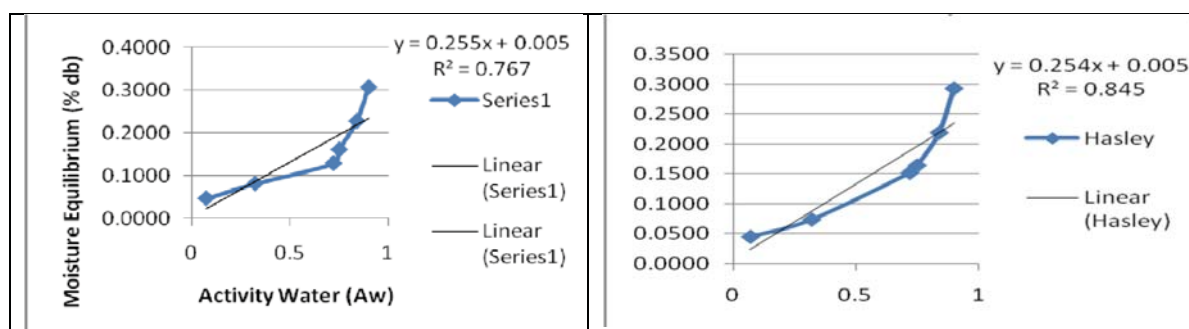

Figure1. Curve of Isothermal Moisture Sorption (Hasley)   **Figure 2**. Curve of Isothermal Moisture Sorption

The Hasley equation model is chosen as the model has the most squeezed curves, the isothermal sorption curves describe the entire isothermal sorption curve of crackers rather precisely ($5 < MRD < 10$). While the model equations of Chen Clayton, Oswin, Henderson and Caurie describe the overall isothermal sorption curves that are not appropriate because MRD is > 10. The slope value on the isothermal sorption curve is 0.254 based on the Hasley equation model. The relation dots between water activity and moisture equilibrium make a linear equation: $y = a + bx$. A value of 0.254 is determined as a linear slope that passes through the moisture initial and moisture equilibrium at each storage RH. This is in accordance with Labuza's statement that the linear area for determining the isothermal sorption slope curve is taken in the area that passes through the Mi (Moisture Initial).

Moisture content can be determined by using the Brunauer-Ermet-Teller (BET) equation, with a linear regression curve connecting aw of [aw / (1- aw) M]. If the slope and intercept data are included in the formula, moisture content durian seed flour of 2.80% (dry based) powder is obtained.

The determination of permeability is performed at temperature 280 ℃ by using NaCl solution having RH equal to 75.5%. The outer air pressure (P out) is determined by multiplying the vapor pressure at

the storage temperature with RH. According to the water vapor table of Labuza (1985), the vapor pressure at 28 ℃ is 28.349 mmHg. So P out in this research is 21.4035 mmHg.
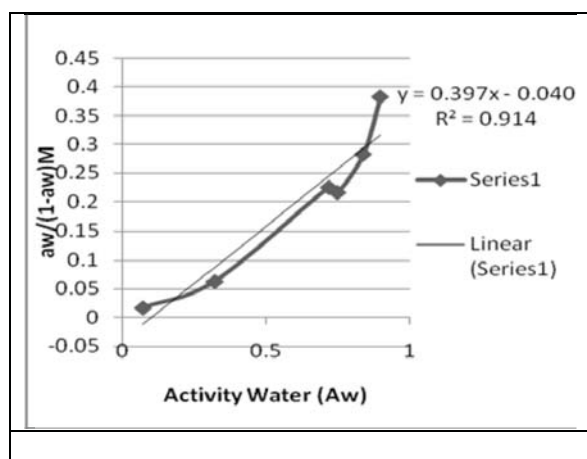

Figure 3. Brunauer-Ermet-Teller (BET) Curve

In general, PP plastic has the lowest permeability. Compared to polyethylene, the polypropylene properties which are the reasons why many are used as packaging materials are the low price, flexibility, appearance, smoothness, inert to chemicals, and low moisture permeability. Polypropylene has better tensile strength and clarity as well as lower water vapor and gas permeability [12]. Other properties of polypropylene are not reacting with materials, able to reduce the contact between materials with oxygen, not toxic and able to protect the material from contaminants.

The isothermal sorption model chosen for this durian seed flour product is the Hasley equation model (5 <MRD <10) [13]. The slope value is determined from the linear area of the isothermal sorption curve predetermined from the isothermal sorption curve of the Hasley model of 0. 2542. The shelf life of the product is calculated under storage conditions at 70% RH.

Table 4. Shelf Life of Durian Seed Flour in Different Plastic Packaging

Type of Packaging	k/x	Shelf Life (day)
LDPE	1.098681334	134
HDPE	0.640897445	230
PP	0.274670334	536

Table 4 showed that shelf life of durian seed flour packaged in LDPE packaging is 134 days, in HDPE packaging 230 days and in PP packaging 536 days. Durian seed flour packaged with PP plastic packaging with a thickness of 0.05 mm has a longer shelf life, 536 days. This is because the PP packaging has a lower permeability so that durian seed flour takes longer to reach its critical moisture content than it does in other packs with higher permeability. As the lower permeability of packing, the higher ability of protection against the absorption of water vapor, the shelf life of food products in the packaging is longer. The storage of durian seed flour with PP plastic packaging with a thickness of 0.05 mm at 28℃ and 70% RH is advisable to be at 2.80% moisture content.

4. Conclusion

Durian seed flour produced from local durian seeds contains 13.42% water, 4.46% ash, 0.55% fat, 9.08% protein and 72.49% carbohydrate (by difference). Besides, the microbiological analysis results in 6.4 x 103 colony/gram total plate number, 5.0 x 10 colony/gram molds, 3 APM / gram *Escherichia coli*, and <100 colony/gram *Bacillus cereus*. The shelf life of durian seed flour packaged in LDPE packaging is 134 days, in HDPE packaging 230 days and in PP packaging 536 days.

Acknowledgments

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