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POTENTIAL OF GOROHO BANANA FLOUR AND *TANDUK* BANANA FLOUR FROM NORTH MALUKU AS ALTERNATIVE FOOD INGREDIENTS

POTENSI TEPUNG PISANG GOROHO DAN TEPUNG PISANG TANDUK DARI MALUKU UTARA SEBAGAI BAHAN PANGAN ALTERNATIF

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ABSTRAK

Pisang Goroho dan pisang tanduk adalah pisang lokal yang terdapat di semua kabupaten/kota di Maluku Utara. Kedua jenis pisang ini biasanya dikonsumsi di Maluku Utara dalam bentuk panganan tradisional. Untuk dapat diolah menjadi produk turunan lain dan agar memiliki masa simpan yang lebih lama, maka inovasi produk yang dapat dilakukan adalah mengolahnya menjadi tepung pisang. Tepung pisan dapat menjadi alternatif sumber karbohidrat dan berpotensi menggantikan tepung terigu yang masih diimpor. Sehingga tepung pisang diharapkan dapat menjadi bahan pangan alternatif. Tujuan penelitian ini adalah mengetahui karakteristik fisikokimia dari tepung pisang goroho dan tepung pisang tanduk. Selain itu, penelitian ini bertujuan untuk mengetahui potensi tepung pisang goroho dan tepung pisang tanduk sebagai bahan pangan alternatif. Rancangan penelitian yang digunakan adalah Rancangan Acak Lengkap non faktorial, dengan faktor perlakuan adalah jenis pisang (pisang goroho dan pisang tanduk). Hasil penelitian menunjukkan bahwa karakteristik fisikokimia dari tepung pisang goroho adalah rendemen 30%, warna L 84,48, a 1,18, b* 17,78, karbohidrat 82,91%, kadar protein 3,51%, kadar lemak total 1,41%, kadar air 9,69%, kadar abu 2,50%, energi total 358,31 Kcal/100g, energi dari lemak 12,65 Kcal/100g dan pH 5,43. Karakteristik fisikokimia dari tepung pisang tanduk adalah rendemen 31%, warna L 82,36, a* 2,85, b* 18,36, karbohidrat 83,69%, kadar protein 2,65%, kadar lemak total 1,54%, kadar air 10,19%, kadar abu 1,94%, energi total 359,2 Kcal/100g, energi dari lemak 13,86 Kcal/100g dan pH 6,38. Karakteristik fisikokimia yang dimiliki oleh tepung pisang goroho dan tanduk dari Maluku Utara ini memberikan keduanya berpotensi sebagai bahan pangan alternatif.*

Keywords: bahan pangan altenatif, tepung pisang goroho, tepung pisang tanduk, Maluku Utara

ABSTRACT

Goroho bananas and *tanduk* bananas are local bananas found in all districts/cities in North Maluku. These two types of bananas are usually consumed in North Maluku in the form of traditional foods. In order to be processed into other derivative products and to have a longer shelf life, the product innovation that can be done is to process them into banana flour. Banana flour can also be an alternative source of carbohydrates and has the potential to replace wheat flour which is still imported. So that banana flour is expected to be an alternative food ingredient. The purpose of this study was to determine the physicochemical characteristics of goroho banana flour and *tanduk* banana flour. In addition, this study aims to determine the potential of goroho banana flour and *tanduk* banana flour as alternative food ingredients. The research design used was a non-factorial Completely Randomized Design, with the treatment factor being the type of banana (goroho banana and *tanduk* banana). The results of the study showed that the physicochemical characteristics of goroho banana flour were 30% yield, color L 84.48, a* 1.18, b* 17.78, carbohydrate 82.91%, protein content 3.51%, total fat content 1.41%, water content 9.69%, ash content 2.50%, total energy 358.31 Kcal/100g, energy from fat 12.65 Kcal/100g and pH 5.43. The physicochemical characteristics of tanduk banana flour are yield 31%, color L 82.36, a* 2.85, b* 18.36, carbohydrate 83.69%, protein content 2.65%, total fat content 1.54%, water content 10.19%, ash content 1.94%, total energy 359.2 Kcal/100g, energy from fat 13.86 Kcal/100g and pH 6.38. The physicochemical characteristics of goroho and *tanduk* banana flour from North Maluku give both the potential as alternative food ingredients.

Keywords: alternative food ingredients, Goroho banana flour, *tanduk* banana flour, North Maluku

INTRODUCTION

North Maluku has a variety of local bananas, including goroho bananas and tanduk bananas. Both types of bananas are found in all districts/cities in North Maluku. The largest production potential is in West Halmahera and North Halmahera Regencies.

Goroho bananas (*Musa acuminafe, sp*) are bananas found in North Maluku that are very popular. Goroho bananas contain polyphenol compounds that

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have antioxidant properties. Based on the research results of Suryanto *et al.* (2011) goroho bananas have phenolic phytochemical content that can act as antioxidants with a total antioxidant content of 1.83 mmol/100g. Therefore, food diversification by utilizing goroho bananas needs to be done.

Tanduk bananas are one type of banana that grows a lot in North Maluku. Tanduk bananas are very large, green when unripe then turn yellow when ripe and have a large, curved shape like a tanduk. The flesh of the fruit is white, the texture is soft, and the taste is slightly sweet and sour (Anonim, 2012).

Both types of bananas are usually consumed in North Maluku by being processed into traditional foods such as kolak, boiled bananas and fried bananas. The shelf life of fresh bananas is quite short. This is because bananas are classified as climacteric fruits that experience a spike in ripeness even after the harvesting process (Murtadha *et al.*, 2012).

One of the banana-based product innovations that can increase its economic value is banana flour. Banana flour is one of the processed products of fresh bananas which is a semi-finished material. Banana flour has a fairly long shelf life of 6 months (Lolodatu, 2015). Processing fresh bananas into banana flour can be an alternative diversification of banana commodities that is recommended because it is more durable in storage, easy to mix or make into composites, can be enriched with nutrients (fortification), and is cooked faster according to the demands of modern life that is very practical (Kusuma *et al.*, 2017).

Banana flour can also be an alternative source of carbohydrates and has the potential to replace wheat flour which is still imported. Indonesia is still highly dependent on wheat imports as the main raw material for wheat flour. According to the Central Statistics Agency (BPS, 2022), Indonesia imports more than 10 million tons of wheat per year, most of which is processed into wheat flour. This dependence causes unstable food raw material prices and has an impact on the wheat flour-based food industry. Utilizing flour from local sources, such as goroho banana flour and tanduk banana from North Maluku, can help reduce dependence on imports, support the local farmer economy, and increase national food security (Astawan *et al.*, 2021). In other words, banana flour is expected to be an alternative food ingredient.

The purpose of this study was to determine the chemical characteristics of goroho banana flour and tanduk banana flour. In addition, this study aims to determine the potential of goroho banana flour and tanduk banana flour as alternative food ingredients.

MATERIALS AND METHODS

The materials used in making flour are white goroho bananas and tanduk bananas (harvest age 85-90 days) from North Maluku, water, distilled water, lime and sodium metabisulfite. The materials needed for analysis include distilled water, cotton, $H2SO4$ (sulfuric acid), NaOH, hexane, selenium, acetic acid, chloroform.

The tools for making flour are oven, pan, knife, basin, scales, blender, sieve, tray, stove, spatula, and gloves. The tools for analysis include oven, porcelain cup, analytical scale, colorimeter, beaker, dropper, desiccator, mufle furnace, Kjeldahl flask, paper sleeve, soxhlet, Erlenmeyer flask and micropipette.

The making of goroho banana flour and tanduk banana flour begins with blanching for 5 minutes with water at a temperature of 80°C. The bananas are not peeled. After that, the bananas are cooled and peeled. Next, the banana flesh is sliced using a slicer with a thickness of 2-4 mm. Small pieces of goroho bananas are soaked in a basin containing 2500 ppm sodium metabisulfite (goroho bananas) or 0.15% lime (tanduk bananas) for 30 minutes. The bananas are drained for 5 minutes. The bananas are dried using an electric oven at a temperature of 60 ° C for 8-9 hours, then ground using a blender until smooth at a speed of 20.400 rpm for ±15 minutes. The mashed banana flesh powder is then sieved using a 60 mesh sieve. The making of goroho and tanduk banana flour was modified from research by Silviana (2024).

The flour produced was analyzed physically and chemically. Physical analysis, namely yield (AOAC, 2005) and color (L, a *, b * with CIELAB). Chemical analysis, namely water content (SNI 01-2891-1992 point 5.1), ash content (SNI 01-2891-1992 point 6.1), protein (Titrimetry, 18-8-31/MU/SMM-SIG), carbohydrates (By Difference, 18-8-9/MU/SMM-SIG), total fat (Gravimetry, 18-8-5/MU/SMM-SIG point 3.2.2), energy from fat (calculation, 18-8-9/MU/SMM-SIG), total energy (calculation, 18-8-9/MU/SMM-SIG) and pH (AOAC, 2005).

RESULTS AND DISCUSSIONS

Yield

Yield is the percentage of the product obtained by comparing the initial weight of the material with the final weight (Kemalawaty *et al.*, 2019). According Rahmawati (2014), yield is the percentage of the product that is known to lose its mass during the processing process by comparing the initial mass of the material with the final mass of the material.

The purpose of the yield analysis is to predict how much raw material is needed to produce the product and to determine the efficiency of the processing process (Julianto *et al.*, 2011). The results of the yield test in the manufacture of goroho and tanduk banana flour from North Maluku can be seen in Table 1. It can be seen that the yield of tanduk banana is slightly lower than goroho banana.

The main component of flour is carbohydrates, so the main factor that affects its yield is its

carbohydrate content (Patola dan Ilminingtyas, 2017). The yield of banana flour produced in this study was higher than the yield of goroho banana flour produced by Abu, (2024), which was 17.02% -20.60%. The yield of banana flour is influenced by various factors, including starch content, water content, variety, and flour processing.

Table 1. Yield of goroho and tanduk banana flour from North Maluku

No	Types of Flour	Yield
1	Goroho banana	30%
2	Tanduk banana	31%

The process of making goroho bananas in this study used sodium bisulfite as a soaking agent, while Abu's (2024) study used kalamansi orange as a soaking agent with a pH of 2.3-2.5. Sodium bisulfite does not directly increase the yield, but it can reduce the degradation of starch components due to enzymatic reactions, so that more materials can be processed into flour or higher yields. Soaking in an acidic solution that is too strong can soften the bananas, causing more materials to be wasted during the processing process, so that the yield decreases. This is what causes the yield of goroho banana flour from this study to be higher than Abu's (2024) study.

High banana flour yield does not always directly indicate the quality of the flour, but can be an indication of the efficiency of the production process. High yields can be related to several aspects of quality and its potential as a food ingredient, depending on the characteristics of the flour produced. The yield of goroho banana flour produced in this study was higher than in previous studies, presumably because the starch content was not much degraded. This can be advantageous because starch is a major component in many food applications.

Color

Color is one of the main indicators in determining the quality of flour, especially if it is to be used as an alternative to wheat flour. The color of flour can affect consumer acceptance, application ability in food products, and storage stability.

Color measurement using Colorimeter which produces L*, a* and b* values, L value indicates brightness (0 = black: to 100 = white), a value (red-green) a+ = 0-100 for red; a-= 0-(-80) for green, and b* (yellow-blue) b+ = 0-70 for yellow; b- = 0-(-70) for blue (Engelen, 2018). Table 2 shows the color of goroho and tanduk banana flour from North Maluku.

Goroho banana flour looks brighter than *tanduk* banana flour as indicated by the higher L value of goroho banana flour. The higher the lightness value (L*) means that the color of the sample is brighter Pardede (2017). Goroho banana flour also has lower red and yellow colors, compared to *tanduk* banana flour. The higher brightness value of goroho banana flour compared to *tanduk* banana flour indicates the potential of goroho flour to be an alternative to wheat flour in terms of color.

According to Ashraf *et al*. (2019), flour color greatly influences consumer preferences. Whiter or creamier flour is easier to use in making bread, cakes, and noodles because it gives a final result similar to wheat flour. This is in line with the opinion of Okafor *et al.* (2012), flour color affects the acceptance of flour-based products such as noodles and bread.

The processing method plays a major role in determining the final color of banana flour as an alternative to wheat flour. Soaking in sodium metabisulfite ($Na_2S_2O_5$) solution can inhibit enzymatic browning and maintain the white color (Adelekan dan Oyewole, 2013).

Table 2. Color of goroho and *tanduk* banana flour from North Maluku

No	Color parameter	Goroho banana flour	*Tanduk* banana flour
1	L	84.48	82.36
2	a*	1.18	2.85
3	b*	17.78	18.36

Chemical Characteristics

The chemical characteristics of goroho banana flour and *tanduk* banana from North Maluku are shown in Table 3. The chemical characteristics observed were carbohydrates, protein content, fat content, water content, ash content, total energy and energy from fat.

Table 3. Chemical content of goroho banana flour and *tanduk* banana flour from North Maluku

No	Parameter	Unit	Goroho banana flour	*Tanduk* banana flour	Flour (*)
1	Carbohydrates (By difference)	(%)	82.91	83.69	77
2	Protein content	(%)	3.51	2.65	8.9
3	Total fat content	(%)	1.41	1.54	1.3
4	Water content	(%)	9.69	10.19	12
5	Ash content	(%)	2.50	1.94	1
6	Total energy	(Kcal/100g)	358.31	359.2	365
7	Energy from fat	(Kcal/100g)	12.65	13.86	-
8	pH	-	5.43	6.38	6.26

Note : *= Direktorat Gizi Departemen Kesehatan (1996)

Carbohydrates

The carbohydrate content is the highest compared to other proximate contents. Carbohydrates are the main source of calories, and several groups of carbohydrates produce dietary fiber. The largest carbohydrate component in bananas is starch in the flesh of the fruit, and will be converted into sucrose, glucose and fructose when the banana is 15-20% ripe (Bello *et al.*, 2005). The high carbohydrate content in the banana flour produced is inversely proportional to the levels of nutritional components in it. This is in accordance with the method of determining carbohydrates using the by difference method.

The carbohydrates in goroho banana flour are lower than those in *tanduk* banana flour. However, both of these banana flours still have higher carbohydrate content than wheat flour. The results of the carbohydrate content in goroho bananas are slightly higher than the starch content in goroho banana flour produced by Sondakh (1990), which is 80.89% and research by Sjarif dan Indriaty (2015) , which is 75.34-78.19%. The carbohydrate content of goroho banana flour is lower than that produced by Abu (2024) in drying at a temperature above 60 oC and for 8 hours, which is 83.04-86.63%. The carbohydrates in this *tanduk* banana flour are also higher than the *tanduk* banana flour researched by Sani (2015), which is 79.9%.

Processing methods can affect the carbohydrate content of food, mainly through starch degradation, sugar dissolution, or thermal reactions. High temperature drying (above 70°C) can cause starch degradation into dextrin and simple sugars through partial gelatinization (Falade dan Olugbemi, 2020). This study used temperatures below 70oC, resulting in higher carbohydrates than previous studies.

Carbohydrates have various functions in the food industry, especially in forming texture, stability, and sensory characteristics of products. Carbohydrates are the main source of calories in processed foods such as bread, biscuits, and pasta. Simple carbohydrates (glucose, fructose) provide sweetness and fast energy. Carbohydrates in the form of starch and fiber help bind water and retain moisture in bakery products and processed meats. Starch functions as a thickener in sauces, soups, and bakery products (Adelekan and Oyewole, 2013). In the process of making breakfast cereals, starch is an important component to produce a crunchy structure and also as a source of calories (Susi *et al.*, 2019). Modified starch can increase viscosity and stability in products such as milk-based beverages and baby food (Nurul *et al.*, 2017).

The main function of digestible carbohydrates for humans is to provide energy for cells, including brain cells whose work depends on the supply of carbohydrates in the form of glucose. Lack of blood glucose (hypoglycemia) can cause fainting or be fatal; while excess blood glucose causes hyperglycemia which if it continues increases the risk of diabetes or diabetes mellitus (Mahan and Escott-stump, 2008).

Protein Content

The protein content of goroho banana flour is higher than that of jackfruit banana flour, but still lower than the protein content of wheat flour. The results of this study on the protein content of goroho banana flour are still higher when compared to the results of Sondakh's (1990) study, which is 2.89%, but lower than Abu's (2024) study, which is 4.71-5.49%. For *tanduk* bananas, the protein content of *tanduk* banana flour from North Maluku is slightly lower than that of Sani's (2015) *tanduk* banana study, which is 2.9%.

Processing methods greatly affect the structure, solubility, and functionality of proteins in food. High-temperature drying (>70°C) can cause protein denaturation, which can reduce its solubility but increase its ability to bind water (Falade dan Olugbemi, 2020). Higher protein content increases the water-binding capacity and emulsifying capacity of flour, while low protein content is more suitable for products with a soft texture.

High protein content increases water-binding capacity, making flour more suitable for use in bakery products that require a soft and elastic texture (Adelekan dan Oyewole, 2013). The lower protein content compared to wheat makes banana flour suitable for biscuits, cakes, and pancakes, but less optimal for bread because it does not contain gluten (Falade dan Olugbemi, 2020). In the food industry, banana flour can be used in bakery, gluten-free products, thickening agents, and as a source of vegetable protein in health product formulations.

Protein has many benefits, including for growth and maintenance of the body; regulating damaged cells; the formation of important body compounds, such as hormones, enzymes, and hemoglobin; forming body antibodies. In addition, it plays a role in transporting nutrients and regulating water balance in cells (Widodo, 2019).

Total Fat Content and Energy from Fat

The fat content of goroho banana flour is slightly lower than *tanduk* banana flour, but both banana flours have higher fat content than wheat flour. This is in line with the energy from the fat produced, goroho banana flour is slightly lower than *tanduk* banana flour. This goroho banana flour has a higher fat content than the results of Sondakh's (1990) study, which is 0.67%. For *tanduk* banana flour, the fat content is also higher than that produced by Sani's (2015) study, which is 1.1%.

The fat content in banana flour is influenced by several factors, especially the processing method used during the flour making process. The main processes that play a role in determining the fat content are the drying and milling methods. Higher fat content tends to increase the softness of the

product and provide a creamy sensation in products such as bread and cakes (Fellows, 2009), but is at risk of experiencing rancidity more quickly. Conversely, lower fat content increases water absorption and shelf life, but can produce a drier texture. The selection of fat content in banana flour must be adjusted to the desired food product application.

High or low levels of fat in the diet and body have significant impacts on health and physiological function. The function of fat is as a source of energy, protector of body organs, cell formation, source of essential fatty acids, means of transporting fat-soluble vitamins, saving protein. Fat also provides a feeling of fullness and deliciousness, as a lubricant, and maintains body temperature.

Water Content

Water content is one of the crucial parameters that determine the quality of flour. The lower the water content, the longer the shelf life of the flour product, conversely the higher the water content, the easier the flour product is to be damaged both chemically and biologically and the shelf life is short.

The water content contained in these two bananas meets the requirements for banana flour from SNI 01-3841-1995, which is a maximum of 12% w/w. Both of these banana flours will have a long shelf life, making it possible to be used longer as food ingredients. When processed into other dry derivative products, this flour has the potential to make its products have a longer shelf life. The water content of the goroho banana flour obtained is still lower than the water content of the goroho banana flour from Sondakh's (1990) research which is 11.99%.

Ash Content

The remaining combustion products which are inorganic substances from organic materials are called ash. Usually the measurement of ash content is related to the mineral content in the material (Husna *et al.*, 2017). The ash content of goroho banana flour is higher than the ash content of *tanduk* banana flour. And both have a higher ash content than wheat flour. Goroho banana flour from this study has a higher ash content than the ash content of Abu's research results which is 1.69-2.03% (Abu, 2024).

The banana flour processing method greatly affects the ash content, where the washing, drying, and milling processes must be carried out properly to obtain better flour quality. Nurfiani *et al.* (2018) showed that temperature and drying time significantly affect the ash content in flour, where increasing temperature and drying time tend to increase the ash content.

High ash content can affect the texture, taste, shelf life, and safety of food products. High ash content can cause the texture of the product to become rougher and less soft. Research by Amelia *et al.* (2021) shows that the chemical composition of flour, including ash content, can affect the physical properties of the final product. High ash content can indicate mineral contamination that can accelerate chemical reactions during storage, thereby shortening the shelf life of the product. A study by Nurfiani *et al.* (2018) stated that increasing ash content is related to decreased quality during storage. Therefore, choosing the right processing method is very important to maintain the quality of the final product.

Total Energy

Total energy can be a benchmark for managing daily calorie intake. The total energy needs of adults are needed for: Basal metabolism, Physical activity, Food effects or special dynamic influences. The total energy of both types of banana flour is still lower than the total energy of wheat flour. This is in line with the lower protein content of wheat flour. Between the two, the total energy of *tanduk* banana flour is slightly higher than goroho banana flour.

The total energy value of banana flour is influenced by the processing method applied during the production process. The drying method used can affect the water content in banana flour. Effective drying will reduce the water content, thereby increasing the concentration of nutrients such as carbohydrates, proteins, and fats, which in turn increases the total energy value of the flour. For example, drying with an oven at a certain temperature and time can produce flour with low water content and optimal energy value.

This high energy content makes banana flour suitable for use in various food products, such as: breakfast cereals because as a source of complex carbohydrates, banana flour can provide the energy needed to start the day. Banana flour can be used as a raw material in making bread, cakes, and pastries, providing additional flavor and nutritional value. The use of banana flour in making bread has been tested, producing bread with good chemical characteristics and a high level of panelist preference (Zainal, 2022).

pH (Degree of Acidity)

The acidity of a solution is determined by the concentration of H+ contained in the solution. The degree of acidity (pH) of a solution is defined as the negative logarithm value of the concentration of H+ ions in the solution which can be expressed by the following equation pH=-Log [H] (Suciningsih, 2006).

The results of the pH analysis of goroho banana flour were 5.43, *tanduk* banana flour 6.38 and wheat flour 6.26. It can be seen that goroho banana flour has a lower pH and tends to be acidic than *tanduk* banana flour and wheat flour. The pH of this goroho banana flour is lower than the pH of goroho banana flour obtained from research (Sjarif dan Indriaty, 2015) which is 6.0-6.8.

The pH value of banana flour is influenced by various processing methods applied during the production process. Research by Palupi (2011) showed that the use of soaking agents such as sodium

metabisulfite ($Na_2S_2O_5$) and calcium carbonate affects the quality of banana flour, including its pH. Blanching before drying can affect the pH of banana flour. This process helps inactivate enzymes that can cause pH changes and prevent browning reactions. Research by Mariani (2019) showed that the blanching method affects the characteristics of dried bananas, including their pH.

The acidity (pH) of banana flour plays an important role in determining its physical, chemical, and functional properties in food products. A lower acidity (pH) (acidic) can affect the texture of the final product, such as bread or cake, by producing a softer crumb. Conversely, a higher pH (alkaline) can produce a drier and more fragile texture. An acidic acidity (pH) can provide a sharper or sour taste, while a basic pH can produce a more bitter taste. Products with a lower pH tend to have a longer shelf life because the acidic environment inhibits the growth of pathogenic microorganisms.

Potential of Alternative Food Ingredients

This banana has the potential as one of the food diversification materials that is an alternative to other food materials. This potential is based on the content of carbohydrates, fat, protein, ash, energy, pH and water that meet the requirements as a food commodity. In addition to the physical characteristics it has (yield and color).

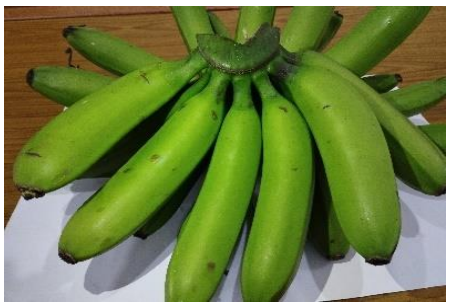
Banana flour as a food ingredient must meet certain requirements to be safe, nutritious, and of high quality when used in food products. Among the general physical requirements that flour as a food ingredient must have is that it must have a fine powder texture, be free from foreign objects, and not clump. Flour must have a distinctive color according to the raw material, for example wheat flour which is yellowish white or banana flour which tends to be cream or slightly brown. Flour must have a natural odor according to the raw material and not smell rancid or other foreign odors. In terms of physical characteristics, goroho and *tanduk* banana flour in this study have the required texture, color, and odor.

Goroho bananas (Figure 1a) in North Maluku society are usually processed into snacks only when raw such as boiled bananas, fried bananas and chips. Eaten with chili sauce. Often not consumed when ripe. *Tanduk* bananas (Figure 1b) are usually processed into snacks when ripe such as fried, boiled, made into traditional cakes such as "pisang coe". The price of goroho bananas in the local market is IDR 8,000 - IDR 15,000 (per comb), while *tanduk* bananas are IDR 5,000 - IDR 10,000 (per fruit).

Goroho and *tanduk* bananas which are usually processed in traditional snacks have the potential to be processed into other derivative products, if processed into flour. Processing goroho and *tanduk* bananas from North Maluku into flour provides opportunities for more varied development, which indirectly helps accelerate the achievement of the food security program.

Several studies that utilize goroho banana flour to be processed into various products include flakes (Papunas *et al.*, 2013), biscuits (Sayangbat. *et al.*, 2013), food bars (Yasim *et al.*, 2018), sponge cakes (Datunsolang, 2018), analog rice (Putra *et al.*, 2013) and Semprong (Uller *et al.*, 2017). For *tanduk* banana flour, there are several products processed from the banana, including biscuits (Sungkar, 2020), cookies (Siswanto *et al.*, 2013) , vegetarian sticks (Fernanda *et al.*, 2017), non-fat yogurt (Karlin dan Arintina, 2014), croffle (Dewi, 2024), biscuits (Hartanto, 2016), pound cake (Nita, 2007) dry noodles (Sanita, 2007), steamed cake (Basuki *et al.*, 2017), and dodol (Eriyana *et al.*, 2018).

The results of this study indicate the great potential of goroho and *tanduk* banana flour as alternative food ingredients, especially in replacing wheat flour. The high carbohydrate content of goroho and *tanduk* banana flour from North Maluku makes both of them alternative food ingredients. In addition to its protein content which is also quite high, it has the potential to be processed into several processed food products such as noodles with the addition of eggs to increase protein and mocaf flour, for example, to increase binding power. Its high ash content also provides the following opportunity to make it an alternative food ingredient. In addition to its water content which still meets the requirements for flour content (max 12%). The large contribution of energy, both total and from fat, also makes it a food source that produces sufficient energy.



(a)

(b)

Figure 1. Goroho banana (a) and *tanduk* banana (b) from North Maluku

Goroho and *tanduk* banana flours are gluten-free, making them an excellent alternative for people with gluten intolerance or celiac disease. This makes them very relevant in the manufacture of gluten-free food products. Research shows that banana flour not only has good nutritional potential, but can also provide functional benefits in food products. For example, research conducted by Kiay *et al.* (2019) showed that banana flour contains antioxidants that are beneficial for health and can improve the quality of food products such as cakes and bread. Banana flour is also reported to have the potential to increase the content of dietary fiber in processed products.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The results of the study showed that the physicochemical characteristics of goroho banana flour were 30% yield, L color 84.48, a* 1.18, b* 17.78, carbohydrate 82.91%, protein content 3.51%, total fat content 1.41%, water content 9.69%, ash content 2.50%, total energy 358.31 Kcal/100g, energy from fat 12.65 Kcal/100g and pH 5.43. The physicochemical characteristics of *tanduk* banana flour are 31% yield, L color 82.36, a* 2.85, b* 18.36, carbohydrate 83.69%, protein content 2.65%, total fat content 1.54%, water content 10.19%, ash content 1.94%, total energy 359.2 Kcal/100g, energy from fat 13.86 Kcal/100g and pH 6.38.

Goroho and *tanduk* banana flour have various characteristics that support their potential as alternative food ingredients. High yield, neutral color, stable pH, low water content, high carbohydrate and low fat content make them ideal ingredients for various food products. Sufficient energy content and rich minerals support their use in healthy and functional food products. With these advantages, banana flour can be a potential alternative in the food industry, especially as a substitute for wheat flour in gluten-free products.

Recommendations

It is necessary to conduct research on the thermal characteristics, water absorption and sensory (color, odor and texture) of the flour produced to see the further potential of goroho and *tanduk* banana flour as food ingredients. For implementation as a food raw material, it can be used for biscuits, flakes, sponge cakes, sticks and non-gluten products. If processed into noodles, eggs and mocaf need to be added to improve the composition and texture of the noodles. In addition, it is also necessary to conduct research to determine the expiration date of goroho banana flour and *tanduk* banana flour, so that the storage period of goroho and *tanduk* banana flour as food raw materials is known.

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