Vol. 10, No. 2, 2024, pp. 835-842
DOI: https://doi.org/10.29210/020243861

Contents lists available at Journal IICET

JPPI (Jurnal Penelitian Pendidikan Indonesia)
ISSN: 2502-8103 (Print) ISSN: 2477-8524 (Electronic)

Journal homepage: https://jurnal.iicet.org/index.php/jppi

Nutritional components in instant porridge fortified with fermented lebui beans

Wahyu Mushollaeni[*)], Atina Rahmawati
Department of Agroindustrial Technology, Faculty of Agriculture, Universitas Tribhuwana Tunggadewi Malang, Jalan Telaga Warna, Tlogomas, Malang, Jawa Timur, Indonesia

Article Info

Article history:

Received Apr 19th, 2024
Revised May 24th, 2024
Accepted June 28th, 2024

Keywords:

Solid-state fermentation
Functional food
Local black bean
Instant porridge
Bioactive compunds

ABSTRACT

Functional food refers to a food product that includes nutritional elements, supplements, or bioactive compounds designed to enhance health, boost the immune system, and aid in disease prevention. Functional food enriched with bioactive compounds, minerals, vitamins, fatty acids, dietary fiber, or probiotics. One form of functional food is healthy instant porridge. This study explores the nutritional composition of instant porridge fortified with fermented lebui beans. Lebui bean is the local name for black bean originated from West Nusa. The research used quantitative method analysis such us ANOVA with a factorial randomized block design with temperature (50oC and 60oC) and drying time (5, 6, 7, and 8 hours) as factors. The results showed that instant porridge containing fermented lebui bean with the best nutritional quality was obtained by drying at 60oC for 6 hours. The instant porridge had 19.49% protein, 1.58% lipid, 3.16% moisture, 2.44% ash, 3.29% fiber, 70.05% carbohydrate, 27.62 mgGAE/g phenolics, 98.21 mgQE/g flavonoids, and 85.23 ppm anthocyanin. This result provides insights into the potential of lebui beans as a functional food ingredient in the development of nutritious, ready-to-eat products.

Corresponding Author:

Wahyu Mushollaeni,
Universitas Tribhuwana Tunggadewi Malang
Email: wahyu.mushollaeni@gmail.com

Introduction

Instant porridge is a convenient, widely consumed food product, particularly valued for its ease of preparation and suitability for a variety of diets. However, traditional instant porridges often lack significant amounts of essential nutrients, leading to a growing interest in fortification strategies to improve their nutritional profile. One potential ingredient for fortification is *ebui beans, a lesser-known legume that is rich in protein, fiber, and micronutrients. Fermentation of legumes, including lebui beans, has been shown to enhance nutrient bioavailability by breaking down antinutritional factors and increasing the content of beneficial compounds. The fermentation process can also positively influence the sensory characteristics, such as taste and texture, making fortified foods more appealing to consumers. By incorporating fermented lebui beans into instant porridge, this study seeks to address nutrient deficiencies, particularly in populations that rely on quick, ready-to-eat foods, while exploring the potential health benefits offered by the beans' rich nutritional components. Functional food becomes one of the diversification products which may include i.e nutrition, extra supplement, and or bioactive compound.

The last components are specifically was added to enhance the performance organ at once to gain the immunity system in the human body to be healthier (Corbo dkk., 2014; Hasler, 2002; Heasman & Mellentin, 2001). This functional food can be formed by fortified used specific components or ingredients, such as minerals, vitamins, fatty acids, food fiber, bioactive compounds, or probiotics (EUFIC, 2006).

Lebui beans, a lesser-known variety of legumes, are highly nutritious. They are rich in: 1) Protein: Lebui beans provide a good source of plant-based protein, essential for muscle repair, immune function, and overall growth. 2) Dietary Fiber: These beans are high in fiber, which aids in digestion, promotes gut health, and helps in maintaining cholesterol levels. 3) Micronutrients: Lebui beans contain significant amounts of iron, magnesium, zinc, and B vitamins (especially folate), all of which are crucial for energy production, blood health, and overall metabolic functions. 4) Antioxidants: Fermentation of lebui beans increases their antioxidant content, which helps in neutralizing harmful free radicals and reducing inflammation. 5) Lower Antinutrients: Fermentation reduces the levels of antinutritional factors (such as phytic acid and tannins), which can block the absorption of essential minerals, thereby improving nutrient bioavailability.

Various studies have attempted to reveal the physicochemical components, especially the content or composition of bioactive compounds both from plants and animals (Guaadaoui dkk., 2014; Hanganu dkk., 2010). For example, the bioactive components of various Leguminosae or Fabaceae beans, namely the legume group, have been widely explored, whether extracted from the roots, stems, leaves, seeds, or flowers. Bioactive components as reported by (Ahmed dkk., 2019) that the leaves of Bauhinia galpinii contain bioactive components including myricetin and quercetin which function as anti-diarrhea. This data is strengthened by the results of research and statements from (Velusamy dkk., 2016; Widodo dkk., 2019) that the leaves of the Fabaceae species contain bioactive compounds from the kaempferol, ascorbic acid, limonene, daidzein, routine, terpenoids, steroids, as well as flavonoids which can inhibit the work of cancer cells, anti-inflammatory, antihyperglycemic, and prevent various other diseases. Various other Leguminosae or Fabaceae plants also potential to contain nutrients and other bioactive compounds, including the typical local legume plant from West Nusa Tenggara, namely the lebui bean or black bean plant (Cajanus sp.).

Data or specific statistic about the problem such us global malnutrition, micronutrient deficienct and protein deficiency. The first, according to the World Health Organization (WHO), approximately 1.9 billion adults are overweight or obese, while 462 million are underweight, indicating significant global nutritional imbalances. The second about The Global Nutrition Report states that over 2 billion people globally suffer from "hidden hunger" due to micronutrient deficiencies, particularly in developing countries where access to nutrient-dense foods is limited. In many parts of the world, especially sub-Saharan Africa and Southeast Asia, protein-energy malnutrition remains a significant issue, with about 150 million children under the age of 5 being stunted due to insufficient protein intake.

The application of intermediate products from plant extraction containing bioactive compounds into food products is proven to be able to improve the nutritional quality of food, as well as to increase the diversity of functional food products. As stated by EUFIC (2016), functional food is a food product that contains important nutritional compounds such as essential amino acids and unsaturated fatty acids, as well as bioactive compounds which are very important for maintaining a healthy body. (Maphosa & Jideani, 2017) also noted that the Leguminosae plant is rich in natural bioactive compounds which are essential for the development of functional food products. The previous basic research conducted by (Mushollaeni dkk., 2018) and (Mushollaeni dkk., t.t.) show the potential of Lebui bean plant seeds that have been treated using fermentation methods, either immersed or not immersed in the pre-treatment stage can release bioactive compounds from the bound form into a free form which has acted as a medicinal agent from plant seeds. The primary problem addressed by fortifying instant porridge with fermented lebui beans is the nutrient inadequacy commonly found in processed, ready-to-eat foods. Instant porridge is popular due to its convenience, but it often lacks essential macronutrients (like proteins) and micronutrients (such as vitamins and minerals), which are necessary for maintaining health, particularly in vulnerable populations.

The challenge is to improve the nutritional profile of these porridges without compromising taste, texture, or ease of preparation. By incorporating fermented lebui beans into porridge, the aim is to tackle issues of protein deficiency, insufficient dietary fiber, and low intake of essential micronutrients in diets that rely heavily on processed foods. The high content of flavonoids and anthocyanins can be used as the basis for further development of the extraction results in various food preparations. One of the types of food developed in this study is the fortification of the lebui bean powder which has been fermented into instant healthy porridge. This study aims to apply fermented lebui bean powder containing bioactive compounds to an instant slurry and to obtain data on its nutritional components through physicochemical testing.

Raw materials
Instant porridge is made by Lebui bean powder which has been fermented using Rhizopus sp. within 2 days, rice flour, banana flour, soy flour, skim milk, refined sugar, and distilled water. Lebui beans are black beans from the Leguminosae group found in West Nusa Tenggara Indonesia. The chemicals used in the analysis of physicochemical parameters include chemicals for analyzing protein, lipid, and fiber, as well as chemicals for analyzing the rate of flavonoids, phenolics, and anthocyanins.

Instant porridge making process
The initial process is characterized by weighing all raw materials based on the percentage by weight of the product to be produced. The lebui beans used are the lebui beans that have not gone through a soaking or pretreatment process, then sorted and cleaned of various impurities on the surface of the beans. The next step is the Lebui bean fermentation process using Rhizopus sp. for 2 days, followed by the drying process and crushing it into powder form. The lebui bean powder used has a water content of 6.73-6.8% (Mushollaeni & Tantalu, 2020). The composition of raw materials for making instant porridge in percent includes rice flour 30%, banana flour 40%, 5% soy flour, 10% skim milk, 10% refined sugar, and 5% fermented lebui bean powder. All the ingredients are mixed until homogeneous, then followed by the addition of distilled water. The ratio between distilled water and dry matter mixture was 1: 1 (w / w). The stirring process lasts for 10 minutes then is placed and leveled on the tray. Drying was done in a cabinet dryer. The drying time and temperature were adjusted to the treatment and the combination of each treatment. The process of milling into powder is carried out with an automatic grinder specifically used for the shading process, then followed by sieving using a 60 mesh size sieve. The instant slurry powder is stored in a tightly closed glass jar, stored in a dry place, and given silica gel, to wait for the physicochemical analysis stage.

Method

This research used a factorial randomsized block design. The factorial randomized block design (FRBD) is an experimental design method that combines the advantages of both factorial designs and randomized block designs. Blocking helps control for the variability caused by external or nuisance factors (e.g., environmental conditions, time, location), ensuring that the comparisons among treatments are more accurate. This reduces experimental error by accounting for known sources of variability, leading to more precise estimates of treatment effects. By grouping (blocking) similar experimental units and then applying treatments randomly within those blocks, FRBD increases the precision of the experiment. The comparison between treatments becomes more accurate since the variability due to blocking factors is removed from the treatment effect

A factorial randomized block design was used in this study. The first factor is drying temperature (S), which is 50oC and 60oC, while the second factor is drying time (L), namely 5, 6, 7, and 8 hours. Physicochemical characteristics testing was carried out for all instant porridge samples includes the rates of protein, lipid, water, ash, fiber, and carbohydrates using the AOAC method (2000), while the levels of flavonoids, phenolics, and anthocyanins based on the method of the Airlangga University Testing Laboratory (ULP) (2015) were carried out on the best treatment based on data analysis used SPSS software for randomized block design (ANOVA for randomized block design). Testing the best treatment using the (De Garmo dkk., 1984) of physicochemical parameters.

Reading an ANOVA (Analysis of Variance) result involves understanding the components of the ANOVA table and interpreting the key statistical values to determine whether there are significant differences between the groups or treatments being compared. First, understanding the components of an ANNOVA table. Second, interpret ANNOVA result by looking at the P-Value and evaluate the F-value.

Results and Discussions

Protein Content
The results of ANOVA analysis using SPSS for protein data showed a significant difference in mean value based on the interaction between temperature and drying time factors. Table 1 shows that the highest protein content is the treatment using a drying temperature of 60oC with a drying time of 6 hours. On the other hand, the observations showed no significant difference for the treatment with a drying temperature of 60oC and a drying time of 5 hours. In general, protein content in instant porridge has an average high protein content ranging from 17.81-19.49%. The whole instant porridge has a protein content that meets the Indonesian National Standard (SNI) 01-7111.1-2005, which is not less or at least 8%. The protein content in instant porridge ranging from 17.81-19.49%. The high rate of protein content is also influenced by the sufficient drying time and temperature used. The heating process in this research has been through several previous studies and proved not to cause

damage to protein compounds. The protein content of fermented lebui bean powder is 22.39%, which in this case can contribute to the high total protein content of instant porridge, although the contribution of protein from soy flour also affects it. This condition was compared to the control instant slurry which was not added with fermented lebui bean powder which had an average protein content of 14.2%.

Most of instant porridge powder were accepted by sensory evaluation, while different ingredients impacted color, consistency and the viscosity index. Fortification with lebui beans significantly improved the protein content of instant porridge. The porridge fortified with fermented lebui beans had the highest protein content (9.2%), representing a 268% increase compared to the unfortified porridge. Fermentation slightly enhanced the protein availability, making it a more nutritious option for consumers.

Lipid Content

Lipid content with the highest value was in the treatment with the interaction of drying temperature of 50oC with a duration of 8 hours (1.66%), and the lowest average lipid content rate was obtained at the interaction of the drying temperature of 50oC with a duration of 5 hours (1.40%). However, Table 1 shows the results, that the treatment given did not give too much difference to the lipid content. This shows that the use of temperatures of 50oC and 60oC, and drying time of up to 8 hours does not have much effect on reducing the lipid content of instant porridge. Lipids are a diverse group of hydrophobic organic molecules, including fats, oils, and waxes. They are vital for energy storage, cellular structure, and signaling. Lipid content varies widely among food sources. For example, nuts and seeds are rich in lipids, primarily in the form of healthy unsaturated fats. In contrast, fruits and vegetables generally have lower lipid content. Lipid also reflect to the Health Implications: A diet high in healthy lipids (e.g., omega-3 and omega-6 fatty acids) is linked to reduced risks of heart disease and inflammation, whereas trans fats and excessive saturated fats can lead to negative health outcomes.

Ash Content

The ash content of instant porridge is in the range of 0.83-2.73% (d.b.), this value still meets the standard of ash content in food products, which is less than 3.5%. Based on Table 1, it can be seen that the higher the temperature and drying time, the resulting ash content will increase. The ash content of instant porridge in this experiment is in line with the results of research by Pomeranz and Clifto (1981), where the ash content of food products processed with plant seed raw materials ranges from 1.5-3.5%. The ash content would be increased if the temperature and drying time was increased. This is due to the increasing content of organic matter which is not heat resistant which is damaged by temperature and drying time, leaving more ash components in the product. The ash content in the product is also influenced by the ash content contained in the constituent ingredients, including the mineral content contained in the lebui beans that were 129.834 ± 0.81 mg/kg. Foods with higher ash content generally indicate better mineral profiles. For instance, leafy greens and whole grains often have significant ash content due to their mineral density.

Moisture Content

Moisture content is crucial for food preservation, as high moisture levels can lead to microbial growth and spoilage. It also affects the texture, taste, and overall quality of food. Different food types have varying moisture contents; for example, fresh fruits and vegetables can have moisture content above 90%, while dried foods may have moisture levels below 10%. The highest moisture content was obtained at the interaction treatment with a drying temperature of 50oC for 5 hours at 4.14%, while the lowest average moisture content was found in the interaction of drying treatment with a temperature of 50oC for 6 hours at 2.59%. The moisture content of the slurry is low because it is less than 4%. However, the moisture content in the instant porridge is still in line with the SNI 01-7111.1-2005 standards. The moisture content of the instant powder slurry is influenced by the moisture content of the main ingredients used. The powder form tends to have a fairly low moisture content compared to other form products. Research by (Rosniyana dkk., 2016) regarding the characteristics of rice flour that involves various milling methods, suggests that the moisture content of the rice flour is in the range of 6.2-8.8% (w.b.) and the particle size of rice flour produced from this mill will affect for the drying speed.

Carbohydrate Content

High-carbohydrate foods, especially whole grains, fruits, and vegetables, are associated with numerous health benefits, including improved digestive health and reduced risk of chronic diseases. Conversely, excessive intake of refined carbohydrates and sugars can lead to health issues such as obesity and diabetes. Table 1 shows that fiber content in instant porridge is more influenced by the drying temperature and not much affected by the drying time. The higher the drying temperature, the lower the fiber content. The fiber content was in the range of 0.88-3.29% (d.b.). The carbohydrate content of instant porridge is calculated by using the total carbohydrate by difference method, which is the result of reducing 100% of the components of the total ingredients by the percentage of total water, ash, lipid, and protein content. If the percentage of total components of non-carbohydrate ingredients decreases in number, then the percentage of carbohydrates will increase. The calculation results in determining the best treatment obtained that treatment with a drying temperature of 60oC for 6 hours showed the best performance. The most important parameters of physicochemical components of the product, namely the content of protein, lipid, carbohydrates, fiber, water, and ash. In the best treatment, it was continued with chemical analysis to determine the levels of phenolics, flavonoids, and anthocyanins.

Table 1. Nutritional components of instant porridge fortified with fermented lebui bean

Sample	Nutritional Content					
	Protein	Lipid	Moisture	Ash	Carbohydrate	Fiber
Lebui bean (% d.b.)*	18.49	0.97	8.79	3.37	61.96	7.88
Lebui bean powder (% d.b.)*	18.50	0.88	8.18	3.35	69.02	7.93
Fermented lebui bean powder (Rhizopus sp., % d.b.)**	22.39	0.41	6.73	3.18	67.29	8.23
Extract of fermented lebui bean powder (Rhizopus sp) (% w.b., ethanol 70% fraction)**	26.33	13.60	14.24	3.28	26.54	16.03
Instant porridge fortified with fermented lebui bean powder (% d.b.)						
• S1L1	18.815e	1.395a	4.135d	1.025b	72.805d	1.825c
• S1L2	18.415b	1.480b	4.120d	1.485c	72.305c	2.195d
• S1L3	18.660d	1.505b	3.825c	2.165d	72.040b	1.805c
• S1L4	18.495c	1.655d	2.590a	2.210d	73.265e	1.785c
• S2L1	19.445f	1.530bc	3.960cd	0.825a	73.365e	0.875a
• S2L2	19.490f	1.580c	3.160b	2.435e	70.045a	3.290e
• S2L3	18.670d	1.595cd	3.065b	2.510f	72.730d	1.430b
• S2L4	17.810a	1.595cd	3.015b	2.730g	73.390e	1.460b

* Mushollaeni et al. (2018); ** Mushollaeni et al. (2017)
S: drying temperature (1: 50oC; 2: 60oC); L: drying period (1: 5 h; 2: 6 h; 3: 7 h; 4: 8 h)

Phenolics, Flavonoids, and Anthocyanins

The rate of phenolics, flavonoids, and anthocyanins in the instant slurry was lower than a fermented lebui bean powder (Figure 1). However, the content of phenolics, flavonoids, and anthocyanins of instant porridge is still higher than that of several agricultural products of cereals and various types of beans. Research results by (Xu & Chang, 2007) and (Agostini-Costa dkk., 2014), stated that the total phenolic content of Lima beans (Phaseolus lunatus), Adzuki beans (Vigna angularis), Black soybeans, and Gude ranged from 0.11-8.18 mg EAG / g (d.b.).

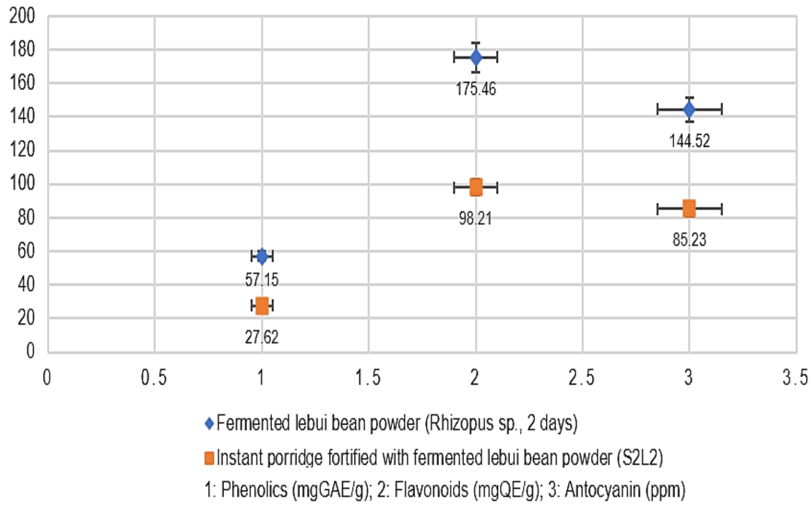

Figure 1. Phenolics, Flavonoid, and Anthocyanin Content of Fermented Lebui Bean Powder and Instant Porridge with Fermented Lebui Bean Powder

Phytochemical and Profilling Screening for Bioactive Compounds

Analysis of the profile of bioactive compounds in fermented lebui bean powder by Rhizopus sp. and in the extract was done. In general, there were more than 35 types of compounds consisting of secondary metabolite components, fatty acid compounds, and fatty acid derivatives. Several types of secondary metabolite components have been identified as bioactive compounds. The identified fatty acid compounds and fatty acid derivatives are short-chain fatty acid (SCFA) and medium-chain fatty acid (SCFA) unsaturated fatty acids (PUFA), as well as other compounds that are part of the fatty acids produced by fermentation and unsaturated fatty acids found in lebui beans (Mushollaeni dkk., 2018). The fatty acid profile in GC-MSD showed that the types of linoleic acid, oleic acid, and palmitic acid predominate in instant porridge. These types of fatty acids are grouped into bioactive lipids or bioactive fatty acids (Abubacker & Devi, 2014; Aluko, 2012).

Table 2. Fatty acids compounds in instant porridge fortified by fermented lebui bean powder*

Parameter	Method + BD	Results		
		RT	**Compounds**	**% Normalization**
GC-MSD Profile	GC-MSD	3,56	Laurat acid	0,09
		6,17	Miristic acid	0,42
		11,47	Palmitic acid	17,60
		16,53	Linoleic acid	45,03
		16,67	Oleic acid	27,42
		16,74	Elaidic acid	2,09
		17,23	Stearic acid	5,76
		21,01	11-eikosanoic acid	0,27
		21,54	Eikosanoic acid	0,50
		25,13	Behenic acid	0,45
		28,28	Lignoseric acid	0,38
		29,74	Pentacosanoic acid	0,21

* the best treatment of instant porridge made with a combination of drying temperature of 60oC and drying time for 6 hours

Understanding the lipid, ash, moisture, and carbohydrate content of food can help guide dietary choices and ensure balanced nutrition. Each of these components plays a critical role in overall health and well-being

Conclusions

Instant porridge containing fermented lebui bean with the best nutritional quality was obtained by drying at 60oC for 6 hours. The instant porridge had 19.49% protein, 1.58% lipid, 3.16% moisture, 2.44% ash, 3.29% fiber, 70.05% carbohydrate, 27.62 mgGAE/g phenolics, 98.21 mgQE/g flavonoids, and 85.23 ppm anthocyanin. There were also more than 35 types of compounds consisting of secondary metabolite components, fatty acid compounds, and fatty acid derivatives identified. The fortified instant porridge, dried at 60°C for 6 hours, exhibits an exceptional nutritional profile that positions it as a high-quality, functional food. With its combination of macronutrients, fiber, antioxidants, and secondary metabolites, it offers numerous health benefits, including improved digestive health, enhanced immune function, reduced risk of chronic diseases, and better energy and protein intake. The fortification with fermented lebui beans significantly boosts its nutritional quality, making it a superior alternative to conventional porridges, especially in areas where nutrient deficiencies are prevalent.

References

Abubacker, M. N., & Devi, P. K. (2014). In vitro antifungal potentials of bioactive compound oleic acid, 3-(octadecyloxy) propyl ester isolated from Lepidagathis cristata Willd.(Acanthaceae) inflorescence. *Asian Pacific journal of tropical medicine*, *7*, S190–S193.

Agostini-Costa, T. da S., Teodoro, A. F. P., Alves, R. de B. das N., Braga, L. R., Ribeiro, I. F., Silva, J. P., Quintana, L. G., & Burle, M. L. (2014). Total phenolics, flavonoids, tannins and antioxidant activity of lima beans conserved in a Brazilian Genebank. *Ciência Rural*, *45*, 335–341.

Ahmed, A. S., Moodley, N., & Eloff, J. N. (2019). Bioactive compounds from the leaf extract of Bauhinia galpinii (Fabaceae) used as antidiarrhoeal therapy in southern Africa. *South African journal of botany*, *126*, 345–353.

Aluko, R. E. (2012). *Functional foods and nutraceuticals*. Springer.

Corbo, M. R., Bevilacqua, A., Petruzzi, L., Casanova, F. P., & Sinigaglia, M. (2014). Functional beverages: the emerging side of functional foods: commercial trends, research, and health implications. *Comprehensive reviews in food science and food safety*, *13*(6), 1192–1206.

De Garmo, E. P., Sullevan, W. E., & Canana, C. R. (1984). engineering Economy 7th. *Edition. New York: Macmilland Publ. Co*.

Guaadaoui, A., Benaicha, S., Elmajdoub, N., Bellaoui, M., & Hamal, A. (2014). What is a bioactive compound? A combined definition for a preliminary consensus. *International Journal of Nutrition and Food Sciences*, *3*(3), 174–179.

Hanganu, D., Vlase, L., & Olah, N. (2010). LC/MS analysis of isoflavones from Fabaceae species extracts. *Farmacia*, *58*(2), 177–183.

Hasler, C. M. (2002). Functional foods: benefits, concerns and challenges—a position paper from the American Council on Science and Health. *The Journal of nutrition*, *132*(12), 3772–3781.

Heasman, M., & Mellentin, J. (2001). *The functional foods revolution: Healthy people, healthy profits?* Earthscan.

Maphosa, Y., & Jideani, V. A. (2017). The role of legumes in human nutrition. *Functional food-improve health through adequate food*, *1*, 13.

Mushollaeni, W., Kumalaningsih, S., & Wignyanto, S. (2018). *Screening of new bioactive in lebui beans (Cajanus sp.) of Lombok.*

Mushollaeni, W., Sanny, R., Nyonya, R. M., & Maf, T. M. (t.t.). *Similarity Effect of immersion-fermentation on decreasing of cyanide acid and physicochemical content of local heveabrasiliensis seeds from borneo Indonesia*.

Mushollaeni, W., & Tantalu, L. (2020). Anthocyanin and nutritional contents of fermented lebui bean (Cajanus sp.) through SSF method and induced by Rhizopus sp. and Saccharomyces sp. *IOP Conference Series: Earth and Environmental Science*, *465*(1), 012037.

Rosniyana, A., Hazila, K. K., & Syed Abdullah, S. N. (2016). *Characteristics of local rice flour (MR 220) produced by wet and dry milling methods.*

Velusamy, B., Kaliyaperumal, S., & Raju, A. (2016). Collection and data-mining of bioactive compounds with cancer treatment properties in the plants of fabaceae family. *International Journal of Pharmaceutical Sciences and Research*, *7*(5), 2065.

Widodo, H., Rohman, A., & Sismindari, S. (2019). Pemanfaatan tumbuhan Famili Fabaceae untuk pengobatan penyakit liver oleh pengobat tradisional berbagai etnis di Indonesia. *Media Penelitian dan Pengembangan Kesehatan*, *29*(1), 65–88.

Xu, B. J., & Chang, S. K. C. (2007). A comparative study on phenolic profiles and antioxidant activities of legumes as affected by extraction solvents. *Journal of food science*, *72*(2), S159–S166.

Adeyeye, S. A. O. (2020). Fermented Plant-Based Foods: Nutritional and Health Benefits. Critical Reviews in Food Science and Nutrition, 60(18), 3042-3053.

Afoakwa, E. O. (2011). Fermentation Processes: Engineering and Microbiological Aspects. CRC Press.

Amarakoon, A. M. T., Gunathilake, D. M. C. C., & Weerakkody, N. S. (2018). Nutritional and Functional Properties of Porridge Mix Incorporated with Plant-based Proteins. Journal of Food Science and Technology, 55(7), 2569-2575.

Arendt, E. K., & Zannini, E. (2013). Cereal Grains for the Food and Beverage Industries. Woodhead Publishing.

Barampama, Z., & Simard, R. E. (1993). Nutrient Composition, Protein Quality, and Antinutritional Factors of Some Varieties of Dry Beans (Phaseolus vulgaris L.). Food Chemistry, 47(2), 99-102.

Chandra-Hioe, M. V., Wong, C. H., & Arcot, J. (2016). The Potential Use of Fermented Legumes to Enhance the Nutritional Profile of Functional Foods. Food Chemistry, 210, 182-189.

Gibson, R. S., Perlas, L., & Hotz, C. (2006). Improving the Bioavailability of Nutrients in Plant Foods at the Household Level. Proceedings of the Nutrition Society, 65(2), 160-168.

Granito, M., & Alvarez, I. (2006). Polyphenols and Antioxidant Capacity of Phaseolus vulgaris Stored Under Extreme Conditions. Plant Foods for Human Nutrition, 61(3), 103-108.

Gunaratna, N. S., De Groote, H., Nestel, P., Pixley, K. V., & McCabe, G. P. (2010). A Meta-analysis of Community-based Studies on Quality Protein Maize. Food Policy, 35(3), 202-210.

Hotz, C., & Gibson, R. S. (2007). Traditional Food-processing and Preparation Practices to Enhance the Bioavailability of Micronutrients in Plant-based Diets. Journal of Nutrition, 137(4), 1097-1100.

Kiers, J. L., Meijer, J. C., Nout, M. J. R., & Rombouts, F. M. (2000). In vitro Digestibility of Processed and Fermented Soya Bean, Cowpea, and Maize. Journal of the Science of Food and Agriculture, 80(9), 1325-1331.

Liu, R. H. (2013). Dietary Bioactive Compounds and Their Health Implications. Journal of Food Science, 78(S1), A18-A25.

Murty, C. M., Pittaway, J. K., & Ball, M. J. (2010). Chickpea Supplementation in an Australian Diet Affects Food Choice, Satiety and Bowels Habits. Appetite, 54(2), 282-288.

Oboh, G., & Rocha, J. B. (2007). Antioxidant in Foods: A New Challenge for Food Processors. Leading Edge Antioxidants Research, 1, 35-64.

Oshodi, A. A. (1993). Proximate Composition, Nutritionally Valuable Minerals and Functional Properties of Adenopus breviflorus Benth Seed Flour and Protein Concentrate. Food Chemistry, 45(2), 79-83.

Prinyawiwatkul, W., Beuchat, L. R., McWatters, K. H., & Phillips, R. D. (1997). Functional Properties of Cowpea (Vigna unguiculata) Flour and Starch as Affected by Soaking, Boiling, and Fermentation. Journal of Food Science, 62(4), 838-843.

Tang, C. H., & Ma, C. Y. (2009). Heat-Induced Modifications in Legume Proteins. Critical Reviews in Food Science and Nutrition, 49(5), 377-398