ISTEK
p-ISSN: 1979-8911
Volume 13 Number 2 | December 2024: 36-40

Potential of Peanut and Pumpkin-Based Biscuits for Dietary Management in Diabetes Mellitus Patients

Fadia Imanda Nurhaliza[1] , Nunung Kurniasih[2]
[1,2]Department of Chemistry, UIN Sunan Gunung Djati Bandung, Indonesia

Article Info

Article history:

Received October 29, 2024
Revised November 26, 2024
Accepted December 23, 2024

Keywords:

biscuits
diabetes
diet
pecans

ABSTRACT

People with type 2 diabetes mellitus often face challenges in achieving an adequate balanced diet that fulfills their nutritional needs. Pecans *(Carya illinoinensis)* are known to be rich in dietary fiber, protein, and healthy fats, and are a rich source of antioxidant polyphenols. Consumption of pecan nuts can help control blood sugar levels by lowering lipid levels and oxidative stress to improve insulin sensitivity in patients with type 2 diabetes mellitus. Therefore, this study aims to explore the potential of pecan nut biscuits as an alternative food that can help increase nutritional value and improve dietary management in patients with type 2 diabetes mellitus. The research methods used included biscuit recipe development, analysis of SNI No. 3571:2009, *in vivo* test of pecan nuts in male wistars, and nutritional analysis of raw materials. Pecan nut biscuits contain 35.0% carbohydrate, 12.7% protein and 33.1% lipid. Pecan nut biscuits are the most bioactive diet biscuits for patients with type 2 diabetes mellitus.

Corresponding Author:

Fadia Imanda Nurhaliza
Chemistry Department, Faculty of Science & Technology, UIN Sunan Gunung Djati Bandung
Jl. A. H. Nasution No. 105, Cibiru, Bandung, Indonesia. 40614
Email: fadiaimanda459@gmail.com

1. INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic condition caused by insulin resistance or ineffective use of insulin by the body [10]. According to data from the International Diabetes Federation Diabetes Atlas, the number of adult diabetics (20-79 years) worldwide is projected to be 537 million in 2021, increasing to 643 million in 2030, and will continue to increase to 784 million in 2045 [8].

People with type 2 diabetes mellitus often face challenges in achieving an adequate balanced diet that fulfills their nutritional needs. To overcome these challenges, the development of pecan nut biscuits as an alternative food rich in fiber and nutrients is relevant to increase nutrient intake and assist in dietary management for people with type 2 diabetes mellitus.

Biscuits are snacks that are most often consumed by all groups [4]. Based on research by Setyowati and Nisa (2014), commercial biscuits are considered to have unbalanced nutritional content. To increase the nutritional content of biscuits, functional food ingredients can be added. Pecan nuts as the main ingredient in making biscuits will increase nutritional value and provide a distinctive flavour.

Pecans *(Carya illinoinensis)* are the most valuable nut tree native to North America. Pecans are known to be rich in dietary fiber, protein, and healthy fats, and are a rich source of antioxidant polyphenols [1]. Pecan consumption can help control blood sugar levels by lowering lipid levels and oxidative stress to improve insulin response in patients with type 2 diabetes mellitus [7].

This article aims to explore the potential of pecan nut biscuits as a food alternative that can help increase nutritional value and improve dietary management in patients with type 2 diabetes mellitus. Biscuit analysis is based on proximate testing by SNI No.3751:2009, such as testing water content, ash content, and nutritional analysis such as carbohydrates, protein, and lipids.

2. METHOD

2.1 Raw Materials

Pecan nut biscuits are made by processing pecan nuts into flour. The process of making pecan flour refers to SNI No. 3751:2009 where good flour has the characteristics of smooth, white, and flavorless. The following are the stages of making pecan nut flour:

1) Pecans are washed 8 times
2) Pecan nuts were chopped and baked at 50 ^{0}C for 30 minutes.
3) Mashed with a food pelletiser and filtered with 100 mesh.

2.2 Preparation of Pecan Nut Biscuits

Margarine, powdered sugar, and egg white were mixed for 2 minutes. Then add pecan flour, wheat flour, cornflour, and baking powder and mix for 5 minutes. The dough was put into a biscuit mold and baked in an oven with an upper temperature of 150 ^{0}C and a lower temperature of 130 ^{0}C for 15 minutes.

2.3 Proximate Analysis

2.3.1 Water Content

Moisture content was measured according to SNI standard No. 3751:2009 using the thermogravimetric method. The mashed biscuits were taken as much as 2 g and placed into a pre-weighed cup. Then, the samples were dried in an oven at a temperature between 100-150 ^{0}C for 3-5 hours. Afterward, the samples were cooled in a desiccator and weighed again. This drying process is repeated until it reaches a constant weight.

2.3.2 Ash content

Ash content was measured according to SNI standard No. 3751:2009. The testing process starts with weighing 2 g of biscuit samples in a porcelain ash cup with known weights. Then, the sample was put into an oven at 100 ^{0}C for 2 hours. After that, the porcelain ash cup was transferred to the furnace and the temperature was gradually increased until it reached 550 ^{0}C. This test was repeated 3 times to ensure the accuracy of the results.

2.4 Nutrient Analysis

2.4.1 Protein Content

Protein content was determined using the Kjeldahl method. The Kjeldahl method is based on the oxidation reaction of a sample by a catalyst. H_2SO_4 with a catalyst K_2SO_4 which converts proteins and amino acids into $(NH_4)_2SO_4$. In the analysis, the sample is put into the Kjeldahl flask as much as 1 g, followed by the addition of 8 g of catalyst K_2SO_4 and 20 mL of a solution of H_2SO_4. In the Kjeldahl method, the sample needs to be deconstructed in a fume hood until the color changes to clear. Next, the sample is distilled by adding a boric acid solution until a filtrate is formed. The filtrate is then titrated with 0.1 N NaOH until a pink color change occurs. Protein content was calculated based on equations 1 and 2:

$$\%\text{Nitrogen} = \frac{\text{mL NaOH (blanko}-\text{sample)}}{\text{sample weight} \times 1000} \times \text{N NaOH} \times 14{,}008 \times 100\ \% \quad \text{.....(1)}$$

$$\%\text{Protein} = \%\text{N} \times 6{,}25 \quad \text{.....(2)}$$

2.4.2 Fat Content

Determination of fat content was carried out using the soxhletation method. In the soxhletation method, the sample is put into a filter paper that is shaped like a sleeve. Then the sample was heated in an oven with a temperature of about 105 ^{0}C for 1 hour. After that, the sample is allowed to stand in a desiccator until it reaches room temperature. The sleeve that already has a constant weight is inserted into the soxhlet. Next, a non-polar solution such as hexane is prepared and poured into the soxhlet, then the test is carried out for 5-8 hours. After the extraction process, the sleeve is dried using an oven at a temperature of about 105 ^{0}C for 1 hour. The casings were then left in a desiccator for 15 minutes before the weight was measured again. The calculation of fat content is based on equation 3:

$$\text{Fat Content} = \frac{\text{B}-\text{A}}{\text{n}} \times 100\ \% \quad \text{.....(3)}$$

Description:
An initial sleeve weight
B final sleeve weight
n = sample weight

Carbohydrate Content

The percentage of carbohydrates is calculated using 100% subtraction from the sum of the other four components, namely moisture content, ash content, protein content, and fat content.

2.4 *In vivo* Test of Pecan Nuts on Wistar Males

Thirty test animals were prepared with an average weight of 148 g and randomly divided into 5 groups. Five dietary treatments were prepared. (1) control group consuming a diet with optimal nutrient concentrations, (2) high fat (HF) group consuming a diet high in lipids, (3) HF + PO (pecan oil) group consuming a diet similar to the HF diet, (4) HF + PP (pecan polyphenols) consuming lipids with pecan polyphenols, (5) HF + WP (whole pecans) consuming pecans.

3. RESULT AND DISCUSSION

3.1 Nutrient Analysis

Pecans contain abundant daily nutrients such as 3.9% carbohydrate, 2.6% protein, 11.57% monounsaturated fat, 6.13% polyunsaturated fat, and 2.7% dietary fiber. This causes pecans to produce 819 kJ of energy.

The nutrients contained in pecan nuts are stealing a lot of attention. Some researchers have made innovative efforts to create new products to improve the quality and quantity of pecan nuts. Nut-based biscuits are one of the innovations to improve the function of functional food in the community. The following data shows the comparison of the nutritional value of biscuits made from pecan flour with biscuits made from mung beans and pumpkin:

Sample	Extraction Method	Test Material	Number (%)	Researcher
Pecan Nut Flour Biscuits	Maceration Kjeldahl Soxheltasi	Carbohydrates Protein Lipids	35,0 12,7 33,1	Muchuittia et al, (2023)
Mung Bean Flour Biscuits	Maceration Kjeldahl Soxheltasi	Carbohydrates Protein Lipids	68,72 19,09 3,60	Ratnasari, et al (2015)
Pumpkin Flour Biscuits	Maceration Kjeldahl Soxheltasi	Carbohydrates Protein Lipids	57,46 11,91 17,98	Koila, et al (2021)

Table 1 Comparison of Nutritional Value of Biscuits Made from Pecan, Mung Bean and Yellow Pumpkin Flour.

Table 1 shows that biscuits made from pecan flour had the lowest carbohydrate content. The low carbohydrate content is an effective indicator for dieting. Low carbohydrate levels can help the metabolic process of blood sugar absorption so that it is effective in weight loss.

There is an increase in the nutritional value of pecans with processed pecan flour. Carbohydrate, protein, and lipid content in pecan nut biscuits are higher than the nutritional content of pecan nuts per serving. This is because the preparation of pecan nut biscuits involves supporting ingredients such as margarine, powdered sugar, and egg whites which can improve the overall nutrition of the biscuits. However, pecans produce both saturated and polyunsaturated lipids. Thus, pecan nut biscuits are bioactive biscuits for patients with type 2 diabetes mellitus.

3.2 Moisture Content Analysis

Analysis of moisture content in biscuits can affect the quality, shelf life, and stability of the product. Too high moisture content can cause the biscuits to become mushy and spoil quickly, while too low moisture content can make the biscuits hard and brittle. The following is the data from the analysis of the moisture content of pecan, mung bean, and pumpkin biscuits:

Table 2. Comparison of moisture content of pecan, mung bean, and pumpkin flour biscuits

Biscuit Sample	Extraction Method	Moisture Content (%)	Researcher
Pecan Nut Flour	Thermogravimetry	6,4	Muchuittia et al, (2023)
Mung Bean Flour	Thermogravimetry	-	Ratnasari, et al (2015)
Pumpkin Flour	Thermogravimetry	9	Koila, et al (2021)

The moisture content of pecan biscuits has a fairly good value. Based on SNI No. 3751:2009, biscuits have a maximum moisture content of 5%. Pecan nuts are a type of nut with a minimal amount of water, but in the process of making pecan nut biscuits, several supporting ingredients are added such as margarine, powdered sugar, and egg whites. These ingredients cause the water content to increase. Margarine is a *water-in-oil* (W/O) emulsifier that can release water in the emulsion during the biscuit-making process.

3.3 Ash content

Ash is a mineral element contained in food. Ash can be left behind during the food manufacturing process. As the proportion of flour in the biscuit dough increases, the ash content decreases. The following is the data from the ash content analysis of pecan, mung bean and pumpkin biscuits:

Biscuit Sample	Extraction Method	Ash content (%)	Researcher
Pecan Nut Flour	Dry Ignition	4,10	Muchuittia, et al (2023)
Mung Bean Flour	Dry Ignition	2,77	Ratnasari, et al (2015)
Pumpkin Flour	Dry Ignition	3,62	Koila, et al (2021)

Table 3 Comparison of ash content of pecan, mung bean, and pumpkin flour biscuits

Based on SNI No. 3751:2009, the maximum ash content is 0.7%. In Table 3, biscuits made from pecans, mung beans, and pumpkin did not meet the quality requirements. This may be due to the presence of minerals contained in the biscuit products. Pecan nuts themselves contain minerals such as Ca, Mg, K, Mn, Na, and Fe. According to Koila (2019), the ash content in a food product varies, depending on the amount of minerals contained in the ingredients used.

3.5 *In vivo* Test of Pecan Nuts on Wistar Males

Evidence regarding the bioactivity of pecan nuts with the addition of each fraction is scarce. In the journal (Jesus, 2015), a high-fat (HF) diet was fed to male Wistar rats supplemented with pecan oil (HF + PO), pecan polyphenols (HF + PP), or whole pecans (HF + WP), and analyzed the effects of each fraction. The HF diet increased serum leptin and total cholesterol (TC) compared to control levels. HF + WP diet prevented hyperleptinaemia and decreased TC compared to control. HF + WP diet upregulated hepatic expression of apolipoprotein B and LDL receptor mRNA concerning HF levels. HF+PO diet decreased triacylglycerol levels compared to controls. HF+PP diet stimulated hepatic expression of hepatic X receptor alpha mRNA. HF + WP diet increased hepatic catalase activity, glutathione peroxidase, and glutathione S transferase compared to the control, and decreased the degree of lipid peroxidation compared to the HF diet. The most bioactive diet was the WP diet.

4. CONCLUSION

The results showed that pecan nut biscuits contained 35.0% carbohydrate, 12.7% protein, and 33.1% lipid. Pecan nuts produce saturated and polyunsaturated lipids. So pecan nut biscuits are bioactive biscuits for people with type 2 diabetes mellitus.

REFERENCES

[1] G. Ana and L. L., *Antioxidants in Pecan Nut Cultivars (Carya illioinensis (Wangenh.) K. Koch)*, California, 2011.

[2] C. Pires, "Superfoods for type 2 diabetes: A narrative review," *Biosciences & Health Technologies*, pp. 1-2, 2023.

[3] D. M. E., "A pecan-rich diet improves cardiometabolic risk factors in overweight and obese adults: A

randomized controlled trial," *Nutrients*, pp. 1-17, 2018.
[4] D. Ratnasari and Yunianta, "The effect of mung bean flour, pumpkin flour, margarine on the physicochemical and organoleptic properties of biscuits," *Journal of Food and Agroindustry*, pp. 1652-1659, 2015.
[5] E. A. Parrilla, R. U. Lopez, and L. d. Rosa, *Journal of Food Bioactives*, pp. 56-58, 2018.
[6] G. S. Muchuittia, N. G. Camera, and J. V., "Analysis of walnut pecan flour (Carya illinoinensis var. Shoshoni) for high-quality dried fruit leather production," *Journal of Agricultural, Food Science & Biotechnology*, pp. 254-260, 2023.
[7] H. H. Ella, *Health Effects of a Pecan (Carya illinoinensis (Wangenh.) K. Koch) Nut-rich Diet*, California, 2011.
[8] International Diabetes Federation (IDF), *International Diabetic Federation Diabetic Atlas, 10th ed.*, IDF, 2021.
[9] J. A. D. A., "The pecan nut (Carya illinoinensis) and its oil and polyphenolic fractions differentially modulate lipid metabolism and antioxidant enzyme activities in rats fed high-fat diets," *Food Chemistry*, pp. 530-532, 2015.
[10] Ministry of Health of the Republic of Indonesia, *Type 2 Diabetes Mellitus*, Jakarta, 2022.
[11] S. Fathonah, Rosidah, and Karsinah, "Mung bean crushing technology and its application," *Journal of Engineering Competence*, pp. 12-19, 2018.
[12] W. M. Koila, L. Karimuna, and Hermanto, "Biskuit substitution of yellow pumpkin (Cucubita moschata Duch) and soy (Glycine max L. Merr)," *Journal of Food Science and Technology*, vol. 6, pp. 4591-4608, 2021.