Potential of Local Food-based Enteral Nutrition to Improve Patient’s Nutrition Status in Hospital in Yogyakarta, Indonesia

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Abstract Most of hospitals in Indonesia provide enteral nutrition from fresh foods, yet it has some weaknesses notably not durable, unstandardized nutrition content, and not ready to use. Improvement of enteral nutrition using local food that containing functional substance is very potential. We aim to formulate local food-based enteral nutrition containing high protein, antioxidant and nutritious; analyze the nutrition content and conduct organoleptic test of the product. This was pure-experimental study conducted along 2017. There were five steps consisted of: (1) Potential local food selection, such as arrowroot as energy source, fish cork and local tempeh as protein, carrot, green bean sprouts and pumpkin as fiber, vitamin and mineral; (2) Ingredients preparation and early formulation, each ingredient was steamed before flouring to minimize odour of the component. We powdered each component using dryer machine, mashed using blender and filtered using pharmaceutical sieve; (3) Nutrition analyses, energy and protein per 100 grams ingredients were 352.69 kcal and 0.23 grams (starch arrowroot), 355 kcal and 0.73 grams (arrowroot flour), 392.17 kcal and 79.33 grams (fish cork flour), 449.67 kcal and 46.5 grams (local tempeh flour), 354 kcal and 38.5 grams (mung bean sprout flour), 356.33 kcal and 10 grams (carrot flour) and 380.63 kcal and 12.67 grams (yellow pumpkin flour); (4) Organoleptic test, conducted by trained panelists. Due to low acceptability and bad flavour impact on the product, arrowroot flour, carrot and mung bean sprouts flour were removed from the formula of the product; (5) Formulation, all components were mixed using homogenous mixer machine and were added skim milk, full cream milk, palm sugar, rice flour and essence into the product to improve nutrition contains and organoleptic components. The conclusion is that starch arrowroot, fish cork, local tempeh and yellow pumpkin floured are potential to be formulated as enteral food to improve nutritional status among malnutrition patients.

Keywords: local food, enteral nutrition, nutrition status, patient, hospital

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1. Introduction

Hospitlalized patients can not eat any or enough food because an illness they suffered from may cause decreased in appetite, difficulties in swallowing, or some type of surgery that interferes with eating. Due to all reasons above, nutrition must be delivered in a different way, one of the methods is using enteral nutrition or tube feeding. Tube feeding is a special liquid food mixture containing macro and micro-nutrient (energy, protein, fats, carbohydrates, vitamins and minerals), given through a tube into small intestine. Patients who were receive this therapy, 25.0% were children and newborns [1].

Malnutrition is one of the problems faced by hospitals that can occur before hospitalization. It usually caused by illness or insufficient nutrition intake. However, malnutrition also often occurs during hospitalization [2]. Malnutrition during hospitalization could affect the patient's clinical outcome such as longer lengths of stay during hospitalization, higher re-admission rates, and increased morbidity and mortality [3,4].

The principle of fulfilling nutrition in hospital patients is to provide food orally. If the fulfillment of nutrients by oral is not possible, then liquid or enteral feeding could be an option. The aim of administering enteral formula is to meet nutritional needs and supplements for malnourished patient [5]. During recent years, the diversity of enteral feeding formulas has been rapidly increased [6]. Liquid food can be developed into a formula consisting of local food that is easily available in the community at affordable prices [7]. There are many local food grow in Indonesia that potentially improve nutrient contains on formulation of enteral nutrition.

In this study, several potential local food which already formulated in previous studies were used. These materials...
include arrowroot starch, arrowroot flour, rice flour, cork fish, local soybean tempeh, non-dairy creamer, mung bean sprouts, carrots, and yellow pumpkin. Arrowroot is type of tuber that has the potential as a functional food. Based on the research, arrowroot tubers contain plenty of total dietary fiber as much as 9.79-13.70% dry basis [8]. Boiled arrowroot has a low GI as little as 14 [8]. One recent study suggested that the arrowroot flour is a potential source of prebiotics and has an immune-modulatory effect [8]. In addition, the source of carbohydrates in this study also uses rice flour which contains 80 grams carbohydrates per 100 grams of ingredients [9].

In this study, cork fish, soybean tempeh, and non-dairy creamer were used as protein source. Cork fish is a type of freshwater fish that contains higher protein and albumin compared to other types of fish. Cork fish contains 25.5% protein and 6.22% albumin and also have complete amino acids both essential and non-essential [10,11]. Soybean tempeh is also rich in protein (20.8 grams/100 grams). Compared to soybeans, tempeh becomes more easily digested due to the fermentation process [12].

Micronutrients such as vitamins and minerals are also needed. The ingredients used are mung bean sprouts, carrots, and yellow pumpkin. Twelve phenolic acids have been identified from mung bean seeds and sprouts [13]. Carrot contains 7125 mg vitamin A per 100 grams, while yellow pumpkin is 1569 mg per 100 grams [9]. In addition, they also contain several minerals such as calcium, phosphorus, and iron. Thus, this study aim to formulate and develop nutrition enteral from potential local food which containing high protein, antioxidant and nutritious by flouring, organoleptic test and nutrition analysis.

2. Materials and Methods

This pure-experimental study was carried out along 2017 in Laboratory of Nutrition and Health, Faculty of Medicine, Public Health and Nursing and Laboratory of Faculty of Food Technology, Universitas Gadjah Mada. We selected some potential local foods like arrowroot as energy source, fish cork / Channa striata and local tempeh as protein, carrot, green bean sprouts and pumpkin as fiber, vitamin and mineral. The ingredients were obtained from several places, arrowroot powder and arrowroot starch from local certified distributor in Yogyakarta, fresh fish cork (Channa striata) was bought from supermarket, tempeh was ordered in local certified distributor named AT-Tempe Yogyakarta, carrot, yellow pumpkin, and green bean sprouts were obtained from the biggest traditional market in Yogyakarta.

All ingredients were powdered using cabinet dryer machine (50°-60°C, 24 – 48 hours), then they were mashed using blender as 60 mesh and filtered using pharmaceutical sieve. Nutrition content was analyzed in each powdered ingredients using Kjeldahl method for protein analysis, Soxhlet method for fat analysis, gravimetric method for analyzing water and ash content, and carbohydrate analyzed with equation (by difference).

Organoleptic evaluation was conducted to assess colour, odour, flavour and texture for each ingredient. The test was performed after all ingredients had been floured and conducted by three trained panelists. The test was consisted of four components which had to be assessed, as follow: colour, odour, flavour and texture for each ingredient. It was served in a plastic cup 50 ml and was placed in the room with a bottle of mineral water, pen and assessment paper. The panelists got into the room without brought all of their stuffs.

After they finished to evaluate of one ingredient, they had to do mouthwash to neutralize after-taste in prior to appraise next ingredient. The panelists had to describe their preferences for each component into a scale named the 5-likert scale. The 5-likert scale consists of 5 category i.e. 1 for strongly do not like; 2 for do not like; 3 for abstain/netral; 4 for like; and 5 for strongly like. They also had to put some evaluations and comments in the paper what should the ingredient put as composition to make local food-based enteral nutrition or not.

3. Results and Discussion

Stage 1. Potential Local Food Selection

Local food as a main composition in making enteral nutrition is selected, since it is easy to find and cultivate in many regions in Indonesia. In addition, local food also has role as potential food due to its complete nutrition contents such as energy, protein, fats, carbohydrates, fiber, vitamins and minerals, and phytochemical substances which one of their functions are as antioxidant [14].

1. Arrowroot

Arrowroot (Maranta arundinacea) is kind of tubers which potentially has role as functional food. Arrowroot has low glychemic index (32.0) and high fiber (9.78%) [10]. In this study, arrowroot flour and arrowroot starch were used. Principally, arrowroot flour is made from all tuber components, yet water is excluded, while arrowroot starch is result from the extraction of arrowroot. In addition, bioavailability of the starch (84.35%) is higher than the flour. In contrast, nutrition content of the flour is more complete than the starch. Except macro-nutrient, micro-nutrient such as calcium, phosphorus, ferrum, potassium, and vitamin A, B, C are also contained in the flour [9].

2. Cork Fish

Cork fish is elected, since it contains quite high protein (25.5%) and some minerals compared to other types of fish. In addition, albumin content in cork fish also high, 6.22%, zinc 1.74%, and rich of several essential amino acids (threonine, methionine, histidine and arginine) and non-essential amino acids (serine, glutamic acid, alanine and proline) [11].

3. Tempeh

Tempeh is a traditional and functional food made from fermented soybeans. Tempeh has high quality of protein, since fermentation process causes protein compounds to be more easily digested [15] and the process also increases the amount of fiber in tempeh [9]. Moreover, soybean in tempeh contains isoflavan that can reveal anti-hypertensive activity [15].

4. Carrot

Orange color of carrot indicates carotene content, together with β-cryptoxanthin as precursor can be converted into retinol (vitamin A) which serves to support antioxidant, immunity, eye and skin health. Even more, carrot also high in vitamin C [9,14].
5. Mung Bean Sprouts
Mung bean sprouts are the result of the growth of green beans that are sown, which are take for 2 – 5 days. It contains a higher vitamin E than green beans (15.3 mg/100 grams) [13]. Furthermore, there are also compounds quite high fitosterol (15 mg/100 grams) which has function as antioxidant [13]. As an important plant-derived food resource, mung bean sprouts are well known for its detoxification bioactivities. Moreover, it also has been used as treatment for several conditions ranging from enhancement of human mental function to alleviation of heat stroke [13].

6. Yellow Pumpkin
Yellow pumpkin has been widely used, since it shelf life is also durable 6 months or more. It is rich in several vitamins (vitamin A, B1, B3 and C), and mineral (calcium, phosphorus, potassium, sodium, ferrum and zine) as antioxidants [16]. Other than that, it is low calories, so that it is suitable for low-calorie diet. Other advantages of yellow pumpkin is soft texture and easy to digest [16].

Stage 2. Ingredients Preparation and Early Formulation
The preparation process in making enteral nutrition from local food consists of steaming and making flour for each ingredient. Notably, tempeh treatments was divided into two groups, steamed and non-steamed to obtain a better odour and flavour. After steaming, each ingredient was dried using a drying machine or oven with temperature 50°C for 2x24 hours. The next step was mashing the ingredients using electronic blender smoothly. Last step was filtering each component using pharmaceutical sieve with 60 mesh.

Formulation of products was performed by calculating of each component based on the nutrient content analysis results. In the early formulation, the selected ingredients were arrowroot flour, arrowroot starch, cork fish, steamed and non-steamed tempeh flour, yellow pumpkin flour, carrots flour, and mung bean sprouts flour. After formulation in several times, it was agreed to use steamed tempeh. The longer steamed tempeh flour, the better its odour and flavour. However, if it is too long steaming and the temperature is too hot, a bitter taste may arise [13]. The best results were shown by samples that steamed for 20 minutes.

It was also agreed to remove arrowroot flour, mung bean sprouts and carrots flour, since they had bad organoleptic properties, both odour, colour, flavour, and texture. Mung bean sprouts are legumes that have a strong beany odour and flavor. The beany after taste in legumes flour can be minimized by exposing the material to moist heat [14]. Previous research found that carrot based food like pasta and cakes were decrease in cooking quality, not so fresh and have coarser grains, uneven shapes and sizes [17].

Formulation was performed by adding skim milk to improve the flavour. However, it still had a fishy odour and a sandy texture that affect product acceptability. Sandy texture appears as a presence of granules measuring 90 to 100 um. Meanwhile, a flour particles larger than 40 um were perceived by the human tongue as sandy texture. In this study, the raw material was milled and then sifted through 60 mesh that will produce particles as 250 um. In addition, sandy texture in the formulation was being sign that product still needs more grinding process [18].

In the present study, gum arabicum also added to prevent product clotting. In the food industry, gum arabicum is primarily used in confectionery, bakery, dairy, beverage, and as a microencapsulating agent. In dairy products, it is used as a stabilizer in frozen products like ice and ice cream, absorbing water and producing a finer texture. The volatile matter determines the nature and degree of polymerization of the compositions contained in sugar (arabinose, galactose, and rhamnose) which exhibits strong binding properties to act as emulsifiers and stabilizers in the manufacture of cough syrups in the pharmaceutical industry [18]. Gum arabicum addition was expected to reduce the rough texture of the product. It addition was carried out for several times to get a sufficient and suitable texture. It was agreed to add 2.0 grams of gum.

Stage 3. Nutrition Analyzes
Nutrition analyzes was performed after all ingredients had been floured. The nutrient content analysis of each component were revealed in the Table 1. Results highlighted that energy and protein per 100 grams ingredient respectively were 355 kcal and 0.7 grams (arrowroot starch), 353 kcal and 0.24 grams (arrowroot flour), 80 kcal and 16.2 grams (fish cork flour), 201 kcal and 20.8 grams (local tempeh flour), 34 kcal and 3.7 grams (mung bean sprout flour), 36 kcal and 1 grams (carrot flour) and 51 kcal and 1.7 grams (yellow pumpkin flour).

| Ingredients               | Energy (kcal) | Protein (grams) | Fats (grams) | Carbohydrates (grams) | Fiber (grams) |
|---------------------------|---------------|-----------------|--------------|-----------------------|---------------|
| Arrowroot starch          | 352.69        | 0.23            | 0.69         | 98.77                 | 2.62          |
| Arrowroot flour           | 355.00        | 0.73            | 0.20         | 85.20                 | 13.20         |
| Fish cork flour           | 392.17        | 79.33           | 2.50         | 12.67                 | 0.00          |
| Tempeh flour              | 449.67        | 46.5            | 19.67        | 30.17                 | 3.17          |
| Mung bean sprout flour    | 354.00        | 38.50           | 12.50        | 45.00                 | 11.50         |
| Carrot flour              | 356.33        | 10.00           | 6.00         | 78.33                 | 10.00         |
| Yellow pumpkin flour      | 380.63        | 12.67           | 3.66         | 74.66                 | 19.99         |

Stage 4. Organoleptic Test
After flouring, sensory evaluation of each ingredient was performed by three expert panelists. There are 4 components evaluated in this organoleptic assessment based on colour, odour, flavour and texture. The component, arrowroot starch and flour, fish cork, tempeh, mung bean sprout, carrot and yellow pumpkin flour were brewed for each on 76 – 80°C of boiled water. The result highlighted that in term of colour and flavour, mung bean sprout and arrowroot flour had more turbid colour that may cause by oxidation in low humidity condition while, carrot also had bad brownish red colour, since temperature increases along the flouring process. Thus, considering the result of the test, arrowroot, mung bean sprout and carrot flour were removed from the formula.

Stage 5. Formulation
Based on the sensory evaluation results, the original product odour is not favored by the panelists. In addition, the flavour and texture also were not preferred over the original formula. For improving odour and flavour, the composition was added with several materials such as...
skim milk, full cream milk, palm sugar, rice flour and essence. After couple of experiments, the essences was poured to the formula, namely ginger, cinnamon and vanilla. We carried out organoleptic test after re-formulation and the result was the odour and flavour of formula with ginger and cinnamon essence was preferred.

Some previous studies stated that home-based or blenderized enteral nutrition (HEN/BEN) is administered to outpatients and may be an option for patients who require life-sustaining nutrition care with a long-term alternative to oral nutrition, yet are otherwise able to live outside of an acute care hospital facility. Some patients may be admitted to hospital for an acute or chronic illness and have enteral nutrition initiated during their hospitalization and then are discharged to the home or other community setting to continue with outpatient enteral feeding. Other patients are identified as being at risk in the outpatient setting and may be admitted specifically to initiate enteral nutrition in hospital and transition to home [19,20]. In centers where there are dedicated HEN/BEN teams to provide monitoring, it is also possible to have enteral access placed and initiate feeding without requiring admission to hospital.

The HEN/BEN has a satisfactory cost-benefit ratio, since it reduces the risk of infection by avoiding prolonged hospital stays, and also is cheaper than hospital enteral therapy [20]. The use of HEN/BEN foods for home tube feeding has been uncommon, but occasionally some patients have asked questions about it and used various puréed foods or juices in their feeding tubes. If done properly, blended foods in feeding tubes can be safe and healthful and improve patient satisfaction; however, it can be difficult to ensure that full nutrition needs are met, and there are some risks. All across the country, more RDs are stepping up to the challenge of assisting home EN consumers with the use of blended foods for tube feeding, yet not much medical research has been done to support this practice [21].

Hundreds of phytochemicals and fibers present in fruits, vegetables, whole grains, and other foods are beneficial to health and gastrointestinal (GI) function. In contrast, conventional EN products contain processed ingredients such as corn syrup, malt-dextrin, sucrose, casein, whey and soy proteins, soy and corn oils, and very limited amounts and types of fiber [22]. Commercial EN products are necessary for hospital use in that they contain concentrated sources of calories and protein and all the known essential vitamins and minerals in standardized amounts and in a convenient and safe form, yet they don't contain the myriad phytochemicals and fibers found in whole foods. The use of blenders makes it possible for home tube-fed individuals to consume fruits, vegetables, whole grains, legumes, fish, nuts, and many other protein sources as well as healthful fats [22,23].

Blenderized foods are a benefit for home EN consumers who have intolerances or are allergic to certain ingredients in standard EN formulas such as soy or casein. Other EN consumers view blended foods as a quality-of-life issue [23]. One can assume that blended foods are healthful for tube-fed individuals, but few published studies have shown that consumers fare better or worse with blended foods compared with standard EN formulas [23].

4. Conclusion

In summarize, arrowroot starch, cork fish, local tempeh and yellow pumpkin are potential to be formulated as HEN/BEN and be used generally in hospital to improve nutritional status among malnutrition patients who do not have kidney disorders or protein allergic. For a better formulation, notably in texture, the product still needs some improvements, specifically in drying and filtering process.

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