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Breakfast development based on jack bean and analysis of physical, chemical and sensory product

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Abstract. The physical characteristics jack bean is hard outer skin, make it difficult to process. This research aimed to determine the proportion of jack bean and tapioca flour for making jack bean breakfast; the effect of peeling method by immersion in CaCO_3 and NaOH solutions and to determine concentration of skim milk for making jack bean breakfast with good physical, chemical, and sensory properties. This research used a randomized block design. Factors studied were the proportion of jack bean flour: tapioca w/w, consisted of 3 levels (70:30, 60:40; 50:50); peeling method consisted of 2 levels (15% CaCO_3 for 1 hour and 3% hot NaOH solution for 7 minutes); and the addition of skim milk consisted of 3 levels (5, 7.5, and 10%). The best treatment combination was jack bean: tapioca flour 60:40; peeling by CaCO_3 , skim milk concentration 7.5%. Jack bean breakfast had a rehydration coefficient of 3.37; water content of 4.57% wb; ash content of 2.54% wb (2.66% db), protein content 12.18% wb (12.76% db); fat 8.13% wb (8.52% db), carbohydrate (by difference) 72.58% wb (76.06% db), crunchy texture value (3.37); a rather distinctive taste (2.17); delicious flavor (2.67); and panelist preferences of favored products (2.63).

1. Introduction

The community activities cause frequent neglect breakfast. Breakfast is very important to support physical activity and mental development. The solution is fast food and practical but it has nutritional standards, namely cereal breakfast, which is ready-to-eat food made through an extrusion process and is usually consumed by adding milk as a breakfast menu [1]. To increase food diversification and provide alternative breakfast products, it is necessary to use other ingredients such as Jack beans (*Canavalia ensiformis*).

Jack bean contains 60.1% carbohydrates, 30.36% protein, and 8.3% fiber [2]. Jack bean has considerable potential to be developed as an alternative food source of protein because of a balance of amino acids, but unfortunately this potential has not been developed optimally so that utilization is still relatively limited. One of the obstacles in utilizing jack bean is its physical character. Therefore, this study uses paring method with alkaline solution, namely NaOH and lime (CaCO_3) to facilitate the hard stripping of the jack bean's skin. Previous study has conducted in making durian seed flour with lime water immersion (CaCO_3) at a concentration of 5, 10, 15% [3]. Therefore, in this study immersion of CaCO_3 solution was carried out at concentration of 15%. To improve the diversity of jack bean, in this study jack bean was processed into flour and used as raw material for making breakfast as a substitute for flour which is the main raw material for making cereal breakfast. Furthermore, the addition of skim milk is expected to improve flavoring, binding water, forming a strong and porous structure, and forming



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colors due to browning reactions in the jack bean breakfast. Skim milk contains food from milk except for fat and vitamins that are fat-soluble [4].

Based on the description, this study aimed to: 1) determine the effect of the method of paring the Jack bean with immersion in a solution of CaCO_3 and NaOH; 2) determine the proportion of jack bean and tapioca flour for making good jack bean breakfast with physical, chemical and sensory properties; 3) determine the concentration of skim milk for making good Jack bean breakfast with physical, chemical and sensory properties; 4) establish the best treatment combination for the physical, chemical and sensory properties of jack bean breakfast.

2. Research methodology

This research was conducted at the Processing Laboratory, Food and Nutrition Laboratory, Faculty of Agriculture, Jenderal Soedirman University, Purwokerto, from September to December 2017. The material used in the manufacturing jack bean flour was obtained from Bogor, 3% NaOH, 15% CaCO_3 . The ingredients used in the manufacture of Jack bean breakfast were skim milk, salt refina brand, tapioca brand Rose Brand, Digisari brand ovalet, Intisari brand sugar, baking powder, and Mama Suka brand oil obtained from Purwokerto Intisari Store. The material used in the analysis of Jack bean chrysanthemum breakfast chemistry consisted of technical NaOH, 0.1 N NaOH, Petroleum ether, $\text{K}_2\text{S}_2\text{O}_8$, HgO , H_2SO_4 , methyl red HCl indicator, and whatman filter No. 41.

The equipment used for chemical analysis of Jack bean breakfast products include porcelain dishes, ovens (Memert 854 Schwabach, Germany), desiccators, analytical balance sheets, Soxhlet (P selecta Recisterm, Germany), fat pumpkins (Duran 250 ml, Germany), pumpkin Kjedaahl (Duran 250 ml, Germany), furnace (Thermolyne Series-1000, Germany) and a set of glassware (Pyrex).

This study used an experimental method with the experimental design used was Randomized Block Design (RBD). The factors studied were paring method consisting of 2 levels (CaCO_3 15% for 1 hour (K1) and 3% NaOH solution heat for 7 minutes (K2)); proportion of tapioca-tapioca flour w/w, consisting of 3 levels (70:30 (P1); 60:40 (P2); 50:50 (P3)); and addition of skim milk consisting of 3 levels (5% (M1); 7.5% (M2); 10% (M3)). The treatment was arranged factorially with 18 treatment combinations and 2 replications to obtain 36 experimental units.

The variables observed consisted of physical variables namely rehydration coefficient; chemical variables included moisture content, ash content, total protein content, total fat content, and carbohydrate content (by difference); and sensory variables included texture, typical Jack bean flavor, flavor, and preference, as well as protein, fat content, and carbohydrate (by difference) levels which are only carried out on the best treatment combination.

Physical and chemical variable data were analyzed using Variance Analysis (Test F) at the level of 5%, if the results of the analysis had a significant effect followed by DMRT at the level of 5%. Sensory variables were analyzed using Friedman Test and if significantly different, it would be followed by a double comparison test at the 5% level. The best treatment combination is determined using the Effectiveness Index Test.

3. Result and discussion

3.1. Physical and chemical variable

The results of various analysis of the effect of stripping method (K), the proportion of jack bean flour: tapioca (P), and the addition of skim milk (M) and the interaction between the three ($\text{K} \times \text{P} \times \text{M}$) on physical and chemical variables of Jack bean breakfast are presented in Table 1.

Table 1. Results of analysis of variance (F test) stripping method (K), the proportion of Jack bean flour: tapioca (P), and the addition of skim milk (M) and interaction between the three (KxPxM) to physical and chemical variables of Jack bean breakfast

Variable	Treatment						
	P	K	M	P x K	P x M	K x M	P x K x M
Coefficient rehydration	**	Ns	**	ns	ns	ns	ns
Water content	**	*	ns	ns	ns	ns	ns
Ash content	ns	Ns	ns	ns	ns	ns	ns

K = stripping method; P = proportion of jack bean flour: tapioca; M = concentration of skim milk; K x P x M = interaction between stripping method, proportion of Jack bean flour: tapioca, and skim milk concentration; ns = not significant; * - significant effect, ** - very significant.

3.1.1. *Coefficient rehydration.* Proportion of jack bean flour: tapioca had a very significant effect on the rehydration coefficient of the Jack bean breakfast. The average value of rehydration coefficient of jack bean breakfast in the treatment of proportion of Jack bean: tapioca (P) is presented in Figure 1.

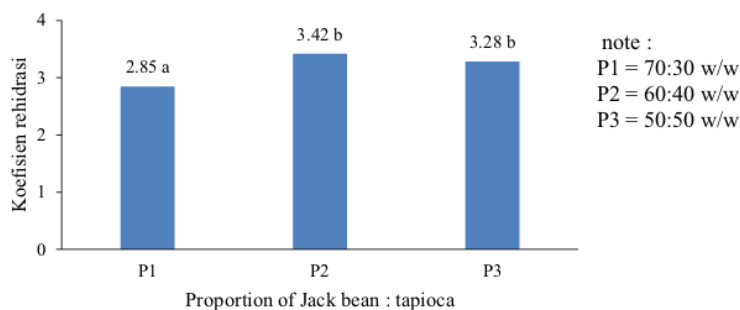


Figure 1. Rehydration coefficient of Jack bean breakfast in the treatment of proportion of jack bean: tapioca.

Jack bean breakfast with a proportion of Jack bean: tapioca 60:40% w/w treatment had a higher average rehydration coefficient (3.42) compared to the proportion of jack bean: tapioca 50:50% w/w (3.28) although not significantly different. The average value of the lowest rehydration coefficient, which is 2.85 is produced from the proportion of jack bean flour: tapioca 70:30% w/w. The use of tapioca increased the rehydration coefficient value. Water absorption (rehydration) in breakfast products is related to serving for consumption. The faster the product absorbs water, the better because it is faster to consume. Starch is a homopolymer of glucose with α -glycoside bonds which have hydroxyl groups that can form hydrogen bonds with water molecules [5]. The more starch added, the higher the porosity of the product.

The concentration of skim milk had a very significant effect on the rehydration coefficient of jack bean breakfast. The average value of rehydration coefficients for jack bean breakfast in skim milk concentration (M) treatment is presented in Figure 2.

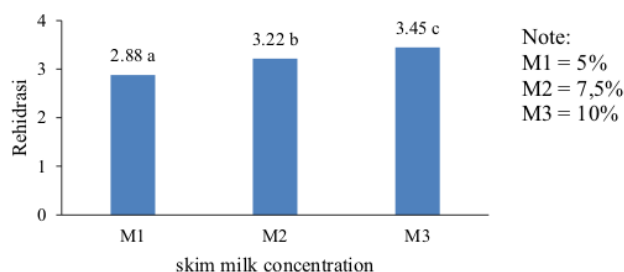


Figure 2. Rehydration coefficient of Jack bean breakfast in the treatment of skim milk concentration.

Jack bean breakfast in the treatment of skim milk concentration was 2.88; 3.22; 3.45. The highest rehydration coefficient value was obtained from the treatment of 10% skim milk concentration, while the lowest rehydration coefficient was obtained from 5% skim milk concentration. This was due to the protein content in skim milk that can bind water. Protein is hydrophilic so that the higher the protein content of a food ingredient, the higher the water binding ability [6]. The protein content in skim milk is 39.48% [7].

3.1.2. *Water content.* The paring method significantly affected on the water content of the Jack bean breakfast. The average value of the water content of jack bean breakfast (K) is presented in Figure 3.

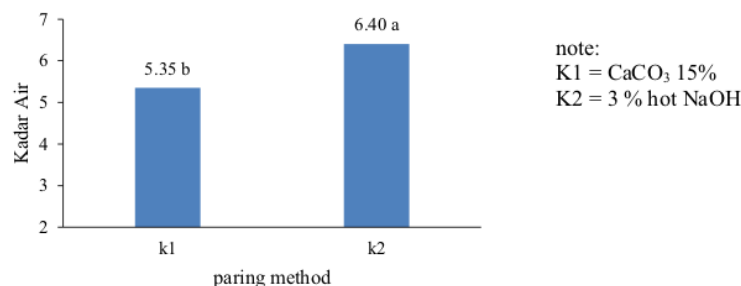


Figure 3. Water content of Jack bean breakfast in the stripping method treatment.

Jack bean breakfast of paring using soaking in CaCO_3 (K1) produced a breakfast of jack bean with lower moisture content. CaCO_3 or lime water contains calcium which can strengthen the tissue [8]. Strong tissue structure can cause difficulty in the diffusion of water into the material, so that the water content in the Jack bean does not increase. This is consistent with previous finding that the effect of lime water concentration on water content is due to the fact that this lime is binding to CO_2 and water (hygroscopic) thus forming Ca(OH)_2 and reducing water content [9]. Ca ion in lime will enters the material and binds water so that the water content will decrease.

Jack bean breakfast of hot NaOH paring method (K2) has an average water content greater than using CaCO_3 (K1) soaking. The nature of the basic NaOH solution makes lignin in jack bean dissolve so that the skin can peel and heat in the solution causes the hydrolysis process to take place. This hydrolysis

process causes higher levels of heat (K2) paring treatment water. Previous study showed that during boiling treatment in 2.5% NaOH boiling for 5 minutes, the Cubiu peel gradually proves the hydrolysis of the inner layer, but the skin remains detached from the fruit without tearing [10]. When the fruit is removed from boiling water and exposed to tap water, the skin is easily removed under running tap water.

The proportion of jack bean flour: tapioca had ³very significant effect on the water content of the Jack bean breakfast. The average value of water content of Jack bean breakfast in the treatment of proportion of jack bean: tapioca (P) is presented in Figure 4.

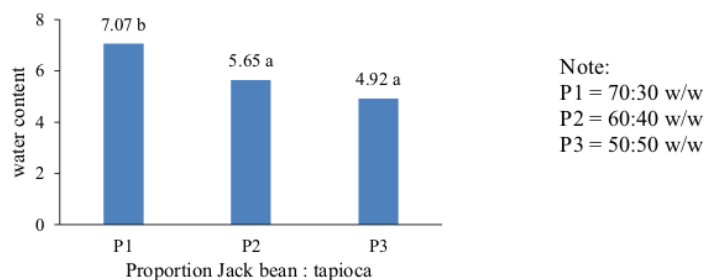


Figure 4. Average value of water content of jack bean breakfast in the treatment of proportion of Jack bean: tapioca

In the treatment proportion of Jack bean flour: tapioca P2 60:40% w/w and P3 50:50% w/w had no significant effect. Average value of water content in the treatment of proportion of jack bean flour: tapioca, respectively 7.07% w/w; 5.65% w/w; 4.92% w/w. A decrease in the proportion of jack bean causes the product's water content tends to decrease. The water content of Jack bean breakfast is influenced by the protein content of Jack bean flour which has a higher water binding ability so that with a decrease in the proportion of flour causes water content in the jack bean breakfast decreased. This is in accordance with the opinion that protein has a higher water binding ability than starch [11]. The hydrogen bond formed between starch molecules and water will decrease with the interaction between starch and protein.

3.1.3. Ash content. The effect of paring method (K), the proportion of jack bean flour: tapioca (P), and the addition of skim milk (M) and the interaction between the three (KxPxM) did not significantly affect the ash content of jack bean breakfast. The average ash content of Jack bean breakfast is based on the interaction of paring methods; the proportion of Jack bean flour: tapioca; and the concentration of skim milk ranged from 1.48-3.73%. The average ash content of swordfish is quite high. This is because the jack bean has an ash content of 2.7% dry weight [12], while according to [13], tapioca has 0.16% ash content.

3.2. Sensory variable

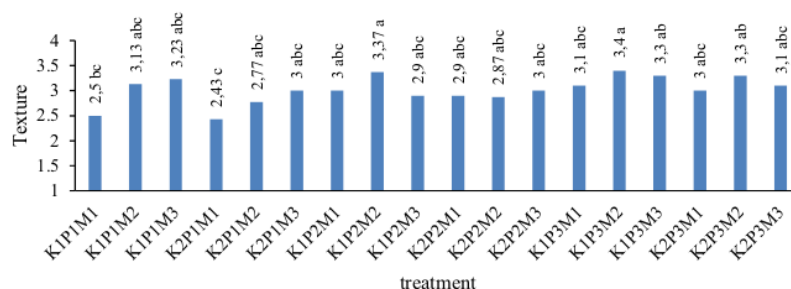
Friedman test results influence the combination of paring method treatment; the proportion of Jack bean flour: tapioca; and the concentration of skim milk (KxPxM) on the jack bean breakfast sensory variables is presented in Table 2.

Table 2. Friedman test results influence the combination of paring method treatment; the proportion of Jack bean flour: tapioca; and skim milk concentration.

Variable	treatment KPM
Texture	**
Typical taste of Jack bean	**
Flavor	**
Preference	**

KxPxM = stripping method, the interaction between the proportion of Jack bean flour: tapioca, and skim milk concentration; ** - very significant effect based on the *Friedman* test.

3.2.1. *Texture*. Friedman test results show that the combination of stripping method treatment, the proportion of jack bean flour: tapioca; and the concentration of skim milk has a very significant effect on the texture of the Jack bean breakfast. The average value of jack bean breakfast texture can be seen in Figure 5.



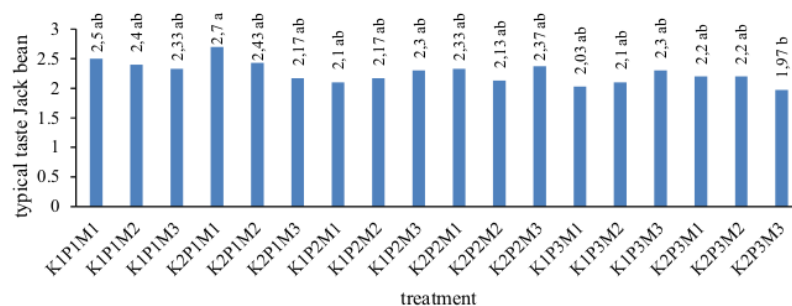
K = stripping method (K1 = CaCO₃ 15%; K2 = NaOH 3% heat); P = proportion of Jack bean flour: tapioca (P1 = 70: 30%; 60: 40%; 50: 50%); M = concentration of skim milk (M1 = 5%; M2 = 7.5%; M3 = 10%). 1 = not crisp; 2 = rather crunchy; 3 = crisp; 4 = very crunchy.

Figure 5. The average score of jack bean breakfast texture score on the combination of stripping method treatment; the proportion of jack bean flour: tapioca; and skim milk concentration.

The average value of jack bean breakfast texture ranged from 2.43 to 3.4 which means it was rather crispy to crunchy. The results showed that the jack bean breakfast texture in the combination treatment K1P3M2 (paring CaCO₃; Jack bean flour: 50:50 tapioca; 7.5% skim milk concentration) produced the highest value of 3.4 which means crispy. The treatment of K2P3M2 was not significantly different from K2P3M3. The combination of K2P1M1 treatment (NaOH stripping; jack bean: tapioca 70:30; skim milk concentration 5%) resulted in the lowest value of 2.43.

Jack bean breakfast texture is influenced by the availability of starch in the raw material and the presence of starch gelatinization process. The higher starch added produced a high porosity product and have many cavities so that the product becomes crispy [5]. In addition, the texture of the jack bean's breakfast texture is also influenced by the amount of amylopectin found in the mixture. The level of development and texture of snacks is influenced by the content of amylose and amylopectin [14]. Starch which has high amylopectin content tends to give a fragile (easily broken) product character. Tapioca has an amylopectin content of 83% [15], while the jack bean amylopectin content is lower at around 68.88% [16]. In addition, the texture of the jack bean is also influenced by skim milk. Skim milk is used as a source of protein and improves texture in the final product [17].

3.2.2 Typical taste Jack bean. Friedman test results show that the combination of treatments between stripping methods; the proportion of jack bean flour: tapioca; and the concentration of skim milk has a very real effect on the typical taste of Jack bean breakfast. The average value ranges from 1.97-2.7 it is mean the typical taste of jack bean. The results showed that the texture of jack bean breakfast in the combination treatment K2P1M1 (stripping NaOH; jack bean flour: tapioca 70:30; skim milk concentration 5%) yielded the highest value of 2.7, which means typical of jack bean. This is because the jack bean flour used in this study has a very typical jack bean, so it has a distinctive jack bean flavor.

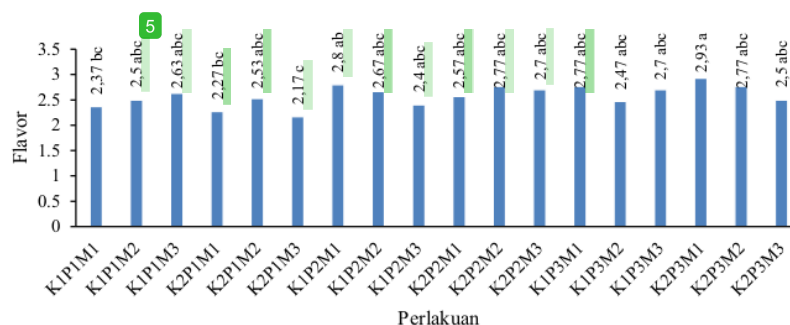


Description: K = stripping method (K1 = CaCO₃ 15%; K2 = NaOH 3% heat); P = proportion of Jack bean flour: tapioca (P1 = 70: 30%; 60: 40%; 50: 50%); M = concentration of skim milk (M1 = 5%; M2 = 7.5%; M3 = 10%). 1 = not typical; 2 = rather typical of Jack bean; 3 = typical; 4 = very typical.

Figure 6. Mean score of typical jack bean score for breakfast on a combination of stripping method treatment; the proportion of Jack bean flour: tapioca; and skim milk concentration.

3.2.3. Flavor. Flavor or taste is a sensation produced by food ingredients when placed in the mouth especially caused by taste and smell [18]. Friedman test results show that a combination of stripping methods; the proportion of jack bean flour: tapioca; and the concentration of skim milk significantly affect the flavor of the jack bean breakfast. The average value of the Jack bean breakfast flavor can be seen in Figure 7.

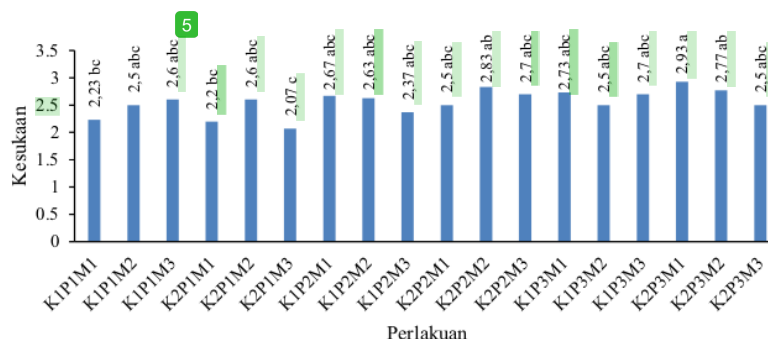
The average value of the jack bean's breakfast flavor ranged from 2.17–2.93 which meant it was rather tasty to tasty. The highest average flavor value in Jack bean breakfast was 2.93 in K2P3M1 treatment (NaOH stripping; jack bean flour: 50:50 tapioca; 5% skim milk concentration). Jack bean breakfast treatment of K2P1M3 (stripping NaOH; jack bean flour: tapioca 50:50; skim milk concentration 10%) having the lowest value of 2.17 which means rather tasty. Based on the results, jack bean breakfast with a proportion of tapioca which produces more delicious flavor than Jack bean breakfast with less tapioca. This seems to be influenced by the level of product crispness. Panelists tend to like crispy breakfast when eaten.



Description: K = stripping method (K1 = CaCO_3 15%; K2 = NaOH 3% heat); P = proportion of Jack bean flour: tapioca (P1 = 70: 30%; 60: 40%; 50: 50%); M = concentration of skim milk (M1 = 5%; M2 = 7.5%; M3 = 10%). 1 = not good; 2 = rather good; 3 = delicious; 4 = very good.

Figure 7. The average score of jack bean breakfast flavor score on the combination of stripping method treatment; the proportion of jack bean flour: tapioca; and skim milk concentration.

3.2.4. *Preference.* Friedman test results show that a combination of paring methods; the proportion of jack bean flour: tapioca; and the concentration of skim milk has a very real effect on the preferences of the Jack bean breakfast. The average value of a favorite breakfast can be seen in Figure 8.



Description: K = stripping method (K1 = CaCO_3 15%; K2 = NaOH 3% heat); P = proportion of Jack bean flour: tapioca (P1 = 70: 30%; 60: 40%; 50: 50%); M = concentration of skim milk (M1 = 5%; M2 = 7.5%; M3 = 10%). 1 = dislike; 2 = rather like; 3 = likes; 4 = really like it.

Figure 8. Mean score of jack bean breakfast preference score on a combination of paring method treatment; the proportion of jack bean flour: tapioca; and skim milk concentration.

The average value of paringists' preference for jack bean breakfast produced in the combination of stripping method treatment; the proportion of jack bean flour: tapioca; and the concentration of skim milk ranges from 2.07 to 2.93 which means it's rather like to like. The highest level of panelist preference (2.93) was found in K2P3M1 treatment (NaOH stripping; jack bean flour: 50:50 tapioca; 5% skim milk).

concentration). Breakfast of jack bean treatment K2P1M3 (stripping NaOH; jack bean flour: tapioca 50:50; skim milk concentration 10%) has the lowest value of 2.07. The level of panelists' preference for Jack bean breakfast tends to decrease with the increasing proportion of jack bean flour. This is because the panelists are not familiar with the taste of the jack bean which tends to be "bitter". In addition, the level of preference is influenced by various factors including taste, aroma, and texture.

3.3. The best treatment of chemical variable

3.3.1. Total protein content. Based on the effectiveness index analysis, a combination of the best treatment was obtained from K1P2M2 jack bean breakfast (stripping with CaCO_3 ; jack bean flour: tapioca 60:40; 7.5% skim milk concentration). Results of total protein analysis of K1P2M2 Jack bean breakfast were 12.18% fresh weight (12.76% dry weight). The total protein content of the jack bean breakfast comes from the main raw material, namely the Jack bean which has a large protein content. Jack bean has a protein content of 30.36% [2]. In addition, the use of skim milk of 7.5% also increases the Jack bean's breakfast protein. The protein content of skim milk was 39.48% [7].

3.3.2. Fat content. The results of the analysis of fat content in the jack bean breakfast combination of the best treatment of K1P2M2 was quite high, which was 8.13% fresh weight (8.52% dry weight). This is presumably because the fat content of jack bean seeds is quite high, containing fat by 3.9% dry weight [12]. In addition, the use of soybean oil is also able to increase fat levels by 18.1% [19]. Therefore, more and more proportions of jack bean and soybean oil are used, it will produce high levels of fat.

3.3.3. Carbohydrate content by the difference. The results showed the carbohydrate value by the difference in the jack bean breakfast the best treatment combination of K1P2M2 was 72.58% fresh weight (76.06% dry weight). Carbohydrate levels were calculated using the by difference method which is influenced by other chemical components namely the value of water, protein, fat, and ash [20]. If the total amount of these compounds is lower, the carbohydrate content will be higher and vice versa.

The results of the evaluation of the data with the effectiveness index showed the best treatment was the jack bean breakfast K1P2M2 (stripping CaCO_3 ; jack bean: tapioca 60:40; 7.5% skim milk concentration). The results of the best jack bean breakfast products in this study were compared with the commercial cereal breakfast "Koko crunch" and SNI 01-4270-1996 can be seen in Table 3.

The water content of jack bean breakfast K1P2M2 (stripping with CaCO_3 ; jack bean flour: tapioca 60:40; skim milk concentration 7.5%) in this study was higher (4.57% fresh weight) compared to SNI 01-4270-1996 (maximum 3%) but tends to be lower than commercial products (4.8% fresh weight). When viewed from the basic ingredients, jack bean has a protein content of 30.36% [2], and jack bean flour has a water content of 10.09% [16]. The possibility of a high-water content of jack bean breakfast is caused by high protein and skim milk which easily binds water molecules. Protein has the ability to easily bind water molecules in the presence of hydrogen bonds so that the more protein contained in the material, the more water is bound [23].

K1P2M2 jack bean (2.66% dry weight) was higher than the commercial product (1.76% dry weight) but lower than SNI 01-4270-1996 (maximum 4% fresh weight). The average ash content of jack bean is quite high. This is because the jack bean has ash content of 2.7% dry weight [12], while according to [13], tapioca has 0.16% ash content. Besides that, the skim milk ash content is 0.8% [4].

The total protein content of K1P2M2 jack bean breakfast was higher (12.76% dry weight) compared to commercial products (8.7% dry weight). This is because the use of Jack bean flour is quite large at the K1P2M2 jack bean breakfast. Jack bean has a high protein content of 30.36% [2] while commercial products use wheat flour. Protein in wheat flour is 8-12% [24]. In addition, the K1P2M2 jack bean breakfast product uses skim milk of 7.5%. Skim milk contains protein of 39.48% [7]. The total protein

³ content of K1P2M2 jack bean breakfast meets the standards set by SNI 01-4270-1996, namely a minimum of 5% fresh weight.

Table 3. Comparison of the chemical content of K1P2M2 jack bean breakfast products and commercial cereal breakfast "Koko crunch" and SNI 01-4270-1996

Parameter	<i>breakfast</i> K1P2M2 product		¹ commercial product "Koko crunch"		² SNI 01-4270-1996	
	% fesh weight	% dry weight	% fresh weight	% dry weight		
Water content	4.57	-	4.8	-	Max 3.0% bb	
Ash content	2.54	2.66	1.67	1.76	Max	4.0% fresh weight
Protein	12.18	12.76	8	8.7	Min	5.0% fresh weight
fat	8.13	8.52	8	8.7	Min	7.0% fresh weight
Carbohydrate content by the difference	72.58	76.06	77.53	81.44	Min	60% fresh weight
Texture	Crispy		-		Crispy	
Typical taste	Light		-		Normal	
Jack bean Flavor	Good		-		Normal	
Preference	Like		-		Normal	

Source: [21]
[22]

K1P2M2 jack bean breakfast fat content was higher (8.52% dry weight) compared to commercial products. This is because in the manufacture of jack bean breakfast products added 5% soybean oil as a substitute for margarine so that the fat content of the jack bean breakfast products increased. But the K1P2M2 jack bean breakfast still meets the standards set by SNI 01-4270-1996 which is a minimum of 7% fresh weight.

K1P2M2 jack bean breakfast carbohydrate levels were lower (76.06% dry weight) compared to commercial products which was 81.44% dry weight. This is because the carbohydrate content of wheat flour is greater than that of jack bean. According to the [25] wheat carbohydrate content was 71% while in the jack bean 66.1% [26]. But the K1P2M2 jack bean breakfast still in the standards set by SNI 01-4270-1996 which is a minimum of 7% fresh weight. Breakfast jack bean K1P2M2 has crisp texture (3.37); rather typical jack bean taste (2.17); delicious (2.67); and the level of panelists' preference for products like (2.63).

4. Conclusions

4.1. The method of paring the jack bean affects the water content of jack bean breakfast. The method of paring jack bean that is suitable for producing breakfast products with good physical, chemical and sensory qualities was breakfast with paring immersion in CaCO₃ 15% solution (K1) has a lower moisture content than the jack bean breakfast paring with solution 3% NaOH heat (K2).

4.2. Proportion of jack bean: tapioca which for producing breakfast products with good physical, chemical and sensory qualities is 60: 40% w/w that produces a jack bean breakfast with crispy texture, rather typical of jack bean flavor, delicious flavor, and the high level of preference of the panelists.

4.3. The addition of skim milk that for producing breakfast products with good physical, chemical and sensory properties was 7.5% w/w.

4.4. The best treatment combination was K1P2M2 Jack bean breakfast (soaking with CaCO_3 ; Jack bean flour: tapioca 60:40: 7.5% skim milk concentration). Breakfast jack bean K1P2M2 has a rehydration coefficient of 3.37; water content 4.57% fresh weight; ash content 2.54% fresh weight (2.66% dry weight), protein content 12.18% fresh weight (12.76% dry weight); fat 8.13% fresh weight (8.52% dry weight), carbohydrate (by difference) 72.58% fresh weight (76.06% dry weight), crisp texture value (3.37); rather typical jack bean taste (2.17); delicious (2.67); and the high level of panelists' preference for products like (2.63).

7. Acknowledgments

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