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The Characterization of Jackfruit Seed Flour and Its Application for Crackers

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Abstract :
Jackfruit seed has been utilized for food consumption for many years. The processing into flour may increase its use for wheat substitute in several kind of snacks. This study aimed to determine the effect of jackfruit seed flour concentration on the physicochemical and sensory properties of crackers. The experiment used a complete randomized design, consisting of 6 levels of jackfruit seed concentration (0, 10, 20, 30, 40 and 50%) and 3 replications. The result shows that jackfruit seed flour has higher ash and crude fiber content than wheat flour and has a comparable amount of protein. The jackfruit seed flour can be used for a wheat flour substitute in crackers production. Based on ANOVA, the concentration of jackfruit seed flour does not significantly affect water content, crispness, taste, and overall acceptance measured by sensory tests however, it significantly affects the hardness, expansion volume and brightness. The concentration of jackfruit seed flour can be used up to 30% of the total flour used in cracker production without a change in hardness and sensory properties and slightly different expansion volume when compared to wheat crackers.

Keywords: Jackfruit Seed, Wheat Flour, Crackers.

1. Introduction

Cracker is a type of biscuit made from hard and flat dough that tastes salty and crispy. In general, the basic ingredient for crackers production is wheat flour. As many snacks are made of wheat, the need for wheat flour is supposedly increasing, too. Indonesia is not the producer of wheat therefore needs to import from other countries (Santoso et al., 2014). Wheat flour in Indonesia is imported from America, Canada, Europe, Central Asia and Australia. Imports of wheat flour in 2010 reached 775 thousand tons and in 2011 wheat consumption rose by 10% (Nugrahawati, 2011). On the other hand, Indonesia is rich of sources which may be used as a substitute for wheat such as jackfruit seed flour.

In 2013 Jambi Province produced 8.742 tons jackfruit (Central Statistics Agency, 2013). One part of the jackfruit that can be processed as food is the seeds. As jackfruit production increases, seeds are produced which have not been used or are simply thrown away without any further processing. Jackfruit seeds are relatively cheap and sometimes they are considered as waste. Generally, jackfruit seeds are only consumed after being grilled, boiled, or fried.

Jackfruit seeds contain quite a lot of nutrients, including carbohydrates (36.7 grams), phosphorus (200 mg), iron (1 mg), protein (4.2 grams) and vitamin C (10 mg). The starch contained in jackfruit seeds is 56.21%, starch is the main constituent of flour, making it possible to process it into jackfruit seed flour. Processing into flour is an effort to utilize jackfruit seed waste and an effort to increase added value (Juwariyah, 2000). Furthermore, Safitri (2013) reported that jackfruit seeds can prevent colon cancer. In addition, jackfruit seeds have the potential to be prebiotics because they contain polysaccharides and oligosaccharides that cannot be digested by digestive enzymes.

Jackfruit seed flour is the product of processed dried jackfruit seeds that have undergone grinding and sieving. Jackfruit seed flour has a carbohydrate content of 81.7%, protein 13.6% and water 11.4% (Purbasari et al., 2014). Wheat flour on the other hand contains 77.2% carbohydrate, protein 9.0% and water 11.8%

(Indonesian Food Composition Table, 2009 in Sari, 2012). Jackfruit seed flour as a substitute for wheat flour in making crackers will enrich macro and micronutrients such as iron, phosphor, and calcium. According to Winarno (2004), jackfruit seeds are high in calcium (33 mg/100 g) and phosphorus (200 mg/100 g). Ocloo, et al (2010) reported that jackfruit seed flour has a lot of potential in the bakery industry, especially its amylographic properties, namely that it can be used as a thickener and has good water binding ability. The water bound by starch when gelatinization occurs will be lost during the drying process, leading the dough to turn crispy in crackers (Williams and Margareth, 2001).

There has been a lot of research conducted on the substitution of wheat flour in crackers production. Crackers with the best physical and sensory properties were successfully made by substituting 30% of wheat using *gadung* tuber flour (Anderson, 2018). According to Darmatica (2018), the ratio of wheat flour to cowpea flour of 3:2 successfully meets the cracker quality criteria, namely ash content and protein content in accordance with SNI 01-2973-1992, in exception for water content. Crackers are a dry product that has low water content. Crackers are made from fermented dough. The starch in jackfruit seed flour contains amylose and amylopectin which are useful for increasing the firmness and viscosity of the gel, thus affecting the level of elasticity and shape of processed food such as crackers. This research aims to determine the effect of jackfruit seed flour as a substitute for wheat flour on the physical and sensory characteristics of crackers.

2. Research Methods

Material

Jackfruit seeds were the waste obtained from fruit salad market in Jambi city. The other materials were low protein wheat flour, yeast, skim milk, refined sugar, margarine, butter, salt and baking powder. Steven LFRA (Leatherhead Food Research Association) Texture analyzer was used to determine the hardness of crackers. Color Reader was used for brightness determination.

Research Design

This research used a Completely Randomized Design (CRD) with treatment use of jackfruit seed flour consisting of 6 levels of treatment (0, 10, 20, 30, 40 and 50% of the amount of total flour) and 3 repetitions.

Jackfruit Seed Flour Preparation (Yunarni, 2012)

The jackfruit seeds are sorted from round to oval, smalls in size of about ± 3.5 cm, washed, boiled for 30 minutes, peeled the epidermis with a knife, sliced thin and dried in an oven dryer at 60^{o}C for 4 hours. The dried slices were grinded using a flour milling machine and sifted using a 60-mesh sieve.

Crackers Preparation (Ferazuma, et al., 2011) with a modification

The ingredients were weighed according to the formula in Table 1. Water and salt were put into a bowl and stirred evenly using a spoon (dough 1). In another bowl, jackfruit seed flour, wheat flour, yeast, powdered sugar, baking powder, margarine and butter were mixed and stirred evenly (dough 2). Dough 1 and dough 2 were mixed and kneaded by hand until smooth. The fermentation process was carried out by letting the dough sit for 30 minutes with the dough covered with a cloth. After the fermentation process completed, the dough was made into sheets and cut into 4x5 cm length and 1 mm thickness. Holes were made on top before baking at 160^{o}C for 20 minutes and 5 minutes at 25^{o}C - 30^{o}C.

Table 1. Formula for crackers production

Composition	Jackfruit seed flour (%)					
	0	10	20	30	40	50
Wheat flour (g)	100	90	80	70	60	50
Jackfruit seed flour (g)	0	10	20	30	40	50
Sugar flour (g)	1	1	1	1	1	1
Margarine (g)	20	20	20	20	20	20
Yeast (g)	2	2	2	2	2	2
Skimmed milk (g)	4	4	4	4	4	4
Baking powder (g)	0,1	0,1	0,1	0,1	0,1	0,1
Salt (g)	2.20	2.20	2.20	2.20	2.20	2.20
Butter (g)	10	10	10	10	10	10

Water Content Analysis

Determination of water content was carried out using gravimetric method.

Texture (Baer and Dilger, 2014 in Lesmana, 2017)

Texture measurements were carried out using the Steven LFRA (Leatherhead Food Research Association) Texture Analyzer. The Steven LFRA Texture Analyzer tool was set as follows. Mode: measure force in compression (measure the amount of force required to press the sample), Plot: Final, Option: Normal, Trigger: Auto 4g standards, Distance: 3mm, Speed: 0.5 mm/s.

The crackers to be measured were placed on a supporting table plate. The start button on the Steven LFRA Texture Analyzer was pressed. The probe presses the biscuit at a speed of 0.5 mm/s until the pressing distance was 3 mm. The probe used was cylindrical in shape with a diameter of 2 mm. The trigger type used was the auto type. In this type, the probe will automatically search on the sample surface. The texture value is finally displayed on the display which was expressed in gram force (gF) units.

Brightness (Andarwulan, et al., 2011)

Brightness measurements were carried out using a color reader. Measurements were carried out by placing an inspection lamp in a plane above the surface of the material. Measurements were carried out in triplicate. The percentage of light read by the instrument was recorded, namely the L* or brightness. The scale for L* is between 0 – 100 (black – white).

Expansion Volume (Aj-juwita and Kusnadi, 2015) modified.

The volume of crackers before baking (V_1) and after baking (V_2) were determined by measuring the length, width and height of the crackers. Expansion volume or the percentage volume of cracker expansion was calculated using the formula below:

$$\text{Expansion volume} = (V_2 - V_1) \times 100\%$$

Sensory Properties (Soekarto, 1985)

Sensory tests on crackers were carried out using product description tests and multiple comparisons. Product description tests were carried out on crispness and taste (Table 2). Multiple comparisons are made to overall acceptance (Table 3). There were 20 trained panelists who participated in the test. They were students of Agricultural Product Technology, Faculty of Agriculture, Jambi University.

Table 2. Score for sensory evaluation.

Score	Crispness	Taste
5	Very crispy	Very delicious
4	Crispy	Delicious
3	A little bit crispy	A little bit delicious
2	Not crispy	Not delicious
1	Not crispy at all	Not delicious at all

Table 3. The score for multiple comparison test

Numeric Scale	Comparison Scale
7	Much preferred than R
6	Preferred than R
5	A little bit preferred R
4	As preferred as R
3	Less preferred than R
2	Not preferred than R
1	Completely not preferred than R

Data Analysis

The data were analyzed using the Analysis of Variance (ANOVA) and Duncan's New Multiple Range Test (DNMRT) when necessary using SPSS software.

3. Result and Discussion

Jackfruit Seed Flour and Crackers

Jackfruit seed flour contains high crude fiber and minerals as seen in Table 4. Jackfruit seed flour also contains a comparable amount of protein. The nutritional value of jackfruit seed cracker produced using 30% jackfruit seed flour can bee seen in Table 4.

Table 4. Chemical composition of jackfruit seed flour and wheat

Chemical composition	Jackfruit seed flour	Wheat flour *	Jackfruit seed crackers**
Water (%)	10.52	8.58	8.82
Ash (%)	3.00	1.10	1.57
Fat (%)	1.03	1.44	16.17
Protein (conversion factor 6.25) (%)	12.40	12.45	9.75
Carbohydrate (by difference) (%)	73.37	75.85	63.69
Crude fiber (%)	4.92	0.61	2.11
Starch (%)	65.97	na	54.37

* Oyeyinka & Bassey (2023)
** Formulation: 30% jackfruit seed flour

Water Content

Water content is one important parameter in determining the quality of food product which aims of providing a minimum or vulnerable limit for the water content in the product. Apart from that, it is important to measure water content in food products because water may affect the texture and taste of food. Analysis of the variety of crackers showed that the substitution of jackfruit seed flour in crackers production had no

significant effect on the water content of the crackers produced. The percentage of cracker water content can be seen in Table 5.

Table 5. Physicochemical characteristics of crackers at several concentration of jackfruit seed flour

Jackfruit seed flour (%)	Water content (%)	Hardness (gF)	L*	Expansion volume (%)
0	2.441	649.7[a]	48.13[a]	2.53[a]
10	2.428	910.4[a]	47.73[a]	2.43[ab]
20	2.367	954.4[a]	46.80[b]	1.87[bc]
30	2.363	814.9[a]	46.07[c]	1.67[c]
40	2.312	1531.6[b]	45.17[d]	1.40[c]
50	2.308	1958.4[b]	39.93[e]	0.73[d]

Note: numbers in the same column followed by the same superscript are not significantly different at the 5% level in the DnMRT

Table 5 shows that there is no effect of jackfruit seed flour concentration on the cracker's water content. This water content of the product is also influenced by the initial water content of the raw material (Pratama, 2011). The water content of jackfruit seed flour is 11.4%, higher than its substitute counterpart (wheat flour) with 11.8% water content (Sari, 2012). Based on the quality requirements for biscuits SNI 01-2973-1992 which states a maximum water content of 5%, the water content in all treatments in this study meets the requirements as crackers. According to Nurjanah et al (2011), the baking process at a temperature of 150^0C evaporates and reduces the amount of water content in the crackers. Jackfruit seed flour and wheat flour contain starch which are able to absorb water to different extents. In addition, during baking there is a loss of moisture from the surface of the product by evaporation followed by the transfer of moisture to the surface which is continuously lost to the oven environment.

Hardness

Another physical characteristic of crackers that influences the quality and acceptance of crackers is hardness (Wenchoa et al., 2013). According to Andarwulan et al. (2011) hardness is the property of a food product that shows its resistance to breaking due to the applied compressive force. Analysis of various textures of crackers shows that the level of substitution of wheat flour with jackfruit seed flour has a significant effect on the texture of the crackers produced.

As seen in Table 5, the texture of jackfruit seed flour crackers ranges from 649.7 to 1958.4 gF. The hardness value of the crackers up to 30% substitution of wheat flour with jackfruit seed flour was not significantly different to the crackers produced. Meanwhile, by substituting 40% and 50% of wheat flour with jackfruit seed flour, the hardness increased. This shows that the greater the amount of jackfruit seed flour added to the crackers, the level of hardness will also increase. The results of this research are similar to research by Anderson (2018) which shows that the higher the substitution of wheat using gadung flour, the harder the cracker and less crispy. The measured hardness and crispness values of the crackers will be influenced by the composition of the crackers, temperature, fermentation and baking time.

The hardness value of commercial crackers, 653.4 gF, was used as a standard reference for cracker hardness in this research. The substitution of wheat flour with jackfruit seed flour caused an increase in hardness to 0% to 50% than the standard value. The principle of measuring texture using a texture analyzer is to measure the amount of force needed to press the sample. The greater the force required, the harder the crackers will be (Rianti, 2008).

The hardness value of crackers can also be influenced by the ratio of amylose and amylopectin in the basic ingredients for crackers production. The amylose and amylopectin content in jackfruit seed flour is 16.72% and 83.28%, while in wheat flour is 10.23% and 89.77% (Imanningsih, 2012 and Ejiofor et al., 2014). The higher the amylose content in starch tends to produce a harder product because the starch granules composed of amylose have a straight structure, the granule composition is denser and more compact, so that during the baking process the expansion occurs in a limited manner (Hee-Joung An, 2005 and Rauf, 2015).

The higher amylose content in jackfruit seed flour than wheat flour promoting an increase in the hardness of the crackers.

The hardness value of crackers is also influenced by the protein in the form of gluten contained in wheat flour. The higher the jackfruit seed flour substitution, the lower the gluten content in the cracker dough. A lower gluten content can result in a decrease in elastic properties, so that the texture of the crackers becomes harder after baking. According to Subandoro, et. al. (2013) low gluten content in the dough will cause the dough to be less able to hold gas, so that the pores formed are small. During the baking process the dough does not expand properly, resulting in a hard product. The texture of the crackers is closely related to the volume of expansion of the crackers. As jackfruit seed flour increases and wheat flour decreases, the volume of expansion tends to decrease and therefore cause increase in the hardness.

Brightness

Brightness as a part of color parameter, is a quality attribute that can be captured by our eyes as soon as we see it, so its existence is very important and determines consumer acceptance. Analysis of cracker brightness shows that the level of jackfruit seed flour concentration has a significant effect on the brightness of the crackers. The brightness value of the crackers ranged from 39.93 to 48.13 (Table 5). As the concentration of jackfruit seed flour increases and the amount of wheat flour used decreases, the brightness of the crackers produced tends to decrease. As the color of jackfruit seed flour is brownish, the higher concentration of jackfruit seed flour may cause the color of the crackers to tend to be more brownish and less bright (Qomari, 2013).

Expansion Volume

The volume of expansion is one of the quality factors of crackers due to its capability to predict crispness and consumer acceptance. Analysis of the various volumes of cracker expansion shows that the level of substitution of wheat flour with jackfruit seed flour has a significant effect on the volume of expansion of the crackers. Table 5 shows that the volume of cracker expansion becomes lower with increasing substitution of jackfruit seed flour used. The expansion volume in crackers ranges from 0.73% to 2.53%. The expansion volume tends to decrease along with the increasing use of jackfruit seed flour. The substitution of wheat flour with jackfruit seed flour for crackers production decrease the amount of gluten available for volume expansion. According to Subandoro et al (2013), a small amount of gluten in the dough can cause the dough to be less able to hold gas, so that the pores formed in the dough are also small. As a result, the dough does not rise and has little volume expansion.

Sensory Properties

Crispness is one of the factors determining the quality of crackers that needs to be considered, because it is closely related to the degree of consumer acceptance. In general, crackers that are considered good are crackers that have a brittle texture, that is, if you press the cracker with your finger, it will break easily. The analysis of variance for the sensory parameters are all not significant (Table 6).

Table 6. Sensory properties of crackers at several concentration of jackfruit seed flour

Jackfruit seed flour (%)	Crispness	Taste	Multiple comparison
0	3.25	3.65	5.35
10	3.60	3.55	5.20
20	3.30	3.35	5.00
30	3.45	3.30	5.15
40	3.20	3.15	4.80
50	2.95	3.25	4.90

Note: the scores for these parameters are listed in Table 2 and 3

Conclusion

Jackfruit seed flour can be used as a substitute for wheat flour in crackers production. The concentration of jackfruit seed flour has no significant effect on water content, crispness, taste, and overall acceptability as measured using sensory tests but has a significant effect on hardness, expansion volume, and brightness. The formulation of 70% wheat and 30% jackfruit seed flour produces crackers with the best hardness and crispness.

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