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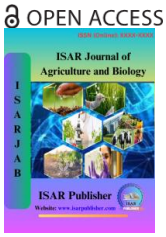

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Nutritional Quality of Tortilla Products with Green Mung Bean Flour Substitution

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Abstract: *Tortillas are generally made from wheat flour containing gluten; if consumed in excessive amounts, it can interfere with digestive health. So, it is necessary to improve the nutrition of tortillas by substituting mung bean flour, which has yet to be widely applied to tortilla products. Mung beans have many nutrients, such as Fiber, vitamin A, folic acid, thiamin, riboflavin, protein, carbohydrates, calcium, and phosphorus. The study aimed to determine a good formulation of the nutritional analysis of tortilla products with mung bean flour substitution. The design used was a completely randomized design (CRD) with four treatments of mung bean flour substitution, namely 0%, 10%, 20%, and 30%. The data obtained were analyzed using SPSS version 23 software through one-way ANOVA and continued with the Duncan Multiple Range Test (DMRT) tests to see differences between treatments. The results showed that adding mung bean flour as a substitute for making tortillas influences the nutritional value of tortilla products. The ratio of wheat flour and mung bean flour (70:30) produced 13.30% carbohydrates. In contrast, the best fiber content is in the treatment of the ratio of wheat flour and mung bean flour (70:30) of 0.11%. The highest protein content is found in the P4 (70% wheat flour and 30% mung bean flour), which is 5.95%, and the water content is found in the control treatment and the ratio of wheat flour and mung bean flour (90:10) of 12.80%. From the study results, recommendations can be given to conduct further research on other nutritional levels of mung bean substitute tortilla products, such as levels of vitamins, minerals, fats, or other micronutrients. In addition, it is necessary to conduct physical tests on tortillas to determine their hardness and elasticity.*

Keywords: *Nutrition, substitutions, green mung bean flour, tortillas.*

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Introduction

Tortillas are traditional food in Meso-America that has become globally popular for chips and wraps [1]. Its use in these countries also varies according to the type of tortilla used. *Corn* tortillas are commonly used for chips or *nachos*, *taco* shells, *enchiladas*, and others. Another type is *flour tortillas*, which are commonly used for *burritos*, *quesadilas*, or kebab skin in Middle Eastern countries [2]. The ingredients of tortillas are wheat flour, water, vegetable oil, salt, and *baking powder*. Quality tortillas have a soft and flexible texture [3].

Because it is made from wheat flour, it will cause dependence on wheat flour, so must carry out imports [4]. In 2020 alone, wheat flour consumption in Indonesia reached 6.66 million tons, equivalent to 500 thousand tons per month. This makes Indonesia one of the largest wheat importers in the world [5]. *Wheat flour* is also high in gluten (a protein), which gives a chewy and elastic sensation, so it is widely used in the *baking* industry [6]. Consuming too much gluten is considered bad for the body because it can interfere with the absorption of nutrients in the small intestine [7]. Individuals who have allergies to gluten, such as people with *autism spectrum disorder* (ASD) and gluten intolerance, should avoid gluten so as not to affect the body adversely [8].

Wheat, as a raw material for wheat flour, is a starch that is not only found in grains but also in legumes such as green beans. Mung beans are legumes and are high in protein, so they are widely used as food ingredients [9]. Besides being rich in protein, mung beans contain other nutrients such as Fiber, vitamin A, folic acid, vitamin B1, vitamin B2, protein, carbohydrates, calcium and

phosphorus [10].

One of the uses of mung beans is that they are made as mung bean flour and processed into various dishes. Mung bean flour is a processed mung bean product that starts from washing, roasting, grinding, and sieving into flour [11]. This flour is widely used in baby food packaging because of its complex nutrients; besides that, it also develops in snacks, cakes, noodles, and so on [12]. In a study, by replacing biscuit products with mung bean flour, pumpkin flour, and margarine, it was found that adding 20% mung bean flour to mung beans produced the best biscuit product of the three comparisons. specifically 30%, 25% and 20% [13]. The optimal formula for mung bean flour tortilla products was obtained using the Design Expert 10.0 program using the D-Optimal Mixture method, namely mung bean flour 40.983%, tapioca flour 21.321%, margarine 5.696%, and tapioca flour 21.321%, margarine 5.696%: 1% salt and 31% water. Therefore, in this study, mung bean flour was replaced with wheat flour-based tortilla flour, using the results of this study as a reference. Therefore, the comparisons made were 0% as control, 10%, 20%, and 30% [14]. As explained above, corn tortillas have fewer nutrients, while corn tortillas are currently widely used for various dishes. This chickpea flour tortilla substitute can provide an alternative to other tortillas that have better sensory and chemical properties and can maximize the use of mung bean powder.

In the research conducted, researchers used four types of tests, including carbohydrate test, protein test, crude fiber test, and water content test. The selection of carbohydrate and protein testing was carried out because the two nutrients are both contained in macronutrients needed by the body. In contrast, crude fiber testing was carried out to determine the amount of Fiber contained in each tortilla because Fiber plays an important role so that the body creates conditions that support the digestive process. The selection of the water content test was carried out to determine the shelf life of the product.

Methods

Materials used: Wheat flour, mung bean flour, salt, *baking powder*, vegetable oil, and water, water, 3% hydrochloric acid, 30% sodium hydroxide, *Luff Schoorl* solution**,** 30% potassium iodide solution, 25% sulfuric acid solution, 25% sodium triosulfate solution, 0.1 N, 1% amylum indicator, distilled water, tissue, distilled water, concentrated sulfuric acid, sodium hydroxide, selenium, cupric sulfate, ethanol, methyl red indicator, sodium sulfate, pp indicator, hydrochloric acid, concentrated nitric acid, sodium tetra borate, selenium catalyst, n-hexane, sodium hydroxide, alcohol, sulfuric acid, and distilled water.

Tools used: Blender (*dry mill)*, pan, spatula, 100 mesh sieve, basin, analytical balance, bowl, spatula, measuring cup, spoon, Teflon, rolling pin, stove, erlenmeyer, upright cooler, volumetric flask, glass funnel, beaker, volumetric pipette, water bath, burette, dropper, clamps and stative, Kjehdahl flask, set of distillation apparatus, beaker glass, test tube, watch glass, vaporizer cup, knife, Petri dish, burning trifle, filter paper, set of sokhlet apparatus, *Fibrebag*, desiccator, set of *fibretherm* apparatus, platinum cup, oven, furnace, porcelain cup, desiccator, tissue and oven.

Preparation of Mung Bean Flour

Green beans without epidermis are washed thoroughly and drained. Then, they are roasted until completely dry. Then, the mung beans are blended until smooth and sieved using a 100-mesh sieve. The result of the sieve is mung bean flour that is ready to be processed [15].

Tortilla flour processing

Ingredients such as wheat flour, mung bean flour, *baking powder*, salt, water, and vegetable oil are weighed first. Mix flour, mung bean flour, salt, and *baking powder* into a bowl, then add oil and water and stir using a spatula until mixed. After mixing, continue to knead the dough by hand until smooth. Divide the dough into 6 pieces, let it rest for 20 minutes. Flatten the dough rounds using a *rolling pin* until slightly thin. Heat the Teflon ins, ert the tortilla sheet, and bake until bubbles appear and are browned on both sides, and the tortilla is ready to use [3]. The formulation of this product can be seen in **Table 1.**

Table 1. Formulation of mung bean flour substitution tortillas

Treatment	Wheat Flour (g)	Mung bean flour (g)	Baking powder (tea spoon)	Salt (tea spoon)	Water (mL)	Vegetable oil (mL)
P1	200	0	0.5	0.5	125	125
P2	180	20	0.5	0.5	125	125
P3	160	40	0.5	0.5	125	125
P4	140	60	0.5	0.5	125	125

Carbohydrate test

The test method used is the Luffschoorl test with the procedure of making Luffschoorl peraction [16]. A total of 143.8 g Na_2CO_3 anhydrate was dissolved in 300 ml of distilled water. While the solution is stirred, add 50 g of citric acid dissolved in 50 ml of distilled water. After that, add 25 g CuSO4.5H2O, dissolved in 100 ml of distilled water. The solution is then poured into a 1-liter flask, and distilled water until it reaches the line mark. The solution was shaken and left overnight. Then, sample testing was carried out by weighing 1 g of snippet and putting it into a 250 ml Erlenmeyer, adding 40 ml of 3% HCl solution, and boiling for 1 hour with upright cooling. After that, it was cooled and neutralized with a 30% NaOH solution. The solution was transferred into a 100 ml volumetric flask and filled with distilled water until it reached the line and filtered.

The filter was pipetted as much as 10 ml, transferred into a 250 ml Erlenmeyer, and added *luffshoorl* solution, some boiling stones, and 15 ml of distilled water. The solution was heated and tried to boil within 3 minutes. It was sprayed for 10 minutes exactly and then immediately cooled with running water. After that, 15 ml of 30% KI solution and 25 ml of 25% H2SO4 solution were added and carefully titrated with 0.1N Na2S2O3 until light yellow. After the color changes, 2 ml of 1% amylum indicator is added and titrated with sodium thiosulfate until a color change occurs. For the blank, the process is the same as the sample, but using 1 g of snippet, the blank uses 10 ml of distilled water. The following is the formula for calculating starch content.

$$(\%)\ Starch = \frac{mg\ Glukosa\ x\ Fp\ x\ 0.95}{Sample\ Weight} \times 100\%$$

Protein Test

The analysis method used kjeldahl test [17]. The protein test process begins with the deconstruction stage, where the blended sample is weighed at as much as 0.5 g and put into a 100 ml Kjedahl flask. Enter 10 ml of concentrated sulfuric acid and add a catalyst (selenium mixture), accelerating the destruction. The flask is then heated from a small fire and then enlarged so that there is an increase in temperature. Destruction can be stopped if a clear greenish solution is obtained. Which is then continued with distillation, the results of the destruction are cooled and then diluted with 100 ml of distilled water. After homogeneous, 10 ml is pipetted and put into the distillation flask, and 10 ml of 30% sodium hydroxide solution is added through the flask wall to form a layer under the acid solution. The flask is then installed and connected to the conductor. The tip of the condenser is immersed in the collection liquid. The vapor from the boiling liquid will flow through the condenser and into a container Erlenmeyer filled with 10 ml of 0.1 N hydrochloric acid solution and dripped with methyl red indicator. The results are checked with litmus paper, and distillation is stopped when the results are no longer alkaline. After the deconstruction is complete, the titration process is carried out using the solution in the Erlenmeyer directly titrated with 0.1 N sodium hydroxide solution. The titration is complete if the solution which was originally pink becomes yellow. This treatment was repeated three times for each sample. In the Kjehdahl calculation method, all nitrogen is considered to come from protein bonds. The average nitrogen content in protein is 16%, so 1 gram of nitrogen comes from 6.25 grams of protein. So, to get the total protein, the total nitrogen result is multiplied by the conversion factor of 6.25 (the universal conversion factor) so that the calculation obtained is (Sediaoetama, 2012):

(%) =% N x conversion factor (6.25)

Crude Fiber Test

Crude fiber test used gravimetri method [18]. The sample was weighed as much as 0.5 grams. 50 ml of 1.25% H2SO4 solution was added and then boiled for 30 minutes using an upright cooler. A total of 50 ml of 3.25% NaOH was added and then boiled for 30 minutes. In the hot state, it is filtered with a Bucher funnel containing Whatman 541 grayless filter paper that has been dried and has a known weight. The precipitate in the filter paper was washed successively with hot 1.25% H2SO4, hot distilled water, and 96% ethanol. Filter paper is lifted and inserted in a weighing box with known weight, then dried at 105 C, cooled, and weighed until the weight remains. The percentage of crude fiber content can be calculated using the following formula:

$$Crude\ Fiber\ conten\ (\%) = \frac{Sample\ weight - Ash\ weight}{Weight\ settles\ on\ the\ filter\ paper} \text{x } 100\%$$

Water Content Analysis

Water content analysis, using the method suggested in other study [19]. The porcelain cup, and the lid that has been washed clean, in an empty state,, put into an oven whose temperature is 100-105ºC for approximately 1 hour. The cup was moved into a desiccator, cooled for 30 minutes, and then weighed. Into the porcelain cup, insert sample as much as 2-3 grams, then weigh. The porcelain cup containing the sample was put into an oven at 100-105ºC for 3 hours. Drying and weighing are done continuously until a constant weight is obtained. After obtaining a constant weight, the sample was moved into a desiccator, cooled for 30 minutes, and then weighed. Calculation of water content using the following formula:

$$\text{water content } (\%) = \frac{(\text{cup and sampel weight}) - (\text{cup} + \text{final sample weight})}{\text{Sampel Weight}} \text{x } 100\%$$

Data Analysis

Data from the analysis of carbohydrate, protein, crude Fiber, and water content obtained were then analyzed using the SPSS Version 23 software application through the ANOVA (Analysis of Variance) test. Then, it was further analyzed using the DMRT (Duncan et al. Test) test using a test level (α) of 5%.

Results and Discussions

This research is about the manufacture of tortilla products substituted with mung bean flour with several concentrations. Tortilla products are one of the flatbread products without using yeast in the manufacturing process. Thisudy use several nutritional parameters in foods such as water, Fiber, carbohydrate, and protein. The data obtained have been analyzed using ANOVA with SPSS Version 23 followed by further tests using the Duncan multiple range test (DMRT), and the data are presented in Table 2 (1) below:

Table 2. Proximate test result (tortillas product)

Parameters	Treatment (Code)			
	P1	P2	P3	P4
Carbohydrtaes (%)	9.18±0.05^{b}	11.72±0.11^{c}	12.36±0.12^{d}	13.30±0.63^{a}
Protein (%)	3.27±0.00^{b}	3.47±0.15^{b}	4.23±0.15^{c}	5.96±0.30^{a}
Crude fiber (%)	0.07±0.01^{b}	0.07±0.01^{b}	0.08±0.01^{b}	0.11±0.03^{a}
Water Content (%)	12.80±0.34^{a}	12.80±0.34^{a}	13.00±1.38^{a}	14.80±3.30^{a}
Different notations in each column indicate differences, while the same notation indicates no difference in each parameter.				

Carbohydrates

The principle of testing carbohydrates with the *Luffschoorl* method is iodometry or titration of free iodine in solution [20]. The *Luffschoorl* method was chosen because it is the best method for measuring carbohydrate content with an error rate of only 10% [21].

From the results of the existing data, the highest average carbohydrate content is in the P4 code treatment. This can be explained because the addition of mung bean flour contributes to the amount of carbohydrates in tortillas. Mung bean flour has a carbohydrate content of 71.5g per 100 grams, while wheat flour, 56.8g per 100 grams [22].

Wheat flour and mung bean flour are both sources of complex carbohydrates the body needs. Mung bean flour has a higher carbohydrate content than regular wheat flour [23]. Adding to tortilla dough made from wheat flour increases the total amount of carbohydrates in tortillas. The addition of mung bean flour also increases Fiber in tortilla products. Although there is an increase in the amount of carbohydrates, adding mung bean flour to tortillas

can improve the overall nutrition of the product. Like research conducted of chocolate products by add as much green bean flour as possible 29.65% can increase carbohydrate levels by 3.46% from chocolate products without mung bean flour [24]. Also, research conducted by Novia (2023), the addition of mung bean flour in manufacturing RUTF (Ready to Use Therapeutic Food) bars produces higher carbohydrates, namely 51.81% [25].

Protein

The principle of protein testing with the Kjehdahl method is to calculate the amount of free nitrogen in food ingredients, which includes the process of deconstruction, distillation, and titration [26]. The Kjdahl method is simple because nitrogen is analyzed in the food and then multiplied by the conversion rate of 6.25 to obtain the protein content of the selected product [27].

In the study, the tortilla baking temperature ranged from 120-150^0 C with 30 seconds on each side. The wheat flour used is a medium-protein type with a protein content of 9.4%- 11%. Based on the test data, code P4 with a 30% mung bean flour substitution has the highest protein content.

Although mung beans are included in legumes that are high in protein content, most of the protein is a type of globulin protein. Globulin proteins are insoluble in water and easily coagulate when exposed to heat [28]. The recommended heating temperature so that globulin proteins are not damaged or denatured is 50-60^0 C [29].

This can explain why the more green bean flour you add, the higher the protein content, because the more protein there is in the tortilla because the more green bean flour you add, the more green bean protein you add, so the protein increases. The addition of green bean flour can increase the protein content in the tortilla. This is also influenced by the presence of amino acids contained in green bean flour. Mung bean flour also contains other nutrients such as fiber, vitamins and minerals that can provide different nutritional benefits to tortillas.

Crude Fiber

The principle of testing crude Fiber with the gravimetric method is that food ingredients are hydrolyzed with strong bases and dilute strong acids, so carbohydrates, fats, and proteins are hydrolyzed and dissolved. These are then filtered and rinsed with hot water that already contains alcohol and acid. After all the processes are carried out, the Fiber is burned and weighed [30].

The fiber content in mung bean flour is 35.1g per 100 grams [31]. Meanwhile, wheat flour only has 0.3g of fiber per 100 grams [32]. This can explain why the more the addition of mung bean flour in the composition of tortilla products, the higher the fiber content it has [33]. Fiber in mung beans is in the form of soluble and insoluble Fiber. Water-soluble Fiber will help in the process of water absorption and digestion. Meanwhile, insoluble Fiber helps encourage the movement of food in digestion. Both of these fibers help in increasing fiber levels in food.

Tortillas made with a mixture of mung bean flour have a higher fiber content than tortillas without adding mung bean flour. Increased crude Fiber can positively affect the body, such as reducing the risk of constipation and providing a longer satiety effect [34]. This is supported by previous research, which states that the more mung bean flour added to making baked brownies, the higher the crude fiber content. This is evidenced by the crude fiber content, which was originally 0.97% to 1.7%, with the addition of mung bean flour by 60% [35]. Also, research conducted by previous research revealed that the highest crude fiber content of 10.03% was in *snack bar* products with the addition of 70 g mung bean flour [36].

Water Content

The principle of testing water content by thermogravimetric method or drying using an oven is that the water contained in the material will evaporate when it is heated to 105^0 C within a certain period of time, and the difference in the weight of the material before and after curing is the water content of the material [37]. The water content in food ingredients can affect the texture and flavor of food products [38].

Based on the table listed, there is no significant difference in the water content results, which is thought to occur because the volume of water in each treatment is the same, the same cooking process is baked, and the same cooking time is 30 seconds per side. Heating, which in this case is the process of product maturation, clearly influences moisture content.

The water that contained in food ingredients can evaporate due to heating. The higher the temperature and the longer the cooking time, the more water evaporates from the material [39]. Since the temperature and cooking time of the tortillas in each treatment were relatively the same, there was no significant difference in the results of the water content test. In addition, the heating process given can affect the gelatinization of starch so that starch swelling occurs as an effect of the water absorption process. Swelling of starch can reach 30% of the flour weight. If the starch swelling has reached the highest point, it will cause the breakdown of starch granules so that the water in the product is evaporated.

The amount of amylose and amylopectin present in the flour used also influences the result of water content. Amylose has the property of easily absorbing and releasing water, while amylopectin has the property of being difficult to absorb water, but water will be retained if it has been absorbed. Wheat flour contains 28% amylose and 72% amylopectin. In mung bean flour, it has an amylose content of 33% and amylopectin of 67% [40]. The higher amylose content can increase the hardness and reduce the flexibility of the product because it is easy to release water [41].

The content of amylose and amylopectin in both types of flour does not have too much difference, so that even though the addition of mung bean flour in tortilla products causes the texture of tortillas to decrease in flexibility due to the increasing amylose content in tortillas, the difference in texture and water content is not too significant between one and the other. The highest average value is in the P4 code treatment with 14.80%, while the lowest is in the P1 code treatment and P2 code with 12.80%. P4 code treatment has a harder texture than other treatments due to its higher amylose content, so the product decreases its flexibility. The best results are in the P1 treatment because, as a *wrap*, the flexible nature of tortillas is needed so that it can coat all the food ingredients inside.

Concluison

The addition of mung bean flour as a substitute for making tortillas influences the nutritional status of the product. The

ratio of wheat flour and mung bean flour (70:30) produced 13.30% carbohydrates. In contrast, the best fiber content is in the treatment of the comparison of wheat flour and mung bean flour (70:30) of 0.11%. The highest protein content is in the control, which is 5.95%, and the water content is in the control treatment and in the ratio of wheat flour and mung beans (90:10) of 12.80%. From the study results, recommendations can be given to conduct further research on other nutritional content in this mung bean substitute tortilla product, such as vitamin, mineral, and fat content. In addition, it is necessary to conduct physical tests on tortillas to determine their *hardness* and elasticity.

Conflict of Interest

All authors have no conflict of interest in this article.

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