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Short Communication
Nutritional Content of Food Containing Various Mixtures of Eel (*Monopterus albus*) Flour and Tempeh Flour as Supporting Nutrients for Hemodialysis Patients

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Abstract

Background and Objective: Hemodialysis patients are at risk of malnutrition and thus require nutritional support from protein sources that can include eel (*Monopterus albus*) and tempeh. The purpose of this study was to determine the effect of various mixtures of eel flour and tempeh flour on the nutritional content of food and the proportion of animal and plant sources of protein for the nutritional support of hemodialysis patients. **Materials and Methods:** This was a pre-experimental study with two intervention groups and one control group. The study used nuggets made with various mixtures of eel flour and tempeh flour. The dependent variable was nutrient content, while the independent variable was the proportion of animal and vegetable protein sources. Data were analyzed with one-way ANOVA. **Results:** The results of the effect of the proportion of animal and vegetable protein sources on the nutritional content of food were as follows: p = 0.001 for energy, p = 0.000 for protein, p = 0.010 for fat, p = 0.010 for carbohydrates, p = 0,000 for iron, p = 0,000 for calcium, p = 0.565 for sodium, p = 0.441 for potassium and p = 0,000 for phosphorus. Nugget C with a 1:1 proportion of eel flour to tempeh flour had the highest contents of energy, protein, carbohydrates and calcium and the lowest contents of sodium, potassium and phosphorus compared to the contents of the other two nugget variations. **Conclusion:** The proportion of animal and vegetable protein sources influences energy, protein, fat, carbohydrate, iron, calcium and phosphorus contents. Nugget C with the 1:1 proportion of eel flour to tempeh flour had the most suitable nutrient content to meet the dietary requirements of hemodialysis patients.

Key words: Eel (*Monopterus albus*), flour, hemodialysis, nutritional content, nutritional support, outpatient, tempeh

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Malnutrition, which is a powerful predictor of morbidity and mortality, is common in patients undergoing hemodialysis[1]. Protein energy wasting (PEW) or malnutrition occurs in approximately 20-50% of chronic hemodialysis patients[2]. According to the International Society of Renal Nutrition and Metabolism (ISRNM), PEW is characterized by the presence of low levels of serum proteins, reduced body or fat mass, weight loss along with reduced dietary protein and energy intake, reduced muscle mass and muscle wasting[3]. Therefore, for a better overall outcome, adequate nutrition is very important for such patients[1].

Hemodialysis patients need nutritional support that can be supplied by high-protein food ingredients. One of the processed food products that can be accepted by the community is a nugget. Nuggets can be stored for a long time as a frozen food. The nuggets made in this study contained modified eel and tempeh ingredients, which are local foods in Indonesia.

Eel (*Monopterus albus*) is a source of high biological value animal protein; 100 g of eel contains 70 kcal energy, 14.60 g protein, 0.8 g fat, 1.0 g carbohydrate, 49 mg calcium, 155 mg phosphorus, 1.5 mg iron, 55 mg sodium and 169 mg potassium[4]. When compared to other food sources high in albumin such as cork fish, eel is more affordable. Eel is also easily found in rice fields in Indonesia.

Tempeh is a fermented soybean product; 100 g of tempeh contains 201 kcal energy, 20.8 g protein, 8.8 g fat, 13.5 g carbohydrate, 1.4 g fiber, 155 mg calcium, 326 mg phosphorus, 4.0 mg iron, 9 mg sodium and 234 mg potassium[4]. The price of tempeh is also low, so the public can easily afford it.

Eel and tempeh meet the dietary requirements of hemodialysis patients because they contain high levels of protein and calcium and low levels of phosphorus. The phosphorus-protein ratio is still below 16[5]. Both of these materials were pressed first so that a similar texture was obtained for the manufacturing of processed food products. To obtain foods that have the right nutritional content for hemodialysis patients, the proportion of these two ingredients needs to be determined as well. The content of the following nutrients were studied in the food products: energy, protein, fat, carbohydrate, iron, calcium, sodium, potassium and phosphorus. This study aimed to determine the optimal proportion of animal and vegetable protein sources to improve the nutritional content of food for nutritional support for hemodialysis patients.

MATERIALS AND METHODS

This study followed a pre-experimental design and included two groups with one group control group. The experiment of this study was to vary the proportion of eel flour and tempeh flour in nuggets for nutritional support for hemodialysis patients. The study was conducted from March-October 2018.

The research object was a nugget made with several different variations in the proportion of eel flour to tempeh flour. Eel and tempeh foodstuffs were treated prior to being processed into nugget food products. Sieving was performed to facilitate mixing the appropriate proportions due to the similar texture of the flours.

To make the eel flour, the first step was to select the ingredients, namely, fresh eels of medium size (±1-1.5 cm in diameter and ±30 cm in length). The selection procedure was aimed at obtaining a homogeneous sample of eel, including a homogenous nutrient content. A live eel weighs 2 kg; the contents of the stomach were cleaned and the eel was cut into three parts. The weight of the material after cleaning was 1.7 kg. After washing, the eel was steamed for ±15 min. The weight of the eel after being steamed was 1.72 kg.

The next step was to separate the eel meat and bones, which resulted in 1.34 kg of eel meat, while the eel bones (including the head) weighed as much as 0.34 kg. The separated meat and bones of the eels were taken to the Agricultural Technology Laboratory of Universitas Gadjah Mada to be analyzed.

The eel meat and bones were dried using a drying cabinet with a temperature of ±50°C for 24 h and the compounds were then mixed. After sieving, the weight of the eel meat flour was 300 g, while the eel bone flour weighed 150 g.

To manufacture the tempeh flour, fresh large plastic-wrapped tempeh was used (weight ±550 g per pack). The researcher used four packages of tempeh (weight ±2.2 kg) and the tempeh was cut into small pieces measuring 2×2×2 cm. The tempeh that was sliced into pieces was taken to the Agricultural Technology Laboratory of Universitas Gadjah Mada to be analyzed. Fresh tempeh was dried using a drying cabinet with a temperature of ±50°C for 24 h and the tempeh was then mixed. The weight of the tempeh flour produced from 2.2 kg of fresh tempeh was 695 g.

This study used three variations in the proportion of eel flour to tempeh flour to manufacture food nuggets for nutritional support for hemodialysis patients. The various mixtures of eel flour and tempeh flour are shown in Table 1.

After obtaining the material to make nuggets with a mixture of eel flour and tempeh flour, the next process was to

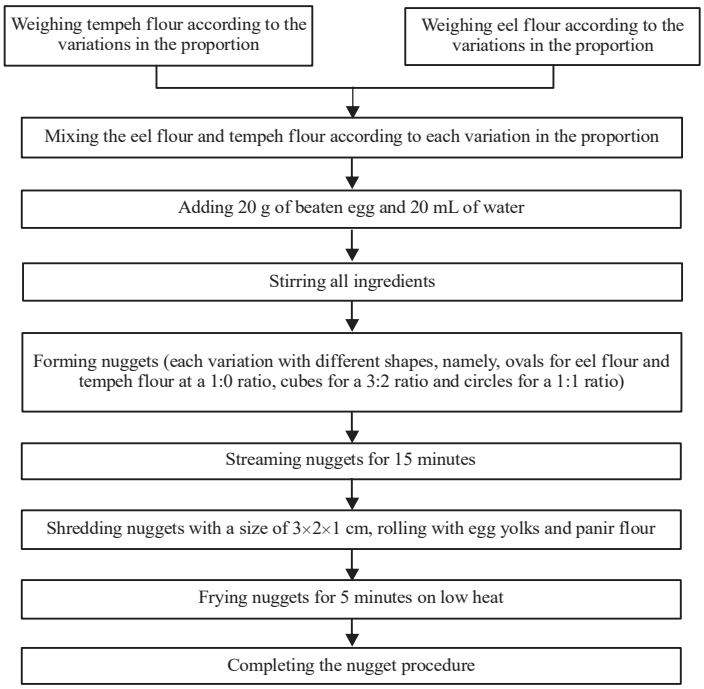

Fig. 1: The process of making nuggets with three different mixtures of eel flour and tempeh flour

Table 1: Various mixtures of eel flour and tempeh flour

Variation	Proportion of eel flour (%)	Proportion of tempeh flour (%)
Nugget A	100	0
Nugget B	60	40
Nugget C	50	50

make the nuggets. The nuggets was made at the Laboratory of Dietetics and Culinary, Universitas Respati Yogyakarta. The method used to make the nuggets is shown in Fig. 1.

The independent variable of this study was the proportion of animal and vegetable protein sources, while the dependent variable was the nutrient content. The various mixtures of eel flour and tempeh flour were defined nominally by the difference in the proportion of eel flour and tempeh flour, which was mixed when the nuggets were made. The nutritional content was defined based on the results of laboratory tests used to determine levels of energy, protein, fat, carbohydrate, iron, calcium, sodium, potassium and phosphorus in the nuggets that were made from a variety of mixtures of eel flour and tempeh flour.

All data in this study are primary data. Data on nutrient content were obtained from the analysis of nugget nutrient content that was performed at Chemix Pratama Laboratory, Yogyakarta. Analysis of total nitrogen/total protein was carried out using the micro-Kjeldahl method. The carbohydrate and energy levels were obtained using the following formula:

Carbohydrate content (%) = 100% - water content-ash content -protein content-fat content-crude fiber

Energy (kcal/100 g) = (protein content×4.27)+ (fat content×9.05) +(carbohydrate content×3.85)

Iron content was analyzed using the spectrophotometry method by making a standard iron curve. The sodium content was analyzed using the argentometric titration method and the potassium levels were analyzed using the gravimetric method. The calcium content was analyzed with the permanganometric titration method and the phosphorus/P_2O_5 content was analyzed using the vanadate-molybdate spectrophotometric method.

The data obtained were processed and analyzed univariately to determine the frequency distribution of each variable, followed by bivariate analysis with one-way ANOVA using SPSS software to determine the effect of the proportion of animal and vegetable protein sources on the nutritional content of the nuggets. The level of significance was set at 5%.

RESULTS

The results of the univariate and bivariate analyses are shown in Table 2. Based on the one-way ANOVA test results, the various mixtures of eel flour and tempeh flour affected

Table 2: The effect of the proportion of animal and vegetable protein sources on the nutritional content of the nuggets

Nutritional variables	Variation of nuggets	Mean contents	p-value
Energy	Nugget A	259.85020	0.001*
	Nugget B	264.89930	
	Nugget C	276.99720	
Protein	Nugget A	28.42965	0.000*
	Nugget B	24.87565	
	Nugget C	29.38475	
Fat	Nugget A	13.38275	0.010*
	Nugget B	14.86855	
	Nugget C	13.68360	
Carbohydrate	Nugget A	4.50415	0.010*
	Nugget B	6.26470	
	Nugget C	7.19145	
Iron	Nugget A	0.02015	0.000*
	Nugget B	0.02020	
	Nugget C	0.01520	
Calcium	Nugget A	0.94540	0.000*
	Nugget B	1.29575	
	Nugget C	1.50395	
Sodium	Nugget A	0.21355	0.565
	Nugget B	0.23160	
	Nugget C	0.13490	
Potassium	Nugget A	0.07375	0.441
	Nugget B	0.08225	
	Nugget C	0.06440	
Phosphorus	Nugget A	0.56070	0.000*
	Nugget B	0.51070	
	Nugget C	0.50140	

*ANOVA test result, significant based on a $p<0.05$

energy ($p = 0.001$), protein ($p = 0,000$), fat ($p = 0.010$), carbohydrate ($p = 0.010$), iron ($p = 0,000$), calcium ($p = 0,000$) and phosphorus ($p = 0,000$) contents in the nuggets made for nutritional support for hemodialysis patients. However, the various mixtures of eel flour and tempeh flour did not have a significant effect on sodium ($p = 0.565$) or potassium levels ($p = 0.441$).

Nugget C, with a 1:1 mixture of eel flour to tempeh flour, had the highest contents of energy, protein, carbohydrate and calcium and has the lowest contents of sodium, potassium and phosphorus compared to the contents of the other two nugget variations. These results indicate that nugget C was the best suited to fulfill the nutritional requirements of hemodialysis patients compared to the other two nugget variations.

DISCUSSION

Consuming a high-protein diet composed of 100% animal protein for one month increased creatinine levels in hemodialysis patients ($p = 0.001$). Therefore, it is recommended that the protein needs of hemodialysis patients be met not only with animal protein sources but also by modifying the proportion of animal protein sources and vegetable protein sources[6].

The results of this study indicate that the various mixtures of eel flour and tempeh flour affected the contents of energy, protein, fat, carbohydrate, iron, calcium and phosphorus but there was not a significant effect of the various mixtures of eel flour and tempeh flour on the content of sodium and potassium. Nugget C with the 1:1 proportion of eel flour to tempeh flour had the most suitable nutrient content to meet the dietary requirements of hemodialysis patients.

In patients on maintenance dialysis, there are additional protein catabolic stimuli, such as the unavoidable loss of amino acids and albumin into the dialysate and the inflammatory stimulus associated with the dialysis procedure. The minimum protein and energy requirements for patients on maintenance hemodialysis are 1.2 g kg^{-1} of ideal body weight per day and 30-35 kcal kg^{-1} of ideal body weight per day based on physical activity level, respectively. Furthermore, it is important that at least 50% of the protein intake be of high biological value. In elderly patients who tend to lead a sedentary lifestyle, an energy intake of 30 kcal kg^{-1} body weight per day is acceptable[7]. Given the exceptionally high dietary protein requirement of dialysis patients (1.2 g kg^{-1} day^{-1}) and given the observation that most dialysis patients eat less than 1.0 g kg^{-1} day^{-1} of protein, an average dialysis patient needs an additional 0.2-0.4 g kg^{-1} day^{-1} of protein[8].

The aim of fulfilling the energy and protein requirements in hemodialysis patients is to achieve weight and nitrogen balance to minimize the risk of morbidity and mortality related to malnutrition. The energy and protein requirements of hemodialysis patients are increased to make up for the activation and release of cytokines from the hemodialysis and uremia processes. Complications can occur along with the decrease in hunger and nausea experienced by these patients. If there is an acute infection, energy needs will increase. The dialysis process can reduce this problem but can increase the loss of significant molecular weight components such as peptides and increase protein requirements in hemodialysis patients to compensate for the loss associated with the dialysis process[9].

In addition to macronutrients, we should consider the daily micronutrient requirements of hemodialysis patients. The daily recommendations are as follows: phosphorus 800-1000 mg, calcium 500-800 mg, sodium 2000-2300 mg, potassium 1950-2730 mg and iron 8 mg for males and 15 mg for females[10].

Normal serum phosphate levels are between 1.1 and 1.7 mmol L^{-1} and if they become elevated, hemodialysis patients can experience hyperphosphatemia and related complications. Therefore, hemodialysis patients must limit their phosphorus intake from food. Additionally, patients must be given counseling regarding the right time to consume protein sources and phosphate binders. Phosphate-binding drugs must be taken together at meals so that they can effectively inhibit phosphate absorption from food. However, oral iron tablets should not be taken concurrently with phosphate-binding agents because they can reduce the effectiveness of these drugs[9].

In addition, the sodium intake of hemodialysis patients must be considered. Reducing salt consumption and sodium dialysate concentration can lower blood pressure. High salt intake can also increase thirst, making it difficult to limit fluids. Patients should be advised to meet the optimal recommendations for interdialytic weight gain, which is a maximum of 2 kg or no more than 4% of dry weight or ideal body weight. Excessive interdialytic weight gain is associated with symptoms that arise during dialysis and left ventricular hypertrophy. Patients are advised to consume only 500 mL of liquid plus their 24 h urine output amount[9].

The results of this study showed no significant difference in the contents of sodium or potassium in the nuggets with varying proportions of eel flour and tempeh flour. This is because eels and tempeh do not have high sodium or potassium contents, which is the advantage of these nugget products for nutritional support for hemodialysis patients.

Water-soluble vitamins are also supplemented to anticipate a shortage associated with a low potassium diet and to replace the loss of water-soluble vitamins through the dialysis process. Fat-soluble vitamins are not supplemented because they are associated with risks. European guidelines recommend measuring vitamin D levels and supplementing if needed at all stages of chronic kidney disease[11]. This is intended to overcome hyperparathyroidism, stimulate bone mineralization and play an essential role in muscle function[12,13]. This process can be supported by the provision of high-calcium foods and this calcium requirement can be fulfilled by mixing eel flour and tempeh flour in a 1:1 ratio, which has the highest calcium content compared to the content of the other mixtures. It should also be noted that protein sources play a role in the regulation of phosphate levels. In a small crossover study, an increased ratio of vegetarian-derived protein sources was found to improve serum phosphorus levels. Patients on maintenance hemodialysis on a phosphorus-regulated diet should be educated on phosphorus restriction in addition to methods of maintaining adequate protein intake from high-quality sources. Informing patients of low-phosphorus protein-containing food options can improve dietary protein intake and prevent the occurrence of malnourishment[14].

The results of this study indicate that the 1:1 ratio of eel flour to tempeh flour provided the most appropriate nutrients for nutritional support of hemodialysis patients. Providing nutritional support to hemodialysis patients with a 1:1 proportion of eel flour to tempeh flour is expected to overcome the deficiencies in dietary intake of hemodialysis patients consuming other foods and drinks.

CONCLUSION

The various mixtures of eel flour and tempeh flour affected the contents of energy, protein, fat, carbohydrate, iron, calcium and phosphorus but not those of sodium or potassium. The nuggets with the 1:1 ratio of eel flour to tempeh flour was the best for fulfilling the dietary requirements of hemodialysis patients because it resulted in the highest content of energy, protein, carbohydrate and calcium and the lowest content of sodium, potassium and phosphorus compared to the contents of the other two nugget variations. Based on these conclusions, experimental research needs to be performed that involves the use of local food with appropriate nutritional content and that is accompanied by good taste so that it can be used for nutrition management in patients with degenerative diseases, especially those who need long-term nutritional support.

SIGNIFICANCE STATEMENT

This study revealed the effect of various mixtures of eel flour and tempeh flour on the contents of energy, protein, fat, carbohydrate, iron, calcium and phosphorus but the different mixtures did not affect the sodium or potassium content. This study will help researchers understand the critical area of the ideal proportion of animal and vegetable protein sources to best meet the dietary requirements of hemodialysis patients. The results of this study indicate that a 1:1 ratio of eel flour to tempeh flour contained the most appropriate nutrients to provide nutritional support for hemodialysis patients. Thus, a new theory on these proportions may be developed.

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REFERENCES

1. Bashardoust, B., M. Gavami, N. Maleki, H. Doustkami and S. Habibzadeh, 2015. Mortality and nutritional status in patients undergoing hemodialysis. Shiraz E-Med. J., Vol. 16, No. 2. 10.17795/semj20076
2. Gharekhani, A., M.R. Khatami, S. Dashti-Khavidaki, E. Razeghi, A. Abdollahi, S.S. Hashemi-Nazari and M.A. Mansournia, 2014. Effects of oral supplementation with omega-3 fatty acids on nutritional state and inflammatory markers in maintenance hemodialysis patients. J. Renal Nutr., 24: 177-185.
3. Fouque, D., K. Kalantar-Zadeh, J. Kopple, N. Cano and P. Chauveau *et al*., 2008. A proposed nomenclature and diagnostic criteria for protein-energy wasting in acute and chronic kidney disease. Kidney Int., 73: 391-398.
4. Ministry of Health Republic of Indonesia, 2017. Tabel komposisi pangan Indonesia 2017. Ministry of Health Republic of Indonesia.
5. Sja'bani, M., 2015. Dahsyatnya Tuma'ninah Dalam Sholat (Gerakan Peregangan Khusus Bersama Pemahaman Bacaan Sholat) Ulasan Kesehatan Fisik dan Kesehatan Hati. PT Leutika Nouvalitera, Yogyakarta, Indonesia.
6. Widiany, F.L. and A.T. Astuti, 2017. Giving of catfish abon to the creatinine level of haemodialysis patients. Proceedings of the 4th International Conference on Health Science, November 5, 2017, Yogyakarta, Indonesia, pp: 163-166.
7. Ikizler, A.T., N.J. Cano, H.A. Franch, D. Fouque and J. Himmelfarb *et al*., 2013. Prevention and treatment of protein energy wasting in chronic kidney disease patients: A consensus statement by the International Society of Renal Nutrition and Metabolism. Kidney Int., 84: 1096-1107.
8. Kalantar-Zadeh, K. and T.A. Ikizler, 2013. Let them eat during dialysis: An overlooked opportunity to improve outcomes in maintenance hemodialysis patients. J. Renal Nutr., 23: 157-163.
9. KDOQI., 2000. Clinical practice guidelines for nutrition in chronic renal failure. Kidney Disease Outcomes Quality Initiative (KDOQI), National Kidney Foundation, Inc., New York, USA.
10. Luis, D., K. Zlatkis, B. Comenge, Z. Garcia, J.F. Navarro, V. Lorenzo and J.J. Carrero, 2016. Dietary quality and adherence to dietary recommendations in patients undergoing hemodialysis. J. Renal Nutr., 26: 190-195.
11. KDIGO., 2009. KDIGO clinical practice guideline for the diagnosis, evaluation, prevention and treatment of Chronic Kidney Disease-Mineral and Bone Disorder (CKD-MBD). Kidney Int. Suppl., 113: S1-130.
12. Holick, M.F., 2007. Vitamin D deficiency. N. Engl. J. Med., 357: 266-281.
13. Bischoff-Ferrari, H.A., B. Dawson-Hughes, E. Stocklin, E. Sidelnikov and W.C. Willett *et al*., 2012. Oral supplementation with 25(OH)D_3 versus vitamin D_3: Effects on 25(OH)D levels, lower extremity function, blood pressure and markers of innate immunity. J. Bone Miner. Res., 27: 160-169.
14. Oehlhof, P. and S. Phillips, 2017. Kidney-friendly protein choices. J. Renal Nutr., 27: e41-e43.