PURPLE SWEET POTATO AND KIDNEY BEAN FLOUR PIE AS A HIGH FIBER SNACK FOR TYPE 2 DIABETES MELLITUS PATIENTS

Pie Tepung Ubi Jalar Ungu dan Tepung Kacang Merah sebagai Makanan Selingan Tinggi Serat untuk Penderita Diabetes Melitus Tipe 2

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ABSTRACT

Type 2 diabetes melitus (DM) is disorder of insulin secretion, decreased insulin action, or both, which cause elevated blood glucose level. Purple sweet potato flour and kidney bean flour contain high dietary fiber which can help control blood glucose level. This research aimed to determine the effect of different ratios of purple sweet potato flour and kidney bean flour on the pie's organoleptik properties and nutrient content as a high fiber alternative snack for patients with type-2 DM. This experimental study employed a Completely Randomized Design (CRD) with 3 treatments of flour ratios F1 (60%: 40%), F2 (70%: 30%), and F3 (80%: 20%) with 2 repetitions. Data on nutrient content were analyzed using ANOVA and Duncan's test, while organoleptic properties were analyzed using Kruskal-Wallis and Man-Whitney tests. The selection of the formulation used the Exponential Comparison Method (ECM). The results were significant effect on nutrient content pie and hedonic organoleptic properties of aroma parameters pie. The F3 selected formulation had nutrient content of water content 35.25%, ash 1.69%, protein 8.25%, fat 10.54%, carbohydrate 44.28%, and dietary fibre 15.15%. Pie serving (84g/3 pcs) contributed 10-15% of the RDA for with type 2 diabetes melitus patient. The pie can be claimed to be high in dietary fiber with a Nutrition Label Reference of 50.5%.

Keyword: *dietary fiber; kidney bean flor; pie; purple sweet potato flour; type 2 diabetes mellitus*

ABSTRAK

Diabetes melitus tipe 2 merupakan penyakit kelainan sekresi insulin, menurunnya kerja insulin ataupun keduanya yang menyebabkan kadar glukosa darah meningkat. Tepung ubi jalar ungu dan tepung kacang merah mengandung serat pangan tinggi yang dapat mengontrol kadar glukosa darah. Tujuan penelitian untuk mengetahui pengaruh perbandingan tepung ubi jalar ungu dan tepung kacang merah terhadap sifat organoleptik dan kandungan zat gizi pie sebagai alternatif makanan selingan tinggi serat untuk penderita diabetes melitus tipe 2. Jenis penelitian eksperimental dengan desain Rancangan Acak Lengkap (RAL) dengan 3 perlakuan perbandingan tepung ubi jalar ungu dan tepung kacang merah F1 (60%: 40%), F2 (70%:30%), F3 (80%:20%) dengan 2 kali pengulangan. Hasil kandungan zat gizi dianalisis dengan uji *Anova* dilanjutkan uji *Duncan*. Hasil sifat organoleptik dianalisis dengan uji *Kruskal-Wallis*

dilanjutkan uji *Man-Whitney.* Pemilihan formulasi terpilih menggunakan Metode Perbandingan Eksponensial (MPE). Hasil penelitian menunjukkan terdapat pengaruh nyata terhadap kandungan zat gizi pie dan sifat organoleptik hedonik parameter aroma pada pie. Formulasi terpilih F3 memiliki kandungan zat gizi kadar air 35,25%, abu 1,69%, protein 8,25%, lemak 10,54%, karbohidrat *by difference* 44,28%, dan serat pangan 15,15%. Pie pertakaran saji (84g/3buah) telah berkontribusi 10-15% dari Angka Kecukupan Gizi (AKG) penderita diabetes melitus tipe 2. Pie terpilih dapat diklaim tinggi serat pangan menurut BPOM RI dengan Acuan Label Gizi (ALG) sebesar 50,5%.

Kata Kunci: diabetes melitus tipe 2; pie; serat pangan; tepung ubi jalar ungu; tepung kacang merah.

INTRODUCTION

Type 2 diabetes mellitus is a metabolic disease characterized by hyperglycemia caused by abnormalities in insulin secretion or reduced insulin action due to impaired function of pancreatic beta cells (Fatimah, 2015). Type 2 diabetes mellitus is the seventh leading cause of death worldwide. The number of people with type 2 diabetes mellitus in Indonesia aged 20–79 years reached 537 million in 2021 (IDF, 2017). According to the 2018 Basic Health Research (Riskesdas), the prevalence of type 2 diabetes mellitus in Indonesia was 8.5% among individuals aged over 15 years (Ministry of Health RI, 2018). In Central Java Province, the prevalence of type 2 diabetes increased from 16.8% to 22.9% between 2016 and 2018 (Central Java Health Office, 2018). In Surakarta City, the number of people with diabetes mellitus rose from 12,105 thousand in 2021 to 18,833 thousand in 2022 (Surakarta Health Office, 2022).

Type 2 diabetes mellitus is caused by factors such as unhealthy lifestyle habits, lack of physical activity, and poor dietary patterns. If left untreated, this disease can lead to complications such as damage to the eyes, kidneys, peripheral blood vessels, and nerves (Widodo, 2014). Efforts to prevent and manage type 2 diabetes mellitus can be carried out, one of which is by controlling dietary intake, including consuming foods high in dietary fiber. Soluble fiber entering the body forms a gel-like mass. This gel slows gastric emptying and digestion, leading to a longer feeling of fullness, reduced food intake, and decreased blood glucose levels. Undigested fiber reaches the large intestine, where it is fermented by gut bacteria to form SCFA (Short-Chain Fatty Acids). SCFA production activates the secretion of GLP-1 (Glucagon-Like Peptide-1), GIP (Gastric

Inhibitory Polypeptide), and PYY (Peptide YY). These hormones enhance insulin action, thereby lowering blood glucose levels (Soviana and Maenasari, 2019). The role of insoluble dietary fiber is related to promoting peristaltic movement in the intestines once it reaches the large intestine (Rantika and Rusdiana, 2018).

Local food ingredients that are high in fiber—such as purple sweet potato flour and red bean flour—can be processed into snack products for patients with type 2 diabetes mellitus, including pie. The nutritional content of purple sweet potato flour is 354 kcal of energy, 2.8 g protein, 0.6 g fat, 84.4 g carbohydrates, 12.9 g dietary fiber, 9.4 g moisture, and 2.8 g ash per 100 g of material (Ministry of Health RI, 2020). Red bean flour contains 369.35 kcal of energy, 22.85 g protein, 2.56 g fat, 64.15 g carbohydrates, 4 g dietary fiber, 13.18 g moisture, and 3.91 g ash (Prasetiya and Niken, 2014; Putri et al., 2023). Pie is a snack made from wheat flour and belongs to the short pastry category, characterized by a dry and crispy texture. Pies are generally filled with sweet or savory fillings (Ruaida and Elida, 2012). Since wheat flour is widely used by the community, alternative products are needed as substitutes,

such as purple sweet potato flour and red bean flour.

A study by Anindya et al. (2023) on the production of milk pie using coconut pulp flour and purple sweet potato flour showed a high dietary fiber content in formulation 3 (50% coconut pulp flour : 50% purple sweet potato flour), which reached 14.3%. Setyowati (2017) reported that brownies made with the addition of 250 g of red beans resulted in a high fiber content of 20.38 g per 100 g of brownies. Biwillatifah et al. (2023) found that pie crust made with red bean flour substitution had the best formulation at F2 (50% red bean flour and 50% wheat flour). However, the resulting pies had less favorable organoleptic characteristics. Therefore, in pie preparation, ingredients are needed that can increase both dietary fiber content and organoleptic quality—namely purple sweet potato flour and red bean flour.

METHODS

Design, Setting, and Time

This experimental study used a Completely Randomized Design (CRD) with 3 treatments and 9 repetitions. The ratios of purple sweet potato flour and red bean flour

were F1 (60% : 40%), F2 (70% : 30%), and F3 (80% : 20%). The manufacturing process, formulation, and organoleptic testing were conducted at the Nutrition Laboratory, Kusuma Husada University Surakarta. Nutrient content analysis was carried out at Saraswanti Indo Genetech Laboratory, Bogor. The study was conducted from November 2023 to June 2024. This research obtained ethical clearance No. 2024/UKH.L.02/EC/III/2024.

Number and Method of Sampling / Research Tools and Materials

Tools and Ingredients for Pie Preparation

Tools used in pie production included a stove, pot, flour sifter, pie molds, large plates, small plates, spatula, oven, scale, brush spoon, mixing bowls, blender, and strainer.

Ingredients for the pie consisted of pie crust components: purple sweet potato flour, red bean flour, margarine, egg yolk, vanilla powder, oatmeal, ice water, and sorbitol sugar. Ingredients for the pie filling were red bean paste, including red beans, glutinous rice flour, salt, palm oil, sorbitol sugar, and chopped roasted peanuts as topping.

Tools and Materials for Nutrient Content Analysis

Tools used for nutrient analysis included analytical balance, oven, distillation unit, crucibles, porcelain dishes, furnace, desiccator, filter paper, tube racks, hot plate, scrubber unit, condenser assembly, volumetric flasks, micropipettes, stirring rods, Erlenmeyer flasks, beakers, Kjeldahl flasks, KjelDigester, thimble, measuring cylinders, gauze, round-bottom flasks, oil paper, test tubes, Falcon tubes, water bath, Soxhlet apparatus, boiling stones, hulls, shaking water bath, beakers, aluminum foil, and test tubes. Materials for nutrient analysis included selenium mixture, concentrated H_2SO_4, 40% NaOH, 4% H_3BO_3, 25% HCl, 0.2 N HCl, 0.561 M HCl, 1 M NaOH, 78% ethanol, 95% ethanol, 1.5 N NaOH, acetone, α-amylase enzyme, Mes-Tris buffer solution, protease enzyme, amyloglucosidase enzyme, filter paper, n-hexane, n-butanol, and distilled water.

Tools and Materials for Organoleptic Testing

Tools used for organoleptic testing included organoleptic test questionnaires,

hedonic quality test questionnaires, and writing tools. Materials used in organoleptic testing were mineral water and the sample.

Types and Methods of Data Collection / Research Procedures

Product Preparation

The stages of pie crust preparation used a method modified from the study by Anindya et al. (2023). The formulation of pies made from purple sweet potato flour and red bean flour can be seen in Table 1 below.

Table 1. Formulation of pies made from purple sweet potato flour and red bean flour

Ingredients	Formulation		
	F1 (60%:40%)	F2 (70%:30%)	F3 (80%:20%)
Pie crust ingredients (g)			
Purple sweet potato flour (g)	150	175	200
Red bean flour (g)	100	75	50
Instant oatmeal (g)	40	40	40
Egg yolk (g)	16	16	16
Margarine (g)	50	50	50
Sorbitol sugar (g)	4	4	4
Vanilla powder (g)	2	2	2
Ice water (g)	130	130	130
Pie filling ingredients:			
Red beans (g)	125	125	125
Palm oil (g)	5	5	5
Glutinous rice flour (g)	25	25	25
Salt (g)	2	2	2
Sorbitol sugar (g)	3	3	3
Chopped roasted peanuts (g)	90	90	90
Total (g)	742	742	742

The pie-making process begins by mixing ingredients such as sorbitol sugar, vanilla powder, egg yolk, and margarine. The mixture is stirred until well blended, then purple sweet potato flour and red bean flour are added. Water is added little by little while mixing evenly, and the dough is kneaded until smooth and elastic. The pie crust dough is then weighed individually at 15 g each and molded into pie molds that have been greased with margarine. The molded pie crusts are baked in an oven at 150°C for 45 minutes.

Once baked, the pie crusts are cooled at room temperature for 5–10 minutes, removed from the molds, and filled with 15 g of red bean paste for each formulation. The preparation of red bean paste refers to the study by Adam et al. (2022) with

modifications, starting with soaking the red beans for 10 hours. The beans are then boiled for 2 hours, blended, and strained for a smoother texture. The red beans are then mixed with glutinous rice flour, palm oil, salt, and sorbitol sugar, and stirred over medium heat. The mixture is stirred until it reaches a smooth and elastic texture. Once ready, the red bean paste is removed from the heat and used as pie filling.

Nutrient Content Analysis

Nutrient content analysis of the pie was carried out based on the standard operating procedures of the Saraswanti Indo Genetech Laboratory, Bogor. The tests were conducted with two repetitions and included: moisture and ash content using the gravimetric method, total protein using the titrimetric method, fat content using the Weibull–Soxhlet hydrolysis method, carbohydrate content using the by-difference

method, and total dietary fiber using the enzymatic method.

Organoleptic Testing

Organoleptic testing of the pies was performed on 30 semi-trained panelists. The panelists were selected from Nutrition students at Kusuma Husada University Surakarta. Organoleptic testing was conducted using hedonic and hedonic quality test questionnaires with a 1–7 scale. The parameters assessed included color, taste, aroma, texture, aftertaste, mouthfeel, and overall acceptance.

The hedonic test was used to determine the panelists' level of liking for the pie products, with the scale: (1) very dislike, (2) dislike, (3) slightly dislike, (4) neutral, (5) slightly like, (6) like, and (7) very like. The hedonic quality scale used to evaluate the characteristics of the pie products can be seen in Table 2.

Table 2. Hedonic quality test scale

Scale	Color	Taste	Aroma	Texture	Aftertaste	Mouthfeel
1	Dark Brown to Blackish	Very Weak	Very Off-Flavored	Very Hard	Very Weak	Very Coarse
2	Dark Brown	Weak	Beany/off-flavor	Hard	Weak	Coarse/Rough
3	Brown	Slightly Weak	Slightly Beany	Not Hard	Slightly Weak	Slightly Coarse
4	Purplish Brown	Moderate	Moderate	Moderate	Moderate	Moderate

Scale	Color	Taste	Aroma	Texture	Aftertaste	Mouthfeel
5	Light Purplish Brown	Slightly Strong	Slightly aromatic	Slightly crispy	Slightly strong	Slightly soft
6	Dark Brownish Purple	Strong	Aromatic	Crispy	Strong	Soft
7	Light Purple	Very Strong	Very aromatic	Very crispy	Very strong	Very soft

Contribution of Nutrients to the Dietary Reference Intake (DRI) of Patients with Type 2 Diabetes Mellitus

The calculation of nutrient contribution to the Dietary Reference Intake (DRI) for male and female patients with type 2 diabetes mellitus aged 19–29 years and 30–49 years refers to PERKENI (2021), covering energy, protein, fat, carbohydrates, and dietary fiber. The percentage contribution is calculated by comparing the amount of nutrients contained in one serving size with the recommended intake for each nutrient. The percentage is then compared with 10–15% of daily energy requirements as a snack.

Product Contribution to Nutrition Facts Reference (NFR)

Nutrient claims for pie products made from purple sweet potato flour and red bean flour were obtained by comparing the nutrient content results with the Nutrition Facts Reference (NFR) and the standards for labeling and advertising claims according to BPOM Regulation No. 9 of 2016 and BPOM Regulation of 2022 (BPOM RI, 2016; BPOM RI, 2022). The resulting percentages were compared with nutrient thresholds to determine eligibility for nutrient claims. The claim requirements are: for a source of fiber, ≥ 3 g/100 g; and for high fiber, ≥ 6 g/100 g.

Data Analysis

Data processing was tabulated using Microsoft Excel 2016 and then analyzed using SPSS version 24. Nutrient content data and organoleptic properties were tested for normality using the Shapiro–Wilk test and for homogeneity using Levene's test. Nutrient content data that were normally distributed and homogeneous were then analyzed using One-Way ANOVA followed by Duncan's post hoc test with a significance level of $p < 0.05$. Organoleptic test data that

were not normally distributed but homogeneous were analyzed using the Kruskal–Wallis test, followed by the Mann–Whitney test with a significance level of $p < 0.05$.

RESULTS AND DISCUSSION

Nutrient Content Analysis

Moisture Content

The results of the moisture content test are shown in Table 3. The moisture content of the pie did not meet the quality requirements of SNI 2973-2022, because the pie's moisture content exceeded 5%. The moisture content of the pie was influenced by the ingredients used, particularly red bean flour. The higher the proportion of red bean flour in the pie, the higher the moisture content, as red bean flour contains 13.18% moisture, while purple sweet potato flour contains 9.4% per 100 g (Putri et al., 2023; Ministry of Health RI, 2020).

In addition, the moisture content of the pie was affected by the addition of ice water to the pie crust dough and the boiling process of the red beans. The moisture content of the pie did not meet the quality standard based on SNI 2973-2022 because it exceeded the maximum limit of 5%. The moisture test was carried out on the product as a whole, including both the crust and the filling.

The high moisture content indicates that the product has excessive humidity in both the crust and the filling, which may affect shelf life, texture, and product stability during storage. This becomes one of the limitations in the pie formulation because it has not met the SNI quality standard for moisture content. Therefore, improvements in ingredient composition, baking process, or drying methods are needed to reduce moisture content according to the requirements.

High moisture content in food products can cause them to spoil more quickly due to microbial growth, resulting in a shorter shelf life (Anindya et al., 2023).

Table 3. Nutrient Content

Parameters	Average±SD			*p* Value	SNI
	F1	F2	F3		
Moisture Content (%)	50.47 ±0.35 [a]	44.20 ±0.31 [b]	35.25 ±0.30 [c]	0.000	Maximum 5%*
Ash Content (%)	1.76 ± 0.02 [a]	1.74 ± 0.02 [a]	1.69 ± 0.02 [b]	0.013	Maximum 0,1 %*
Protein Content (%)	8.73 ±0.14 [a]	8.57 ±0.13 [a]	8.25 ± 0.14 [b]	0.015	Minimum 2,7%*
Fat Content (%)	8.68 ±0.07 [a]	10.09 ± 0.08 [b]	10.54 ± 0.11 [c]	0.000	Minimum 9,5% **
Carbohydrate Content by Difference (%)	30.36 ± 0.40 [a]	35.41 ± 0.15 [b]	44.28 ± 0.57 [c]	0.000	Maximum 70% **
Dietary Fiber Content (%)	13.58 ± 0.20 [a]	14.50 ± 0.31 [b]	15.15 ±0.18 [c]	0.001	3 g (commercial biscuits)
Total Energy Content (kcal)	234 ± 0.17 [a]	267 ± 0.73 [b]	305 ± 0.73 [c]	0.000	Minimum 400 kkal **
Energy from Fat (kcal)	78 ± 0.63 [a]	91 ± 0.76 [b]	95 ± 0.99 [c]	0.000	-

Note: [a,b,c] Different letters in the same row indicate a significant difference ($p<0.05$).
* : SNI 2973-2022
**: SNI 01-2973-1992

Ash Content

The results of the ash content test are presented in Table 3. The ash content of the pies did not meet SNI quality standards, because this study measured total ash content, while SNI specifies acid-insoluble ash. The ash content of the pies increased. This occurred because the ash content of red bean flour is higher than that of purple sweet potato flour. The ash content of purple sweet potato flour is 2.8% per 100 g (Kemenkes RI, 2020), whereas the ash content of red bean flour is 3.91% per 100 g (Prasetiya and Niken, 2014). According to the study by Putri et al. (2023), the higher the proportion of red bean flour, the higher the resulting ash content.

Ash content indicates the mineral content of a food material. The mineral content of purple sweet potato flour per 100 g includes calcium 89 mg, phosphorus 125 mg, iron 3.9 mg, and zinc 0.6 mg (Kemenkes RI, 2020). The mineral content of red bean flour per 100 g includes calcium 502 mg, phosphorus 429 mg, iron 10.3 mg, and zinc 2.6 mg (Prasetiya and Niken, 2014).

Protein Content

The results of the protein content test are shown in Table 3. The protein content in the pie meets the quality requirements of SNI 2973-2022 based on the category of biscuits containing fillers. The protein content of purple sweet potato flour is 2.8 g/100 g (Kemenkes RI, 2020), while red bean flour

contains 22.85 g/100 g (Prasetiya & Niken, 2014). According to the study by Putri et al. (2023), increasing the concentration of red bean flour added to "kue semprit" increases the resulting protein content.

In this study, the protein content of the pie in the selected formulation (F3) already meets the Recommended Dietary Allowance (RDA) for individuals with type 2 diabetes mellitus, particularly females aged 19–29 years and 30–49 years. Protein consumed together with glucose can stimulate insulin activity, thereby reducing the amount of glucose absorbed (Purnama et al., 2018).

Fat Content

The results of the fat content test are shown in Table 3. The fat content of the pie in F1 does not meet the SNI quality requirements; however, F2 and F3 meet the standards of SNI 2973-1992. Fat content is influenced by the amount of red bean flour used, which contains 2.56 g/100 g, higher than purple sweet potato flour, which contains only 0.6 g/100 g (Kemenkes RI, 2020).

Based on the fat content results, the selected formulation F3 already meets the RDA for individuals with type 2 diabetes mellitus for men and women aged 19–29 years and 30–49 years.

Carbohydrate Content (By Difference)

The results of carbohydrate content by difference are presented in Table 3. The carbohydrate content of the pie meets the quality requirements of SNI 2973-1992. According to Cahyani et al. (2023), increasing the proportion of purple sweet potato flour in biscuits results in higher carbohydrate content by difference. This occurs because purple sweet potato flour contains 84.4 g/100 g carbohydrates, higher than red bean flour (64.15 g/100 g) (Kemenkes RI, 2020; Prasetiya & Niken, 2014).

The carbohydrate content in the selected formulation F3 meets the RDA for individuals with type 2 diabetes mellitus (men and women aged 19–29 and 30–49 years). Pie can be categorized as a complex carbohydrate product, as it is made from purple sweet potato flour and red bean flour, both rich in dietary fiber and resistant starch.

Hairani et al. (2018) stated that carbohydrates in purple sweet potatoes are complex and have a low glycemic index (GI

= 54). This product is expected to be digested more slowly, resulting in a lower postprandial glucose response, making it a suitable alternative food for individuals with type 2 diabetes mellitus (Ekasari & Dhanny, 2022).

Dietary Fiber Content

The results of the dietary fiber test are shown in Table 3. According to Utami (2019), dry cookies marketed for people with diabetes typically contain 3 g of dietary fiber**.** The fiber content in this study is higher than that of commercial diabetic-friendly cookies. This is due to the high fiber content of purple sweet potato flour (12.9 g/100 g**,** Kemenkes RI, 2020) and the fiber content of red bean flour (4 g/100 g**,** Prasetiya & Niken, 2014).

Zaddana et al. (2021) reported that increasing the proportion of purple sweet potato flour in snack bars increases dietary fiber content.

Based on RDA calculations for individuals with type 2 diabetes mellitus (men and women aged 19–29 and 30–49 years), the selected pie formulation (F3) meets the fiber requirement when consuming 84 g (3 pieces**)** as a snack. High-fiber foods can improve insulin performance and reduce

glucose absorption rates, thereby helping prevent complications in individuals with type 2 diabetes mellitus (Rusti et al., 2019).

Total Energy Content

The test results for total energy content are shown in Table 3. The total energy content of pies made from purple sweet potato flour and red bean flour increased. Purple sweet potato has a lower energy content, namely 354 kcal, compared with red bean flour at 369 kcal (Kemenkes RI, 2020; Prasetiya and Niken, 2014). In this study, the selected formulation (F3) with a serving size of 84 g (3 pieces) already meets the recommended intake for snacks for individuals with type 2 diabetes mellitus. The results show that the pie does not meet SNI standards because this product is intended for individuals with type 2 diabetes mellitus, who require a lower energy intake to help control blood glucose levels and prevent significant increases in blood sugar.

Energy Content from Fat

The test results for energy from fat are shown in Table 3. The energy from fat in pies made from purple sweet potato flour and red bean flour increased, although the fat-derived

energy in purple sweet potato flour is lower, at 5.4 kcal (Kemenkes RI, 2020). Meanwhile, red bean flour contains 23.04 kcal of energy from fat (Prasetiya and Niken, 2014). Fat is the main factor contributing the highest amount of energy. Margarine was used in the product during dough preparation and for greasing the pie crust molds.

Table 4. Results of the Organoleptic Properties Test

Parameters	Average ±SD			p value
	Hedonic test			
	F1	F2	F3	
Color	4.40 ± 0.12 [a]	4.67 ± 0.96 [a]	4.90 ± 0.12 [a]	0.159
Aroma	4.13 ± 0.10 [a]	4.87 ± 0.11 [b]	4.73 ± 0.14 [a,b]	0.029
Taste	3.77 ± 0.13 [a]	4.50 ± 0.97 [a]	6.03 ± 0.95 [a]	0.052
Texture	3.90 ± 0.15 [a]	4.33 ± 0.13 [a]	4.07 ± 0.14 [a]	0.422
Aftertaste	4.07 ± 0.12 [a]	4.30 ± 0.10 [a]	3.97 ± 0.13 [a]	0.478
Mouthfeel	3.73 ± 0.11 [a]	4.20 ± 0.11 [a]	4.07 ± 0.12 [a]	0.192
Overall	4.00 ± 0.12 [a]	4.47 ± 0.12 [a]	4.47 ± 0.12 [a]	0.113
	Hedonic Quality Test			
	F1	F2	F3	p value
Color quality	3.60 ± 0.15 [a]	4.30 ± 0.14 [a]	4.17 ± 0.14 [a]	0.292
Aroma quality	3.77 ± 0.10 [a]	4.03 ± 0.92 [a]	4.30 ± 0.10 [a]	0.160
Sweet taste quality	3.13 ± 0.11 [a]	3.37 ± 0.11 [a]	3.67 ± 0.11 [a]	0.192
Bitter taste quality	2.60 ± 0.13 [a]	2.67 ± 0.13 [a]	2.73 ± 0.13 [a]	0.876
Characteristic flour taste quality	4.10 ± 0.13 [a]	3.87 ± 0.12 [a]	4.03 ± 0.11 [a]	0.689
Texture quality	4.17 ± 0.98 [a]	4.07 ± 0.10 [a]	4.10 ± 0.11 [a]	0.941
Aftertaste quality	4.07 ± 0.10 [a]	3.80 ± 0.76 [a]	4.17 ± 0.13 [a]	0.304
Mouthfeel quality	3.70 ± 0.10 [a]	3.73 ± 0.98 [a]	4.07 ± 0.12 [a]	0.388

Note: [a,b] Different letters in the same row indicate a significant difference ($p < 0.05$).

Organoleptic Properties Test

Color

The results of the organoleptic test for the color parameter are shown in Table 4. Color is one of the parameters that attracts consumers and gives an impression of whether a product is liked or disliked (Jeon et al., 2021). Based on the hedonic test results for color, the scores were as follows: F1 = 4.40 (neutral), F2 = 4.67 (neutral), and F3 = 4.90 (neutral). The hedonic quality test results for pie color were F1 = 3.60 (brown), F2 = 4.03 (purplish brown), and F3 = 4.17 (purplish brown). The brown color of the pie may be due to the use of red bean flour and sorbitol sugar. Red bean flour contains a high protein level; therefore, amino acids react with sugars

during baking, known as the Maillard reaction (Perwita et al., 2021). The purplish-brown color is caused by damage to anthocyanin content during high-temperature baking (Ayu et al., 2014).

Aroma

The results of the organoleptic test for the aroma parameter are shown in Table 4. Aroma is a parameter used to evaluate a product based on the response to the scent produced (Sukmawati et al., 2021). Based on the hedonic test results for aroma, the scores were: F1 = 4.13 (neutral), F2 = 4.87 (neutral), and F3 = 4.73 (neutral). The hedonic quality test results for pie aroma were F1 = 3.77 (slightly beany), F2 = 4.03 (moderate), and F3 = 4.30 (moderate). In this study, the aroma produced was not overly beany because purple sweet potato flour contains phenolic compounds that release aroma when heated (Fadlila et al., 2023).

Taste

The results of the organoleptic test for the taste parameter are shown in Table 4. Taste is a sensory parameter involving the tongue's response to bitterness, sweetness, sourness, and saltiness (Sukmawati et al., 2021).

The hedonic taste test results were: F1 = 3.77 (slightly dislike), F2 = 4.50 (neutral), and F3 = 6.03 (like).

The hedonic quality test results for sweet taste of pies made from purple sweet potato flour and red bean flour were: F1 = 3.13 (slightly weak), F2 = 3.37 (slightly weak), and F3 = 3.67 (slightly weak). Overall, the sweet taste of the pie was rated as slightly weak. This occurred because the sweetener used was sorbitol sugar, with 4 g added to the pie crust and 3 g to the red bean paste filling in each recipe. Pie is a safe product for individuals with type 2 diabetes mellitus because it has low calorie content and does not raise blood glucose levels rapidly (Aini et al., 2016).

The hedonic quality test results for bitter taste were: F1 = 2.60 (weak), F2 = 2.67 (weak), and F3 = 2.73 (weak). The use of sorbitol sweetener resulted in a slightly sweet and non-bitter product. Additionally, purple sweet potato flour contains 3.15% sugar and high carbohydrates (84.5 g/100 g), contributing to the sweetness of the pie (Nindyarani et al., 2011; Salma et al., 2018).

The hedonic quality test results for the characteristic flour taste were: F1 = 4.10

(moderate), F2 = 3.87 (slightly weak), and F3 = 4.03 (moderate). The pies still had a characteristic flour taste with moderate ratings for F1 and F3. This is because increasing the proportion of purple sweet potato flour enhances the characteristic flour taste due to caramelization with sugar, leading to the Maillard reaction (Wulandari & Elida, 2020).

Texture

The results of the organoleptic test for the texture parameter are shown in Table 3. Texture is a test parameter describing crispness, ease of breaking, and consistency from the first bite of a food product (Mayangsari et al., 2023). The hedonic test results for the texture of pies made from purple sweet potato flour and red bean flour were as follows: F1 = 3.90 (slightly dislike), F2 = 4.33 (neutral), and F3 = 4.07 (neutral). The hedonic quality test results for pie texture were F1 = 4.17 (moderate), F2 = 4.07 (moderate), and F3 = 4.10 (moderate). The results indicated a moderate texture, meaning the pie was neither too hard nor too crunchy. This is due to the starch content in purple sweet potato flour and red bean flour, which contributes to crispness, along with

other ingredients such as eggs and margarine (Rakhmayati et al., 2023). According to Rahardjo et al. (2020), adding oats causes the dough to become unevenly mixed and the resulting texture to be crumbly. Pie texture is also influenced by the red bean paste filling, which tends to be moist or semi-solid and soft, making it easy to chew (Alamri et al., 2019). The addition of chopped oven-roasted peanuts as topping also affects texture, as consuming them together creates a crunchy sensation in the mouth.

Aftertaste

The results of the organoleptic test for the aftertaste parameter are shown in Table 4. Aftertaste refers to the impression that remains after consuming a product, whether it fades easily or lingers (Taufik et al., 2019). The hedonic test results for aftertaste were: F1 = 4.07 (neutral), F2 = 4.30 (neutral), and F3 = 3.97 (slightly dislike).The hedonic quality test results for aftertaste of pies made from purple sweet potato flour and red bean flour were: F1 = 4.07 (moderate), F2 = 3.80 (slightly weak), and F3 = 4.17 (moderate). According to Santosa et al. (2019), purple sweet potatoes contain phenolic or alkaloid

compounds that may produce a bitter aftertaste in the final product. Aftertaste may also result from the red bean paste filling, as red beans contain acrylamide formed during the baking process, which can produce a bitter taste or aftertaste (Damayanti et al., 2020).

Mouthfeel

The results of the organoleptic test for the mouthfeel parameter are shown in Table 4. Mouthfeel is the sensation produced by a consumed product as it stimulates the taste receptors on the tongue (Sari, 2015). Based on the hedonic test results, the mouthfeel scores for the formulations were: F1 = 3.73 (slightly dislike), F2 = 4.20 (neutral), and F3 =4.07 (neutral). The hedonic quality test results for mouthfeel were: F1 = 3.70 (slightly coarse), F2 = 3.73 (slightly coarse), and F3 = 4.07 (moderate). Overall organoleptic evaluation indicated that the pie's mouthfeel tended to be slightly coarse. This may occur due to the higher proportion of red bean flour, which produces a less smooth sensation in the mouth. Additionally, the use of red bean paste filling affects mouthfeel. Red beans boiled for 2 hours increase solubility, contributing to mouthfeel

characteristics such as coarseness, smoothness, softness, and graininess (Huda & Hapsari, 2015).

Overall

The results of the overall organoleptic test are shown in Table 4. The overall organoleptic test represents the assessment of all hedonic parameters including color, aroma, taste, texture, aftertaste, and mouthfeel.

Panelists rated the overall pie quality as neutral, although there was an increase in scores from formulations F1 to F2 to F3. The most preferred formulation was F3, with the ratio 80% purple sweet potato flour : 20% red bean flour.

Determination of the Selected Formulation

The selected formulation for pies made from purple sweet potato flour and red bean flour was determined using the Exponential Comparison Method (Metode Perbandingan Eksponensial, MPE) as referenced in Khoirunnisa et al. (2021). The researchers assigned a weight value of 5% to each hedonic test parameter (color, taste, aroma, texture, aftertaste, mouthfeel,

and overall). For nutrient content, weights were assigned as follows: moisture, ash, protein, and fat each at 5%; carbohydrates at 10%; and dietary fiber at 35%.

A formulation with the highest total score receives the lowest ranking value, while the lowest score receives the highest ranking value. Formulation F1 received a score of 2.55 and ranked third. Formulation F2 received a score of 1.08 and ranked second. Formulation F3 received a score of 1.65; since F3 had the lowest score, it ranked first. Thus, Formulation F3 is the selected formulation.

Contribution of Nutrient Content to the RDA of Type 2 Diabetes Mellitus Patients and ALG

The contribution of the nutrient content of pies made from purple sweet potato flour and red bean flour is presented in Table 3. The contribution was calculated based on nutritional requirements according to PERKENI (2021) for male and female patients with type 2 diabetes mellitus in the age groups 19–29 years and 30–49 years. Snack consumption is recommended in small portions, providing 10–15% of daily nutritional needs (Puspita et al., 2019).

Based on the serving size, the selected pie formulation can be consumed in an amount of 84 g / 3 pieces, which contains the following nutrients: Energy: 256 kcal, Protein: 6.93 g, Fat: 8.85 g, Carbohydrates: 37.19 g, and Dietary fiber: 12.72 g.

Patients with type 2 diabetes mellitus need to pay attention to dietary regulation based on the "3J" principle: appropriate quantity, timing, and type of food, with the goal of maintaining health, preventing complications, and supporting recovery (Amalia & Dewi, 2022).

Table 5. Contribution of Pie Nutrient Content to the RDA of Type 2 Diabetes Mellitus Patients and Contribution of Pie to the ER (Energy Requirement)

Composition	Nutrient Content per Serving (84 g / 3 pieces)	% adequacy level for age group 19–29 years		% adequacy level for age group 30–40 years		% adequacy level for age group 41–49 years	
		M	F	M	F	M	F
RDA							
Energy (kcal)	256	10.94	14.59	10.59	14.32	11.01	14.90
Protein (g)	6.93	7.89	10.53	7.64	10.33	7.95	10.75
Fat (g)	8.85	13.61	18.15	13.11	17.82	13.70	18.53
Carbohydrates (g)	37.19	10.59	14.12	10.25	13.87	10.66	14.42
Dietary Fiber (g)	12.72	38.89	51.91	37.57	50.83	39.07	52.86
Nutrition Facts Reference							

Composition	Nutrient Content per Serving (84 g / 3 pieces)	% adequacy level for age group 19–29 years		% adequacy level for age group 30–40 years		% adequacy level for age group 41–49 years	
		M	F	M	F	M	F
RDA							
Composition	Nutrient Content (100 g)	% Nutrition Facts Reference			Nutrient Claim		
Energy (kcal)	305	14.18			-		
Protein (g)	8.25	13.75			-		
Fat (g)	10.54	15.73			-		
Carbohydrates (g)	44.28	13.62			-		
Dietary Fiber (g)	15.15	50.5			Tinggi		

Note: M (Male), F (Female).
RDA: Recommended Dietary Allowance
NFR: Nutrition Facts Reference

The Nutrition Facts Reference Value results are shown in Table 5. The requirement for claiming a food as a source of dietary fiber is 3 g/100 g, while the requirement for claiming it as high in dietary fiber is 6 g/100 g (BPOM, 2016). The dietary fiber content of the pie per 100 g contains nutrients such as 305 kcal of energy, 8.25 g of protein, 10.54 g of fat, 44.28 g of carbohydrates, and 15.15 g of dietary fiber. Based on the ALG calculation, it can be concluded that the pie can be claimed as a high–dietary fiber product.

CONCLUSION

The pie made from purple sweet potato flour and red bean flour met the SNI standards for protein, fat, carbohydrates, and dietary fiber, while its moisture and ash content did not meet SNI standards. The selected formulation was F3. The F3 formulation pie, with a serving size of 84 g (3 pieces), contributed 10–15% of the daily requirement for snack intake for individuals with type 2 diabetes mellitus and can be claimed as a high–dietary fiber product.

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