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PRODUCT DEVELOPMENT, NUTRITIONAL CONTENT, AND DIETARY FIBER KIDNEY BEANS TEMPEH *(Phaseolus vulgaris L.)* AS FUNCTIONAL FOOD

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Abstract

Introduction: The trend of vegetarian food consumption is currently increasingly in demand by the public for various reasons such as belief, the need for a healthy life, to allergies to certain animal foods. A vegetarian diet has several health benefits such as lowering the risk of cardiovascular disease, obesity, and high blood pressure. This is because the vegan group has a food consumption pattern that does not eat animal meat at all so it tends to be low in fat, low in cholesterol and high in fiber. Processing kidney beans by fermentation into tempeh as one of the foods has several benefits, such as increasing dissolved protein levels and nutritional quality. The aims of this research is to study the process of making kidney beans tempeh *(Phaseolus vulgaris L.)* and analyzing the chemical properties (water content, ash, protein, fat, carbohydrates and dietary fiber) of kidney bean tempeh *(Phaseolus vulgaris L.).*

Method: The study used an experimental design that was carried out for 7 months, namely August 2017 to September 2017 and December 2017 to April 2018.

Results: Kidney beans tempeh *(Phaseolus vulgaris L.)* contains 61.08 (% w/w wb) of moisture and 0.55, 0.69, 12.62, 25.06, and 1.85 (% w/w wb) of ash, fat, protein, carbohydrate, and dietary fiber respectively.

Conclusion: Kidney beans tempeh *(Phaseolus vulgaris L.)* has potential as a functional food and a type of food for a vegetarian diet

Key words : degenerative disease, fermentation, functional food, kidney beans tempeh *(Phaseolus vulgaris L.)*

INTRODUCTION

The trend of vegetarian food consumption is currently increasingly in demand by the public for various reasons such as belief, the need for a healthy life, to allergies to certain animal foods. According to Key et al. (2006), a vegetarian is someone who does not eat meat, poultry, or fish. A vegetarian diet has several health benefits such as lowering the risk of cardiovascular disease, obesity, and high blood pressure. This is because the vegan group has a food consumption pattern that does not consume animal meat at all so that it tends to be low in fat, low in cholesterol and high in fiber (Craig 2009). Some of the foodstuffs commonly consumed by the vegetarian group are vegetables, fruits, nuts, seeds, and grains.

One of the beans that is widely developed in the manufacture of vegetarian patties is kidney beans. Kidney beans are food ingredients that have a hypocholesterolemic effect because they contain dietary fiber and flavonoids, namely proanthocyanidins and isoflavones (Nakamura *et al.* 2010). Processing kidney beans by fermentation into tempeh as one of the raw materials for vegetarian patties has several benefits such as increasing dissolved protein levels and nutritional quality. Dissolved protein shows the level of water-soluble protein so that the protein is easily digested (Purwoko and Handajani 2007). Fermentation produces proteolytic enzymes by molds that break down proteins into amino acids so that the dissolved nitrogen increases and decreases antinutrient compounds and oligosaccharides (Susi 2012).

Therefore, the development of kidney bean tempeh (Phaseolus vulgaris L.) needs to be done as an effort to develop products that are useful in terms of nutritional content, have potential as functional food products and food for vegetarians.

METHOD

Place and Time of Research

The research was conducted for 7 months, namely August 2017 to September 2017 and December 2017 to April 2018. Trial and error of product manufacture was carried out at the Food Experimental Laboratory, Department of Community Nutrition, FEMA IPB. The organoleptic test of the product was carried out at the Organoleptic Laboratory, Department of Community Nutrition, FEMA IPB. Proximate and dietary fiber analyzes were carried out in the Laboratory of Biochemistry and Micronutrient Analysis, Department of Community Nutrition, FEMA IPB. Mineral and amino acid analysis was carried out at the Integrated Chemistry Laboratory, Baranangsiang Campus of IPB.

Materials and Tools

The main ingredient in this study was kidney bean (Phaseolus vulgaris L.) which was obtained from Pasar Anyar, Bogor Regency. Inoculants for kidney bean fermentation were obtained from Tegal Regency, Central Java. In addition, the materials used for chemical analysis include oil paper, concentrated H2SO4, selenium mix, H3BO3 3%, Methyl Red Indicator: Methyl Blue, 30% NaOH, red litmus paper, 0.1 M HCl, cotton, technical hexane, Na2HPO4. 2H2O, NaHPO4.2H2O, 1 N NaOH, tarmamyl enzyme, 1 M HCl, pepsin enzyme, pancreatin enzyme, 95% ethanol, acetone, HNO3, deionized water, distilled water, orthoftaldehyde, brij-30 30% solution 2-mercaptoethanol, aqueous solution standard amino acid 0.5 mol/mL, Na-EDTA, methanol, tetrahydrofuran (ENT), Na-acetate, and high pure aquadest.

The Making of Kidney Beans Tempeh *(Phaseolus vulgaris L.)*

The kidney beans used were kidney beans obtained from Pasar Anyar, Bogor Regency. The basic principles in making tempeh consist of cleaning, washing, boiling, soaking, washing, adding inoculants, packaging, and fermentation. The procedure for making kidney bean tempeh in this study refers to the procedure for making soybean tempeh in Utari's research (2011) with modifications.

Analysis of the Nutritional Content Kidney Beans Tempeh *(Phaseolus vulgaris L.)*

The nutritional content analysis carried out on kidney bean tempeh was in the form of water content analysis using the gravimetric method (AOAC 2005), ash content using the gravimetric method (AOAC 2005), fat content using the Soxhlet method (AOAC 2005), protein content using the micro kjeldahl method (AOAC 2005), and protein content using the micro-kjeldahl method (AOAC 2005). carbohydrate by difference method (AOAC 2005). In addition, another analysis carried out on kidney bean tempeh was the enzymatic method of food fiber analysis (AOAC 2005).

RESULTS

The Making of Kidney Beans Tempeh *(Phaseolus vulgaris L.)*

Kidney beans are food ingredients that have a hypocholesterolemic effect because they contain dietary fiber and flavonoids, namely proanthocyanidins and isoflavones (Nakamura *et al.* 2010). Proanthocyanidins have a function in lowering cholesterol levels by inhibiting lipase activity (Boateng *et al.* 2008). According to Santoso (2011), dietary fiber provides health benefits such as controlling weight or controlling diabetes, preventing gastrointestinal disorders, colon cancer, and reducing blood cholesterol levels and cardiovascular disease.

Tempe is one of the food ingredients from soybeans that have gone through a fermentation process. Processing kidney beans by fermentation into tempeh as one of the raw materials for vegetarian patties has several benefits such as increasing dissolved protein levels and nutritional quality. Dissolved protein shows the level of water-soluble protein so that the protein is easily digested (Purwoko and Handajani 2007).

Fermentation produces proteolytic enzymes by molds that break down proteins into amino acids so that the dissolved nitrogen increases and decreases antinutrient compounds and oligosaccharides (Susi

2012). The procedure for making kidney bean tempeh in this study refers to the procedure for making soybean tempeh in Utari's research (2011) with modifications. The stages of making kidney bean tempeh consist of cleaning, washing, boiling, soaking, washing, adding inoculants (yeast), packaging, and the fermentation process. The stages of the process of making kidney bean tempeh can be briefly seen in Figure 1.

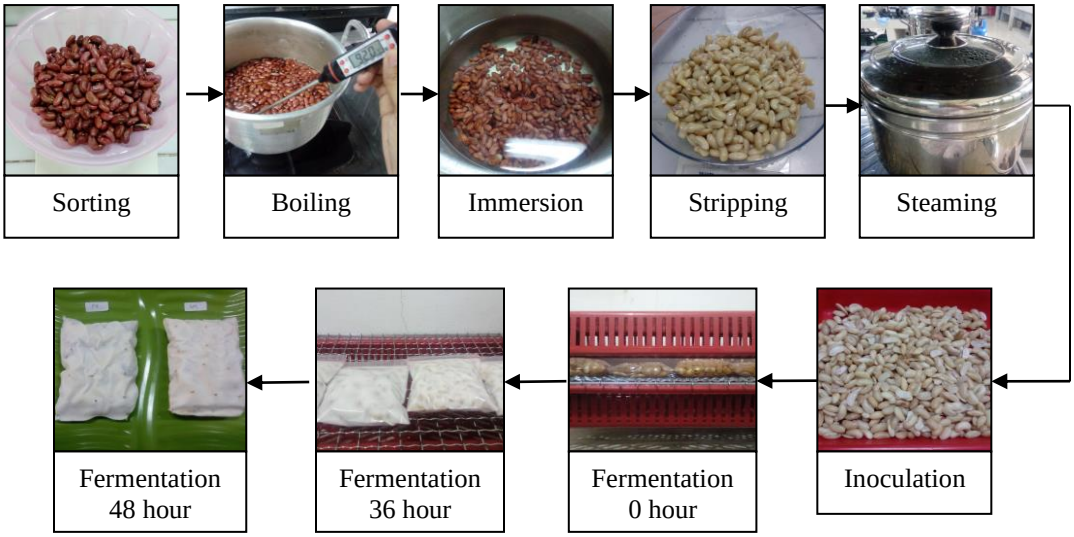

Figure 1. The Making of Kidney Beans Tempeh (Phaseolus vulgaris L.)

Kidney beans tempeh was then analyzed for its nutritional content, including water content, ash, fat, protein, carbohydrates, and dietary fiber. The results of the analysis were then compared with the SNI for soybean tempe as a food ingredient (SNI 01-3144-2009). The following is Table 1 which shows the results of the chemical analysis of kidney bean tempeh per 100 grams.

Table 2 Nutritional content and dietary fiber of kidney bean tempeh

Nutritional content	Kidney beans tempeh	SNI of soybeans tempeh
Moisture(%wb)	61.08±0.11	Maks 65
Ash (%wb)	0.55±0.50	Maks 1.5
Fat (%wb)	0.69±0.01	Min 10
Protein (%wb)	12.62±0.60	Min 16
Carbohydratet (%wb)	25.06±0.54	-
Dietary fiber (%wb)	1.85±0.14	-

DISCUSSION

The making of kidney beans tempeh begins with sorting and washing to obtain good quality kidney beans. The next stage is boiling when the water temperature has reached 90-95°C with a ratio between kidney beans and water of 1:3 for 10 minutes. This boiling is intended so that the kidney beans can absorb as much water as possible so that the texture becomes softer and kills contaminant microorganisms found in kidney beans. Next, kidney beans were soaked in water that had been added with vinegar (2% glacial acetic acid and 98% water) as much as 10% of the total volume of water used during soaking to produce a pH value of 3.94-5.01 for 7 hours. The pH value of the soaking water was in accordance with the required pH value for the growth of tempeh molds, namely 3.5-5.2 (Sapuan & Noer 2001). The addition of vinegar is useful for shortening the immersion time and helping the growth of bacteria for the synthesis of vitamin B2, vitamin B6, vitamin B12, niacin, biotin, folic acid and

pantothenic acid (Herman & Karmini 1999).

After soaking for 7 hours, the kidney bean skin was peeled to facilitate the growth of mycelium during the fermentation process. The kidney beans that have been removed from the skin are then washed thoroughly to remove the mucus on the kidney beans, then steamed for 15 minutes after the steaming water boils at a temperature of 90-95°C so that the texture becomes softer and cleaner. The steamed kidney beans were then air-dried at room temperature for 30 minutes before the fermentation process. The next stage is sowing yeast (inoculants) as much as 0.2% of the weight of kidney beans after steaming. The addition of 0.2% yeast refers to the addition of soy yeast made by soybean tempeh craftsmen in Bogor Regency as much as 1 tablespoon (equivalent to ± 10 grams) for every 5 kg of soybeans after steaming and cooling. So that after being converted it produces a conversion factor of adding yeast of 0.2% by weight of kidney beans after steaming and cooling.

After the addition of yeast, kidney beans are packaged using food-grade polyethylene plastic because it is safe, inert to food, permeable to oxygen so that it can support mold growth (Dirim *et al.* 2004). Packaging using this plastic also aims to monitor the growth of mycelium in kidney beans during the fermentation process. The successful process of making kidney bean tempeh is characterized by a good appearance, a compact texture, and a white mycelium that covers the entire surface of the tempeh. The growth of mold mycelium is influenced by the type of mold used, soluble viability, temperature, and pH (de Reu *et al.* 1993).

This study used 200 grams of kidney beans to produce as much as (339±1.41) grams of kidney bean tempeh. The yield was obtained from the ratio of the weight of kidney bean tempeh produced to the total dry kidney beans before fermentation. The yield of kidney bean tempeh was (169.5±0.71) %. According to Shurtleff & Aoyagi (1979), during the fermentation process, mycelium growth occurs which is indicated by the penetration of the mold mycelium into the bean and covers the beans, causing an increase in final weight.

The moisture content in foodstuffs determines the acceptability, freshness and durability of these foodstuffs (Winarno 2008). The average water content of kidney bean tempeh is 61.08%. According to the Ministry of Health (1992) the water content of whole kidney beans is 12.00%. The water content of kidney beans increased when the fermentation process was carried out. During the fermentation process, the release of water vapor by molds occurs as a result of the decomposition of complex compounds that are blocked by plastic so that the water content of tempeh will increase (Susi 2012). According to BSN (2009), the maximum water content in soybean tempeh is 65%. This shows that the water content of kidney bean temphe is in accordance with the BSN requirements for the water content of soybean tempeh.

The ash content of kidney bean tempeh is 0.55%. When compared with the ash content of soybean tempeh, which is a maximum of 1.50% (BSN 2009), then the ash content of kidney bean tempeh is in accordance with the BSN requirements for the ash content of soybean tempeh. The ash content in food shows its mineral content. The low ash content in kidney bean tempeh indicates low mineral content in kidney bean tempeh.

The fat content of kidney bean tempeh is 0.69%. When compared with the fat content in soybean tempeh, which is at least 10% (BSN 2009), then the fat content in kidney bean tempeh is below the BSN requirements for the fat content of soybean tempeh. Kidney beans have a fat content of 1.5% (Astawan 2009) to 1.7% (Ministry of Health 1992).

Kidney beans have a lower protein content when compared to soybeans, which is 23% (Ministry of Health 1992). Protein content in kidney beans that have been fermented into tempeh has increased to 12.62% (32.35% db). According to Susi (2012), during the fermentation process, molds produce proteolytic enzymes that break down proteins into amino acids so that the dissolved nitrogen increases. When compared with the protein content in soybean tempeh, which is at least 16% (BSN 2009), then the protein content in kidney bean tempeh is below the BSN requirement for soy tempeh protein content.

The carbohydrate content of kidney bean tempeh was calculated using the by difference method. Calculation of carbohydrate content by difference is done by subtracting the number one hundred with

the moisture content, ash content, fat content, and protein content. The carbohydrate content of kidney bean tempeh in this study was 25.06%.

Total dietary fiber (total dietary fiber, TDF) consists of components of soluble dietary fiber (SDF) and insoluble dietary fiber (IDF) (Muchtadi 1989). According to Qi *et al.* (2011), water soluble dietary fiber is fiber that can dissolve in water such as pectin and carrageenan. Meanwhile, water insoluble dietary fiber consists of cellulose, hemicellulose, lignin, and chitosan. The dietary fiber content in kidney bean tempeh is 4.74%.

CONCLUSION

Kidney beans tempeh (Phaseolus vulgaris L.) contains 61.08 (% w/w wb) of moisture and 0.55, 0.69, 12.62, 25.06, and 1.85 (% w/w wb) of ash, fat, protein, carbohydrate, and dietary fiber respectively. Kidney beans tempeh (Phaseolus vulgaris L.) has potential as a functional food and a type of food for a vegetarian diet. Research related to consumer acceptance and product shelf life needs to be done in order to provide a more optimal picture when consumed by the wider community.

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