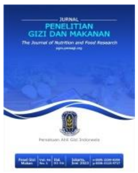

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LEVERAGING LOCAL INGREDIENTS FOR BETTER NUTRITIONAL STATUS: THE ROLE OF SOYBEAN, TEMPEH, AND MORINGA OLEIFERA LEAF

(OPTIMALISASI BAHAN LOKAL UNTUK PENINGKATAN STATUS GIZI: PERAN KEDELAI, TEMPE, DAN DAUN KELOR [*MORINGA OLEIFERA*])

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ABSTRACT

Protein-energy wasting (PEW) is common issue in kidney disease patients, primarily due to inadequate protein and energy intake exacerbated by uremic anorexia. Supplementation of biscuits using local food that contains functional substances have the potential benefit of improving nutrition status in this population. Hence, this experimental study aimed to formulate locally sourced biscuits enriched with high protein, fiber, antioxidants and other nutrients to ameliorate this problem. The study encompassed five key stages: 1) ingredient selection, including soybean (SF) and tempeh flour (TF) as protein, fat, and fiber sources, and Moringa oleifera leaf powder for fiber, vitamins, minerals, and antioxidants; 2) early formulation resulting in three formulation of biscuits namely, SF (45 grams), TF (45 grams), and ST (a combination of 22.5 grams TF and SF), each augmented with 5 grams of Moringa oleifera leaf powder; 3) nutrient analysis on the powder of base ingredients, revealing energy and protein per 100 grams for SF, TF and Moringa oleifera leaf powder were 440 kcal and 34.7 grams, 457 kcal and 39.2 grams, 264 kcal and 23.5 grams, respectively. 4) organoleptic evaluation by trained panelists, leading to the exclusion of SF and TF biscuits due to poor acceptability and unfavorable sensory attributes; and 5) final formulation, where ST biscuits underwent further refinement. In conclusion, ST biscuits show potential as a nutritional intervention for addressing PEW in kidney disease patients, though further research and clinical trials are needed to validate their efficacy and acceptance within this specific patient population.

Keywords: soybean, tempeh, moringa oleifera, kidney disease, nutrition status

ABSTRAK

Protein-energy wasting (PEW) adalah masalah umum pada pasien penyakit ginjal, terutama karena asupan protein dan energi yang tidak memadai yang diperparah oleh anoreksia uremik. Suplementasi biskuit dengan menggunakan bahan pangan lokal yang mengandung zat fungsional berpotensi untuk meningkatkan status gizi pada populasi ini. Penelitian eksperimental ini bertujuan untuk memformulasikan biskuit yang bersumber dari bahan pangan lokal yang diperkaya dengan protein tinggi, serat, antioksidan, dan zat gizi lainnya untuk memperbaiki masalah PEW. Penelitian ini meliputi lima tahap utama: 1) pemilihan bahan, termasuk kedelai (SF) dan tepung tempe (TF) sebagai sumber protein, lemak, dan serat, serta tepung daun kelor (Moringa oleifera) sebagai sumber serat, vitamin, mineral, dan antioksidan; 2) formulasi awal yang menghasilkan tiga formulasi biskuit, yaitu SF (45 gram), TF (45 gram), dan ST (kombinasi dari 22.5 gram TF dan SF), masing-masing ditambah dengan 5 gram serbuk daun kelor; 3) analisis zat gizi pada serbuk bahan dasar, menunjukkan energi dan protein per 100 gram untuk SF, TF, dan serbuk daun kelor berturut-turut sebesar 440 kkal dan 34,7 gram, 457 kkal dan 39,2 gram, 264 kkal dan 23,5 gram. 4) evaluasi organoleptik oleh panelis terlatih, yang mengarah pada tidak diikutsertakannya biskuit SF dan TF karena daya terima yang kurang baik dan atribut sensorik yang kurang baik; dan 5) formulasi akhir, di mana biskuit ST mengalami perbaikan lebih lanjut. Kesimpulannya, biskuit ST menunjukkan potensi sebagai intervensi nutrisi untuk mengatasi PEW pada pasien penyakit ginjal, meskipun penelitian lebih lanjut dan uji klinis diperlukan untuk memvalidasi kemanjuran dan penerimaan mereka dalam populasi pasien tertentu. **[*Penel Gizi Makan* 2024, 47(1):33-42]**

Kata kunci: kedelai, tempe, moringa oleifera, penyakit ginjal, status gizi

INTRODUCTION

Nutrient-rich foods play a crucial role in managing and enhancing nutrition related health outcomes. Among popular food choices, biscuits have emerged as innovative products with the potential to address nutritional deficiencies and prevent diet-related diseases[1]. Biscuits offer an appealing platform for nutrient supplementation, allowing for enhancement of vital components such as protein, dietary fiber, vitamins, and minerals. Their widespread of acceptance, affordability, ready-to-eat, portability, and extended shelf-life make biscuits an ideal candidate for nutritional intervention[2].

Protein-energy wasting (PEW) is highly prevalence, affecting up to 82% in patients with acute kidney injury (AKI), 54% of those with chronic kidney disease (CKD) stages 3-5, and 54% of dialysis patients globally[3]. PEW occurs when the body's protein breakdown exceeds its synthesis, leading to a decline in lean body mass (LBM) and impairing overall bodily functions[4]. In the context of kidney disease, PEW is often a consequence of inadequate protein and energy intake relative to nutritional requirements, primarily attributed to uremic anorexia.

The malnutrition route observed in HD patients encompasses several interconnected factors, including protein catabolism, secondary insulin resistance, inflammation, and elevated levels of blood leptin. Patients with end-stage renal disease (ESRD) who are malnourished and have a low body mass index (BMI) exhibit reduced secretion of leptin by adipocytes. Conversely, improved nutritional condition and higher BMI may lead to an increase in leptin [5]. In severe conditions, it can increase vulnerability to illness, frailty, morbidity, and mortality, particularly among dialysis patients[6]. Dietary supplementation with adequate protein and energy holds promise for mitigating the risk of PEW[7].

According to the guidelines, it is recommended that individuals with ESRD who are having dialysis treatment should increase their dietary protein intake to a range of 1.2 to 1.4 grams per kilogram per day. This greater protein intake is advised in order to prevent the exacerbation of PEW during the dialysis period, as compared to the pre-dialysis phase. The utilization of a plant-based low-protein diet (LPD) in the management of individuals with CKD is believed to have advantageous impacts. This dietary approach aims to prevent glomerular hyperfiltration and reduce the buildup of protein waste products. These effects are thought to be beneficial in enhancing the control of uremic symptoms and metabolic complications, ultimately facilitating the postponement of dialysis initiation[8].

Plant-dominant low protein diets (PLADO), recommended for kidney disease patients, involve a low protein diet (0.6–0.8 g/kg/day) with at least 50% of the protein derived from plant-based sources[9], offering rich fiber content that may foster beneficial alteration in gut microbiota. Such changes can modulate the generation of uremic toxin, slow the progression of CKD, and decrease cardiovascular risk[8]. Indonesia boasts a plethora of locally grown plant-based foods with the potential to enhance and optimize nutrient profile of biscuit formulations.

In this study, we have carefully selected several local ingredients, including soybean flour (SF), tempeh flour (TF), and *Moringa oleifera* leaf powder, all of which hold significant potential as functional food sources. SF and TF serve as sources of protein and fats. Soy, as well as soy-based products are renowned for their protein content, isoflavones, phospholipids and polyunsaturated fatty acids (PUFA), and fibers. Soybeans contain an average amount of protein content of 36%–40% by weight and offer protein quality similar to that animal sources like casein and eggs. Additionally, soy products have a notable fat content (18–24 wt.%) with a composition comprising saturated (SFA), monounsaturated (MUFA), and PUFA, making them a valuable dietary choices [10]. Research has indicated that soy protein, enriched with isoflavones, can significantly reduce serum creatinine, serum phosphorus, C-reactive protein (CRP) and proteinuria in pre-dialysis patients, while maintaining nutritional status in dialysis patients [11].

Tempeh, a traditional Indonesian food made by fermenting local soybeans with the *Rhizopus sp*. fungus, offer higher nutrient content compared to vegetable protein sources. It is particularly rich in isoflavones, arginine, branched-chain amino acids, linoleic acid, and linolenic acid. Notably, tempeh boasts an impressive digestibility value of tempeh is 83% outperforming soybean at 75% [12]. Previous studies have examined the use of tempeh and tempeh flour in CKD patients undergoing hemodialysis. For instance, nuggets made by mixing eel flour and tempeh flour in a 1:1 ratio have been found to have a low glycemic index, making them suitable for diabetic hemodialysis patients[13]. Another study formulated a local food-based product for hemodialysis patients using a mixture of snail, tempeh made from Indonesian local soybean, and moringa leaves[14,15]. Nevertheless, these nutritional support products were found to have suboptimal organoleptic qualities, highlighting the necessity for a new local food formulation that is expected to be better accepted by hemodialysis patients.

Micronutrients, including vitamins and minerals are equally crucial. *Moringa oleifera*, often referred to as a “miracle tree”, is a nutrient powerhouse suitable for food supplementation. *Moringa oleifera* leaves are teeming with macro and micronutrients. Meta-analysis reveals that *Moringa oleifera* dried leaves (MDL) contain approximately 24 g of proteins, 36 g of carbohydrates, 6 g of fat, 20.6 to 28.6 g of fiber, 32.5 mg of iron per 100 g. Incorporating MDL into biscuits results in increased nutrient composition including protein, fiber, beta-carotene, and essential minerals (Fe, Ca, Mg, P, and K)[16]. *Moringa oleifera* exhibits potential in alleviating pathological factors associated with kidney diseases, such as inflammation and oxidative stress[17].

Thus, this study endeavors to formulate local food-based biscuits enriched with high protein, fiber, antioxidants, and essential nutrients through the process of formulation, organoleptic testing and nutritional analysis.

METHODS

This research used a pure-experimental study design and conducted on August 2023 in Laboratory of the Department of Nutrition and Health, Faculty of Medicine, Public Health and Nursing in collaboration with CV (*Commanditaire Vennootschap*) Chem-mix Pratama. The study was conducted in accordance with the Declaration of Helsinki. The ethical approval was granted by the Institutional Review Board (or Ethics Committee) of the Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, with the protocol code KE/FK/1514/EC/2023. We meticulously selected a range of locally available ingredients including SF and TF as sources of protein, fat, and fiber, and *Moringa oleifera* leaf powder as a rich source of fiber, vitamins, minerals, and antioxidants. The ingredients were obtained from several places, SF and *Moringa oleifera* leaf powder from the local certified distributor in Yogyakarta, and TF was sourced from the certified distributor AT-Tempe Yogyakarta.

Subsequently, we developed three distinct biscuit formulations: SF (comprising 45 grams of soybean flour), TF (comprising 45 grams of tempeh flour), and ST (comprising 22.5 grams each of SF and TF). Each formula was augmented with 5 grams of *Moringa oleifera leaf* powder and various additional ingredients including butter, soybean oil, fine granulated sugar, palm sugar, cornstarch, and full cream milk into the product to enhance nutrient content and optimizing organoleptic attributes. This component mixture is based on BSN (Organization and Governance of the National Standardization Agency of Indonesia) Indonesia number 2973 of 2022 requirements for biscuit products. The formula was mixed using a mixing machine. The biscuit dough was weighed and shaped using stainless steel biscuit round cutter with a 3 cm diameter. The biscuits were baked in an electric oven (Oxone OX 858BR) at 150°C for a duration of 30 minutes.

To ascertain nutrient content, powder ingredients underwent comprehensive analysis. Protein levels were determined using Kjeldahl method[18], while fat content was determine using Soxhlet method[19]. Water content, ash content and fiber content were quantified using gravimetric method[20] and carbohydrates content was calculated by difference. The antioxidant activity of the samples was evaluated through the radical scavenging activity assay[21]. The total flavonoid content was measured using the aluminum chloride colorimetric method. The phosphorus content in the samples was determined using the vanadate-molybdate spectrophotometric method.

For the organoleptic evaluation, a panel of five assessors, consisting of six trained individuals, meticulously assessed various aspects including color, odor, flavor, texture, aftertaste, and overall acceptability, for each formula. A standardized protocol was followed: each biscuit (5 grams) was individually sealed in a plastic bag and was placed in the room with a bottle of mineral water, a pen, and assessment paper. The panelists entered the room without personal belongings. After they finished evaluation of one formula, they performed mouthwash to neutralize the aftertaste prior to appraising the next formula. The panelists were instructed to rate each attribute on a 6-point Likert scale, ranging from 1 (dislike very much) to 6 (like very much). Additionally, they were encouraged to provide recommendations and comments on the suitability of each ingredient's composition for the development of local food-based biscuits. Statistical analysis was not conducted in this study.

RESULTS

The formula for these biscuits was determined in 5 steps. During the first phase, we concentrated on choosing possible local food sources, giving particular attention to plant-based choices, which are thought to be highly advantageous for those with chronic kidney disease. Soy beans, tempeh, and moringa leaves were the ingredients that were chosen (Figure 1). The second step involved assembling the materials and creating the first version of the biscuits. The process of creating biscuits involved calculating each ingredient using an analysis of the nutrient content. The original formulation called for the following ingredients: wheat flour SF or TF, or ST (a blend of tempeh flour and soy flour) and moringa flour. In the third step, the first batch of biscuits manufactured using the three local food flours were analyzed for nutrients. The nutrient analysis of the three basic ingredients was conducted in flour form and is illustrated in Table 1. Results highlighted that energy and protein per 100 grams ingredient respectively were 440.2 kcal and 34.7 grams for SF, 456.7 kcal and 39.2 grams for TF, 263.6 kcal and 23.5 grams for Moringa oleifera leaf powder. The organoleptic test of the three different biscuit formulas (Table 2), carried out by skilled panelists, is the fourth step. Next, using the Indonesian Food Composition Table (TKPI) as a rough guide, determine the biscuit formulation's nutrient content for each 100 grams in the final or fifth stage. Table 3 displays the nutrient analysis results per 100 grams for three biscuit formulations: SF (consisting of 45 grams of soybean flour), TF (consisting of 45 grams of tempeh flour), and ST (consisting of 22.5 grams each of SF and TF), as derived from the formulation results. Table 4 shows the organoleptic results from SF, TF and ST biscuits.

Figure 1
Soybean Flour (SF), Tempeh Flour (TF), Moringa oleifera leaf powder

Table 1
Nutrient Content Analysis Results

Nutrient Value per 100 grams	Ingredients		
	Soybean flour (SF)	Tempeh flour (TF)	Moringa oleifera leaf powder
Energy (kcal)	440.2	456.7	263.6
Protein (gram)	34.7	39.2	23.5
Fat (gram)	19.7	18.9	7.8
Carbohydrates (gram)	4.0	1.2	24.3
Fiber (gram)	33.0	35.3	28.0
Potassium (mg)	870.2	627.5	544.8
Phosphor (mg)	723.2	481.6	386.1
Flavonoid (%)	0.02	0.04	1.73
Antioxidant (%)	71.1	46.6	86.0

Table 2
Biscuit Formulation

Ingredients (grams)	F0	F1 (SF)	F2 (TF)	F3 (ST)
Low Protein Flour	50	0	0	0
Soy Flour	0	45	0	22.5
Tempeh Flour	0	0	45	22.5
Moringa Leaf Flour	0	5	5	5
Cornstarch	10	10	10	10
Powdered Sugar	10	10	10	10
Palm Sugar	10	10	10	10
Soybean Oil	10	10	10	10
Butter	20	20	20	20
Total	125	125	125	125

Notes:
F0: Basic formula with low protein flour. F1: Formula with soy flour.
F2: Formula with tempeh flour. F3: Combination of soy flour and tempeh flour.

Table 3
Estimated Nutrition Value per 100 grams of Biscuits Using Indonesian Food Composition Table (TKPI)

Estimated Nutrition Value per 100 grams	Formulation		
	SF	TF	ST
Energy (kcal)	578.8	585.0	581.9
Protein (g)	14.1	15.8	15.0
Fiber (g)	14.1	15.0	14.6
Calcium (mg)	10.8	10.8	10.8
Phosphor (mg)	295.5	204.8	250.1
Fe (mg)	0.6	0.6	0.6
Natrium (mg)	3.5	3.5	3.5
Potassium (mg)	399.9	308.8	354.4

Notes: SF: Soybean flour TF: Tempeh flour ST: Soybean Tempeh flour

Table 4
Organoleptic Test Results for Biscuits

Attribute	Formulation		
	SF	TF	ST
Color	4	3.6	4.4
Taste	3.8	3.2	4.2
Aroma	4	3.8	4.2
Texture	3.8	4.2	4
Aftertaste	4.2	3	4.2
Overall	3.8	3.2	4

Notes: SF: Soybean flour TF: Tempeh flour ST: Soybean Tempeh flour

In the initial trial phase of biscuit formulation, an organoleptic test was conducted with 5 trained panelists to evaluate the color, taste, aroma, texture, aftertaste, and overall quality of the biscuits. Each biscuit formula was presented in 5-gram portions. The organoleptic testing utilized a hedonic test with a Likert scale, where 1 = very strongly dislike, 2 = strongly dislike, 3 = dislike, 4 = like, 5 = strongly like, and 6 = very strongly like. Based on the organoleptic test results, the SF biscuits received an average score of 3, indicating dislike. Meanwhile, the TF and ST biscuits received an average score of 4, indicating like. For the indicators of color, taste, aroma, and aftertaste, the TF biscuits received the lowest scores compared to SF and ST.

DISCUSSIONS

Choosing local plant-based food sources is beneficial because they offer a complete range of essential nutrients, including energy, protein, fats, carbohydrates, dietary fiber, vitamins, minerals, and antioxidants. Plant-based proteins are particularly advantageous because they can reduce the strain on the kidneys, decrease inflammation, lower urea production, and help maintain healthy acid levels in the body. Additionally, consuming more dietary fiber from plant-based foods can help lower phosphorus absorption and improve digestive health, which is important for managing high phosphorus levels [9].

Plant-based diets are being more advised for people with chronic kidney disease. This is due to the fact that eating more vegetables can lower glomerular hyperfiltration, as well as inflammation, urea generation, and acidosis control. Diets high in fiber can improve intestinal peristalsis and decrease phosphorus absorption, which will help regulate hyperkalemia[9]. Soybean (*Glycine max*) is one food product with a high-quality vegetable protein content. Consuming soy protein has been shown in several studies to enhance lipid profiles and kidney function, including lowering serum creatinine, phosphorus, and urine albumin excretion in individuals with chronic renal failure and animal models[22]. The substitution of soy plant protein for animal protein results in a reduction in glomerular hypertension and hyperfiltration, two markers of the progression of chronic renal failure disease[23].

Moreover, the seeds of Moringa (Moringa oleifera) contain fat, particularly oleic acid, saturated palmitic acid, and stereat acid. Iron, calcium, sodium, and potassium concentrations are high in the seeds and pods. Anemia has long been treated using moringa extract. Numerous research have shown that the anti-inflammatory properties of moringa stem from its high content of bioactive substances, including vitamins, carotenoids, polyphenols, phenolic acids, flavonoids, alkaloids, glucosinolates, isothiocyanates, tannins, and saponins[14,24].

Soybean flour is derived from whole soybeans, boasts a cost-effective production process, involving steps like soaking, peeling, drying, grinding, and sifting. This flour is an invaluable addition to food products due to its dual potential for elevating both the quantity and quality of protein. Furthermore, these beans serve as a rich source of bioactive compounds like isoflavones such as genistein and daidzein; alpha-linolenic acid; and phytic acid. Additionally, soybeans contain essential minerals like calcium and phosphorus, as well as vitamins A, B, and C[25]. Soybean flour has characteristics nutty and slightly bitter taste of soy is often attributed to the inherent compounds found in soybeans. The beany flavor of soy is represented by over 20 volatile compounds, mainly including ketones, furan, aldehydes, alcohols, etc., which can trigger a sensory response to undesirable taste. To address this, proper cooking processes can be employed, or soybean flour can be incorporated into recipes with strong flavors to help mask the unwanted taste[26].

Tempeh, an integral part of traditional Indonesian cuisine, is created through the fermentation process of soybeans using the Rhizopus species. Its surging popularity, both within Asia and on the global culinary stage, can be attributed to its health benefits, nutritional richness, ease of preparation, and cost-effectiveness. The fungal fermentation of soybeans enhances the nutritional profile and functional attributes of the base material, leading to amplifying its antioxidant potential and improved digestibility of tempeh[27]. For vegans and vegetarians, tempeh emerges as a dietary treasure trove, primarily owning to its substantial protein content. With its abundant dietary fiber and minimal saturated fat content, it provides a healthful option. Additionally, tempeh is replete with protein and all necessary amino acids[28]. Adding tempeh flour can increase bitterness, potentially arising from the breakdown of proteins during soybean fermentation. Furthermore, the process of lipolysis during fermentation also contributes to enhancing the level of bitterness.

Moringa oleifera is currently garnering significant global interest due to its nutritional and medicinal significance. Moringa leaves possess a notable abundance of protein, vitamins, minerals, tocopherols, ß-carotene, and essential amino acids containing sulfur, which are infrequently encountered in everyday diets. Numerous research works have highlighted the prospective utilization of various components of Moringa for creating functional foods like rigid dough from yam flour, as well as for producing items like bread, cake, and biscuits[29]. *Moringa Oleifera* leaf powder in bakery products is currently receiving attention, focusing on the beneficial bioactive components of moringa for health. The dried or powdered form of moringa leaves is effectively to create delicious food. The inclusion of moringa powder in biscuit formulations can boost their protein content[30]. However, it's important to note that as the amount of moringa powder added to biscuits increases, the taste of the biscuits may become increasingly bitter[31].

The addition of food additives is necessary to enhance flavor and mask undesirable tastes from the three main ingredients. The incorporation of sugar in biscuits acts as a sweetening agent that influences the development of a favorable taste, color, aroma, and texture. Sugar also plays a role in flavor and color development during the baking process through caramelization and the Maillard reaction. Sugar is also responsible for the hard and crisp texture of biscuits[32]. Palm sugar has a hypoglycemic effect on fasting blood glucose levels and may slow down the rate of glucose absorption due to its lower glycemic index compared to granulated sugar, which is 35[33]. The use of full cream milk can also enhance the biscuit's flavor and reduce the bitterness of moringa powder.

Incorporating soybean oil in biscuit production can impact the resulting texture. Soybean oil has the ability to retain more water, which can soften the texture. As a result, after the baking process, the texture is not too hard and easily dissolves in the mouth. Soybeans have 20-22% high-quality oil. The oil of soybean contains 85% unsaturated fatty acids, including 61% polyunsaturated fatty acids and 24% monounsaturated fatty acids[34]. The addition of butter in biscuits is beneficial to facilitate the shaping of the dough, create a soft texture, and enhance the product's flavor[35]. The use of cornstarch can also contribute to a crispy texture in the biscuits. Baking the biscuits is done in an oven at a temperature of 150°C for 25-30 minutes. The selection of temperature and time is based on experiments conducted; if the baking time is too short, the resulting texture will be less crispy, while a longer baking time may lead to a bitter taste in the biscuits.

In the evaluation of organoleptic attributes, SF biscuits garnered an impressive average overall score of 4, denoting a highly favorable response. In contrast, TF biscuits elicited a less enthusiastic average overall score of 3, indicating a degree of dislike among assessors. Meanwhile, ST biscuits mirrored the positive sentiment with an overall score of 4, signifying a general liking among testers. Delving into the nuances, TF biscuits received lower ratings compared to both SF and ST biscuits across various dimensions, including color, taste, aroma, and aftertaste. Specifically, TF biscuits exhibited a darker color in contrast to the brighter hues of SF biscuits and ST biscuits. Regarding texture, both TF and ST biscuits boasted a satisfying crunchiness, distinguishing them from the textural profile of SF biscuits. Notably, TF biscuits carried a discernible bitterness in flavor and aftertaste, which may be attributed to the soybean fermentation process. The organoleptic results obtained in this investigation are consistent with the findings of Lestiarini & Rindiani's research (2023). The panelists enjoyed the slightly brown hue, mild aroma, sweet taste, and crunchy texture of these crispy cookies made with soy flour and moringa flour. Based on the efficacy index test, the cookie formulation with a soy flour:moringa flour ratio of 7:3 is the one that panelists preferred the most[36].

During the formulation phase, the characteristic nutty and slightly bitter taste of soy is often attributed to the inherent compounds found in soybeans. This could potentially limit consumption among a broader audience. The beany flavor of soy is represented by over 20 volatile compounds, mainly including ketones, furan, aldehydes, alcohols, etc., which can trigger a sensory response to undesirable taste. To address this, proper cooking processes can be employed, or soybean flour can be incorporated into recipes with strong flavors to help mask the unwanted taste[37]. Additionally, the use of soybean flour makes the biscuit dough difficult to shape and mold, resulting in a less desirable texture in the biscuits.

In terms of color, taste, aroma, and aftertaste, tempeh flour received the lowest scores compared to the use of soybean flour and the combination of soybean flour and tempeh flour. Adding tempeh flour can increase bitterness, potentially arising from the breakdown of proteins during soybean fermentation, resulting in the creation of diverse peptides. Furthermore, the process of lipolysis during fermentation also contributes to enhancing the level of bitterness[38]. Unlike soybean flour, the addition of tempeh flour in the biscuit-making process makes the dough easier to shape and mold, resulting in a good texture.

In terms of color, taste, aroma, texture, and aftertaste, the combination of soybean flour and tempeh flour received higher scores compared to soybean flour alone. The combination of all three ingredients (moringa flour, soybean flour, and tempeh flour) can compensate for the shortcomings of each individual ingredient. Additionally, with proper quantities, appropriate processing, and the use of other additives, it's possible to create biscuit products that are organoleptically acceptable and have improved nutritional value.

During the experimental phase, the amounts of soy flour and tempeh flour were varied, while the amount of moringa powder remained constant. After several formulations and organoleptic tests, it was agreed to use moringa leaf flour and a combination of soy flour and tempeh flour. The combination of these three flours could provide better color, taste, aroma, texture, and aftertaste for the biscuits. In addition to these main ingredients, other components were added to enhance the biscuit's flavor, including fine sugar, palm sugar, soybean oil, butter, cornstarch, and full cream milk.

This study is subject to limitations as it does not incorporate an analysis of nutrients while taking into account various biscuit processing parameters. The comprehensive analysis of nutrients in biscuits has not yet been conducted. The subsequent research proposal entails the implementation of clinical trials involving patients diagnosed with chronic kidney disease (CKD) in order to assess the effects on both nutritional and inflammatory statuses.

In summary, the combination of soybean flour, tempeh flour and *moringa* flour exhibits significant potential for formulation into a biscuit, offering a promising avenue to enhance the nutritional status of individuals grappling with malnutrition due to kidney disease, with the caveat that soy allergies are not a concern. While this combination holds promise, further development and refinement are necessary, particularly in the areas of texture and flavor, to ensure a superior product that meets both nutritional and sensory expectations.

AUTHOR DISCLOSURE STATEMENT

The author(s) declare(s) no conflict of interest.

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