



Substitution of chayote, dragon fruit peel, and kepok banana peel on nutrient content and sensory of Vegetable Leather as high fiber snack

Substitusi labu siam, kulit buah naga, dan kulit pisang kepok terhadap kandungan gizi dan sensoris Vegetable Leather sebagai snack tinggi serat

Septia Rosdyaningrum¹, Laras Sitoayu^{2*}, Putri Ronitawati³, Vitria Melani⁴,
Reza Fadhillah⁵

¹ Program Studi Ilmu Gizi, Universitas Esa Unggul, Jakarta, Indonesia

E-mail: septiarosdyaningrum@gmail.com

² Program Studi Pendidikan Profesi Dietisien, Universitas Esa Unggul, Jakarta, Indonesia

E-mail : laras@esaunggul.ac.id

³ Program Studi Pendidikan Profesi Dietisien, Universitas Esa Unggul, Jakarta, Indonesia

E-mail: putri.ronitawati@esaunggul.ac.id

⁴ Program Studi Ilmu Gizi, Universitas Esa Unggul, Jakarta, Indonesia

E-mail : vitria@esaunggul.ac.id

⁵ Program Studi Ilmu Gizi, Universitas Esa Unggul, Jakarta, Indonesia

E-mail : reza.fadhillah@esaunggul.ac.id

*Correspondence Author:

Program Studi Pendidikan Profesi Dietisien, Universitas Esa Unggul, Jakarta, Indonesia

E-mail : laras@esaunggul.ac.id

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Abstract

Consumption of vegetables and fruit in school-age children, which is still less than the recommended five servings/day in 2018, can increase the risk of nutritional problems in children due to low fiber consumption, leading to obesity. High-fiber snacks made from local food can be a solution. However, the availability is still limited. This research aims to develop snack products from chayote, dragon fruit peel, and Kepok banana peel. This quasi-experimental study was conducted from April 2021 to August 2022 at Saraswanti Indo Genetech Chemistry Laboratorium in Bogor. The sample consists of moderately trained panelists, as many as 30 people. There were four concentration formulations of chayote, dragon fruit peel, and Kepok banana peel. Data were analyzed using One Way Anova and followed by Duncan Multiple Range Test (DMRT). The result shows significant differences in color ($p=0,000$), taste ($p=0,000$), texture ($p=0,000$), and overall preference level between formulations ($p=0,002$). The selected F2 contains a water content of 18,25%, ash content of 3,12%, protein of 2,82%, fat of 0,28%, carbohydrates of 75,53%, dietary fiber of 10,48 %, and a total plate count of 30 colonies/g. In conclusion, the F2 tends to be more liked by the panelists and can be considered high in fiber.

Keywords: Fiber, snack, vegetable leather, school-age children

Abstrak

Konsumsi sayur dan buah pada anak usia sekolah yang masih kurang dari rekomendasi lima porsi/hari pada tahun 2018 dapat meningkatkan risiko masalah gizi pada anak, salah satunya akibat konsumsi serat yang rendah yang dapat menyebabkan obesitas. *Snack* tinggi serat berbahan dasar pangan lokal dapat menjadi solusi. Namun, ketersediaannya masih terbatas. Tujuan penelitian ini yaitu untuk mengembangkan produk *snack* berbahan dasar labu siam, kulit buah naga, dan kulit pisang kepok. Penelitian ini merupakan penelitian kuasi eksperimental yang dilakukan pada bulan April 2021 - Agustus 2022 di Laboratorium Kimia Saraswanti Indo Genetech di Bogor. Sampel terdiri atas panelis semi terlatih sebanyak 30 orang. Terdapat 4 formulasi konsentrasi labu siam, kulit buah naga, dan kulit pisang kepok. Analisis data menggunakan One Way Anova dan dilanjutkan dengan *Duncan Multiple Range Test* (DMRT). Hasil, terdapat perbedaan yang signifikan pada parameter warna ($p=0,000$), rasa ($p=0,000$), tekstur ($p=0,000$), dan tingkat kesukaan keseluruhan antar formulasi ($p=0,002$). F2 yang terpilih mengandung kadar air 18,25%, kadar abu 3,12%, protein 2,82%, lemak 0,28%, karbohidrat 75,53%, serat pangan 10,48%, dan angka lempeng total yaitu 30 koloni/g.

Kesimpulannya, F2 merupakan formulasi yang lebih banyak disukai oleh panelis dan dapat diklaim sebagai tinggi serat.

Kata Kunci: Serat, *snack*, *vegetable leather*, anak usia sekolah

Introduction

The prevalence of overweight and childhood obesity increased rapidly from 1975 to 2016 in various countries, namely East Asia, Central and North Africa, South Asia, and English-speaking countries with high incomes. There are about 213 million schoolchildren and adolescents who are overweight or close to reaching the threshold of obesity (Bentham et al., 2017). As for Indonesia, the increase in obesity prevalence in 2007, 2010, and 2013 was 7,95%, 9,2%, and 18,8%, respectively (10,8% overweight and 8,8% obese) (Riskesdas 2007; Riskesdas 2010; Riskesdas 2013). Consumption of vegetables and fruits by school-age children who are still eating less than the recommended 5 servings per day in 2018 can increase the risk of nutritional problems in children, one of which is obesity (Riskesdas, 2018). Obesity is caused by the consumption of foods that are high in sugar, salt, and fat and low in fiber (Hermina & Prihatini, 2016; Al Rahmad, 2021).

Research results by Tsani et al. (2022) state that obesity is influenced by the availability of food and the child's home environment, including the availability of fruits and vegetables. Fruits and vegetables contain fiber, which plays an important role in preventing obesity. Dietary fiber is useful for preventing constipation, lowering blood sugar levels, and preventing non-communicable diseases. Polysaccharides contained in fruits and vegetables can control colon cancer, obesity, cardiovascular disease, and type 2 diabetes. These polysaccharides can effectively inhibit inflammatory factors in people with obesity and type 2 diabetes (Ma & Mu, 2016). Despite the many benefits, fiber intake is still relatively low, especially in school-age children (Hermina & Prihatini, 2016). Therefore, it is necessary to grow the child's diet to suit balanced nutrition.

One way to grow a balanced, nutritious diet is to eat healthy snacks such as fruit leather. Fruit leather is a snack food derived from dried fruit meat sheets with a soft, chewy, and sweet texture (Saidi et al., 2020). Fruit leather is the right snack choice because it is liked by many children (Bekti et al., 2017). The processing of vegetable leather is still limited, even though vegetables are one of the more recommended sources of dietary fiber because consumption in large quantities can meet

fiber needs while still being low in sugar (Widani, 2019).

Lack of fiber intake can be met by processed food products, such as vegetable leather, which can be used as an alternative to overcome the problem. Processing vegetable leather with basic ingredients that are high in fiber, including chayote, dragon fruit peel, and kepok banana peel

Siamese pumpkin (*Sechium edule*) has a fiber content of 4,5 g per 160 g of chayote (Bekti et al., 2017). Siamese pumpkin is useful for lowering the risk of coronary heart disease, stroke, hypertension, diabetes, gastrointestinal diseases, and obesity (Coronel et al., 2017). However, the high moisture content of chayote causes its shelf life to be short (Bekti et al., 2017). Likewise, the skin of the red dragon fruit (*Hylocereus polyrhizus*) is still not used optimally and only becomes waste. With a high pectin content of 10,8%, dragon fruit skin can be used as a natural dye (Yati et al., 2017; Winarti et al., 2020). In addition, currently, bananas (*Musaaceae sp.*) are a fruit commodity with increasing production (BPS, 2019). However, banana peels as organic waste in large quantities are still not used properly. Banana peels that contain high pectin content are kepok banana peels, with pectin content ranging from 10,10% to 11,93% (Anwar et al., 2021).

Innovation in processing snacks made from chayote, dragon fruit peel, and kepok banana peel needs to be developed with consideration of its benefits in preventing obesity in school-age children. This research innovation can also help overcome the problem of the availability of dragon fruit peel and kepok banana peel waste, which are still abundant without further processing. Therefore, researchers are interested in developing snack products made from chayote, dragon fruit peel, and kepok banana peel that can meet the fiber needs of school children.

Methods

The study used an experimental design with a complete randomized design (CRD) to develop vegetable leather products by comparing the addition of kepok banana peel and chayote. The preliminary research was conducted in April–August 2021. The main research, which included

sensory tests and tests of nutrient content, dietary fiber, total plate numbers, and shelf life, was conducted in November 2021–August 2022. Proximate, food fiber, and total plate number tests were carried out at the Saraswanti Indo Genetech Chemical Laboratory located in Bogor, West Java.

This study was conducted on 30 semi-trained panelists for sensory testing of vegetable leather formulations.

Tools and materials used are plastic cups, stainless steel spoons and forks, plastic basins, digital food scales (accuracy 0.1 g), aluminum baking sheet size 27 x 20,5 x 1,5 cm, knife, cutting board, plastic container, laddle, scissors, stopwatch, digital food thermometer, digital screw micrometer, dehydrator, stove, blender, pot, steaming pot set, chayote, dragon fruit skin, kepok banana peel, lime, mineral water, liquid fructose, kappa carrageenan, food coloring, and banana flavoring.

The process of processing vegetable leather is carried out in several stages. Siamese pumpkin, dragon fruit peel, and kepok banana peel are washed thoroughly and cut into smaller pieces to be steamed for 3 minutes at a temperature of 70 oC. Then it was cooled for 20 minutes and crushed with a blender for 5 minutes (chayote) and 3 minutes (dragon fruit peel and kepok banana peel) until it became puree. Next, the puree is weighed according to the formulation. Each formulation is mixed with additional ingredients, namely 0,6% kappa carrageenan, 4% lime juice, and 10% liquid fructose. The pure mixture with additional ingredients is then heated for 3 minutes at a temperature of 70 oC, after which it is printed on a baking sheet and dried with a dehydrator for 10 hours at a temperature of 45 oC and 5 hours at a temperature of 50 oC. Four formulations were selected from the results of trial and error, namely with a ratio of chayote: dragon fruit skin: kepok banana peel: F0 (0:100:0), F1 (70:20:10), F2 (65:20:15), and F3 (60:20:20). The vegetable leather formulation was then analyzed for proximate content (moisture content, ash, protein, fat, and carbohydrates), dietary fiber, and total plate number.

Data analysis is processed with the SPSS program and analyzed with the one-way ANOVA test. The results of the sensory test are in the form of a vase scale with values of 1–10 (very dislike to very like). If there is a significant difference, then proceed with the Duncan

Multiple Range Test (DMRT) to see if there are different groups.

This research has passed an ethical review by the Ethics Commission of Esa Unggul University, No. 0922-10.008/DPKE-KEP/FINAL-EA/UEU/X/2022.

Result and Discussion

The final results of the four selected vegetable leather formulations are shown in figure 1. Vegetable leather formulation with different concentrations of banana peel and chayote. (F0) 0% : 0%, (F1) 10% : 70%, (F2) 15% : 65%, (F3) 20% : 60%

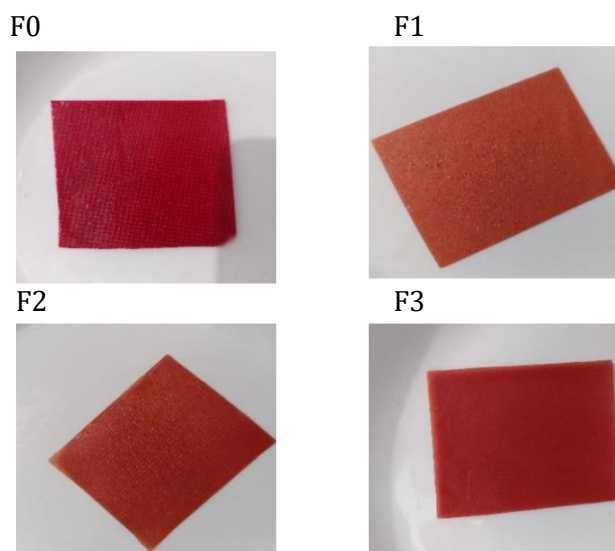


Figure 1. Vegetable leather formulation

Sensory Analysis

Sensory analysis is an analysis that uses the human senses as a measuring tool to determine the acceptance of a product. In this study, sensory testing, namely hedonic testing, was carried out.

Hedonic tests on semi-trained panelists were conducted using a VAS scale of 1–10 cm to determine the level of preference of vegetable leather products in terms of color, aroma, taste, texture (ease of chewing), texture (when pulled), and overall liking level.

Based on table 1, the results of the hedonic average assessment of color parameters ranged from 5,04 to 7,39 in the preferred direction; aroma parameters ranged from 4,84 to 6,09 in the preferred direction; texture parameters (ease of chewing) ranged from 4,54 to 7,22 in

the preferred direction; texture parameters (when pulled) ranged from 4,47 to 6,75; taste parameters ranged from 4,74 to 6,77 in the preferred direction; and overall favorability parameters ranged from 5,36 to 6,98 in the

preferred direction. In general, the results of the sensory assessment show that panelists can accept all formulations of substitution of chayote, dragon fruit peel, and banana peel kepek on vegetable leather.

Table 1. One Way Anova hedonic test results semi-trained panelists

Parameters ¹	Formulation					P ²
	F0	F1	F2	F3		
Hedonic						
Color	7,310±2,328 ^a	5,043±2,067 ^b	6,430±1,838 ^a	7,390±1,258 ^a		0,0001*
Aroma	4,843±2,526 ^a	5,613±1,655 ^{ab}	6,097±1,740 ^b	5,693±1,873 ^{ab}		0,104
Texture (Ease of Chewing)	4,540±2,130 ^a	7,223±1,614 ^b	6,787±1,519 ^b	6,717±1,830 ^b		0,0001*
Texture (When Pulled)	4,473±2,151 ^a	6,750±1,716 ^b	6,580±1,816 ^b	6,073±2,033 ^b		0,0001*
Taste	4,743±2,099 ^a	6,243±1,725 ^b	6,770±1,847 ^b	6,333±1,580 ^b		0,0001*
Total	5,363±2,086 ^a	6,573±1,486 ^b	6,983±1,436 ^b	6,503±1,466 ^b		0,002*

Based on the color parameters, there are significant differences between F1 and F0, F2, and F3. F3 is the formulation most liked by panelists, namely the formulation with the most banana peel (20%) added. Despite the addition of the largest concentration of banana peels, F3 is still reddish in color. This is because dragon fruit skin added to F3 contains water-soluble anthocyanin compounds that bind to the carrageenan double helix structure during the gel formation process so that it can protect antioxidant compounds in dragon fruit skin during the drying process from oxygen. Thus, the red color will be protected from maillard reactions (Winarti et al., 2020).

Based on aroma parameters, there is no significant difference between the four formulations because they are made from the same basic ingredients, namely dragon fruit peel and kepek banana peel, and lime juice and carrageenan are added at the same concentration. The characteristic of carrageenan itself is that it has no aroma, while lime juice helps give a sour aroma, but because it goes through a drying process for a long time, the aroma becomes reduced compared to fresh. These results are in line with the results of research by Fauziah et al. (2015) on the processing of fruit leather made from banana horn. The aroma of bananas becomes a distinctive aroma of banana fruit leather. Research (Cindaramaya & Handayani, 2019) also supports the results of this study. Lime contains 7% citric acid, which is included in weak organic acids so that it does not affect sensory characteristics, one of which is the aroma of yellow pumpkin fruit leather, so that panelists cannot distinguish the aroma smelled.

Based on texture parameters (chewability) and texture parameters (when pulled), there are significant differences between F0 and other formulations (F1, F2, and F3). Based on the results of the study by Werdhosari et al. (2019), In the development of fruit leather from yam and red dragon fruit, the results of differences in the composition of yam and red dragon fruit affect the texture of fruit leather significantly. This is due to the influence of the water content and fiber content contained in the main ingredients (dragon fruit and yam). The more dragon fruit composition given, the softer the texture. The cause is the fiber content of dragon fruit, which is lower than that of yam. Similarly, in this study, from F1, F2, and F3, additional compositions of kepek banana peel (10%, 15%, and 20%).

Based on research by Proverawati et al. (2019), Kepok banana peel is high in fiber, which is as much as 10,44%, which causes the texture of vegetable leather to be difficult to chew, so panelists do not like F3. F0, which is made from 100% dragon fruit skin as the main ingredient, was not liked by the panelists because of its non-plastic texture and difficulty to chew. This is because dragon fruit skin contains a high dietary fiber content of 69,30 ± 0,53 g per 100 g. Jamilah et al. (2011) The dietary fiber will affect the moisture content of vegetable leather. The higher the food fiber content of a food, the higher the water content. The cause of this is food fiber that binds free water (hydrophilic) contained in the material, which will further form a strong structure (Fauziah et al., 2015). Vegetable leather with low moisture content produces a relatively hard texture compared to

vegetable leather with high moisture content (Manurung et al., 2020).

Based on taste parameters, there are significant differences between vegetable leather formulations (F0, F1, F2, and F3). There is an increase in flavor from F1 to F3. The formulation most preferred by panelists is F2, while the formulation least preferred by panelists is F0. Taste parameters are influenced by texture parameters; the harder the texture of vegetable leather, the less acceptance of taste parameters will decrease, as seen in F0, which is less liked by panelists. This is in line with research by Werdhosari et al. (2019) showing that panelists preferred the T2 treatment with a 50%:50% proportion of yam and red dragon fruit to the T0 treatment with a 100%:0% proportion of yam and red dragon fruit, showing the lowest average value on taste attributes. F1 and F3 show an increased average taste value because the addition of banana peel concentrations in F1 and F3 (10% and 20%) causes the pH value to decrease and the acidity to increase. Based on research by Manurung et al. (2020), the lower the composition of banana peel pulp, the higher the degree of acidity. Panelists liked the taste of vegetable leather with a distinctive taste of basic ingredients (sweet acidity). This is in line with the results of the study by Werdhosari et al. (2019), which found that panelists prefer the distinctive taste of vegetable leather due to the basic ingredients used.

Based on overall favorability, there are significant differences between formulations. The formulation received by the panelists in color, aroma, texture, taste, and overall favorability level was F2, which is a vegetable leather formulation with the addition of chayote and kepok banana peel as much as 65%: 15%.

Proximate Analysis

Proximate analysis aims to assess the quality of a product by estimating the relative amounts of protein, fat, water, ash, and carbohydrates. The results of the nutritional content analysis are as follows in Table 2.

Water is a component of food that can affect texture, appearance, and taste. The good moisture content of fruit leather is 10–20% (Fauziah et al., 2015). The result of the analysis of the F2 moisture content is 18.25%. Water content is also influenced by chemical content, one of which is fiber. This is because, according

to Praseptiangga et al. (2016), high amounts of fiber will facilitate water absorption capacity. According to Manurung et al. (2020), the water content in kepok banana peel is 70,06%, and the more kepok banana peel pulp added, the higher the moisture content of red guava fruit leather. When compared with SNI 01-3710-1995 concerning the quality requirements of dried fruit, vegetable leather products have met the maximum moisture content requirement of 31%.

Table 2. Nutrient content analysis

Parameters	F2	SNI Quality
Water Content (%)	18,255±0,120	<30%
Ash content (%)	3,120±0,014	-
Protein (%)	2,815±0,021	-
Fat (%)	0,280±0,000	-
Carbohydrate (%)	75,530±0,113	-
Dietary Fiber Content (%)	10,480±0,056	-

The ash content is a type of mineral that includes inorganic substances and is not burned out in the combustion process (Erdiyus & Pato, 2017). High ash content describes the higher mineral content in a food (Manurung et al., 2020; Proverawati et al., 2019). The ash content in fruit leather is increasing along with the increase in hydrocolloid concentration (Ramadhan et al., 2015). From the results of the analysis, the ash content of F2 is 3,12%. The higher the concentration of kepok banana peel, the higher the ash content of vegetable leather. This is because the selected banana peel is a banana peel with a slightly greenish yellow color. According to Septiani et al. (2020), the maturity level of kepok bananas can increase the ash content of banana peels.

Next is the analysis of protein levels. Protein is a polymer consisting of amino acids as monomers and has a role in addition to forming biomolecules and being an energy source. The F2 protein content is 2,81%.

Protein levels in the basic ingredients used will affect the protein levels of vegetable leather. Kepok banana peel contains 1,5% protein, dragon fruit peel contains an average protein of 6,39 per 100 g, and chayote contains 0,6 g of protein. The results of this study are in line with the results of the study by Septiani et al. (2020), namely the biscuit protein content of 5,64%.

The next parameter is the result of the fat content analysis. Fat is a lipid consisting of one glycerol molecule and three fatty acid molecules. Lipids are soluble in nonpolar organic solvents and insoluble in water. Fat contributes as much energy as 9 kcal/g. The fat content in F2 is 0,28%.

The fat content in vegetable leather is low. This is because the fat content contained in the basic ingredients used, such as chayote, kepok banana peel, and dragon fruit skin, is relatively low. The results of this study are in accordance with those of Akther et al. (2019). Namely, in fruit leather made from mango, pineapple, and papaya, an average fat content value of 0,03% was obtained.

The next parameter is carbohydrates. Carbohydrates are divided into two types: simple carbohydrates and complex carbohydrates (Almatsier et al., 2011). In food, carbohydrates are in the form of sugar, starch, and fiber. The results of the carbohydrate content analysis are seen in Table 3, which is 75,53%.

Carbohydrates contained in basic ingredients can increase carbohydrate levels in vegetable leather. In accordance with the research of Vidayanana et al. (2020), the increase in carbohydrates in raw materials increases the carbohydrate content of Moringa leaf catfish nuggets. This is also in line with the results of the study Offia-Olua & Ekwunife (2015), namely the average value of carbohydrate content of fruit leather banana-pineapple-apple, which is 800,10–84.770,06.

The last parameter is the content of dietary fiber. Dietary fiber is a type of food that cannot be hydrolyzed in the digestive tract (Praseptianga et al., 2016). Based on the results of the analysis, the value of F2 food fiber content was 10,48%. The content of dietary fiber is influenced by water content. F2 contains a high-water content, so it contains a fiber content that is quite low compared to F0. This is in line with the results of the study (Bekti et al., 2017). In Siamese pumpkin leather, when the water content decreases, the fiber content will increase.

The addition of kappa carrageenan can also increase the content of dietary fiber in vegetable leather. This is in accordance with the results of the study by Puteri et al. (2017): the addition of carrageenan as much as 0,6% and

0,8% has a significant effect on the texture of tomato fruit leather.

The average dietary fiber needs of school-age children (10–12 years old) based on the RDA in 2019 are 27,5 g. The contribution of snacks to the need for dietary fiber is 10–20% (Febriani & Margawati, 2013). So that the need for dietary fiber from snacks ranges from 2,75 to 5,5 g. From the results of the analysis of food fiber content, vegetable leather meets 38,1% of the dietary fiber needs of school-age children from snacks.

The addition of kappa carrageenan can also increase the content of dietary fiber in vegetable leather. This is in accordance with the results of the study by Puteri et al. (2017): the addition of carrageenan as much as 0.6% and 0,8% has a significant effect on the texture of tomato fruit leather.

The results of studies have proven that the most preferred vegetable leather is in the F2 formulation. However, this study has the limitation that the level of panelists' liking for the aroma of vegetable leather is still lower than other sensory parameters.

Conclusion

F2 is the vegetable leather most liked by panelists. Vegetable leather can be an alternative, healthy snack for school-age children. The dietary fiber content in the selected formulation F2 is 10,48%, and the product is high in fiber.

Suggestions for future research need to be tested quantitatively for water activity (AW), tensile strength, and shelf life to determine the length of storage.

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