ORIGINAL ARTICLE

Characterization of High Protein Liquid Food Formula Containing Catfish (*Clarias gariepinus sp*) Flour and Moringa (*Moringa oleifera*) Leaf Powder for Burn Patients

Mia Srimiati[1], Clara M Kusharto[2], Mira Dewi[2], Utari Yunitaningrum[2], NA Shofiyyatunnisaak[2], Merry Aitonam[3]

[1] Nutrition Science Department, Faculty of Public Health, Binawan University, Jakarta 13630, Indonesia
[2] Community Nutrition Department, Faculty of Human Ecology, IPB University, 16680 West Java, Indonesia
[3] Food Service Unit, Cipto Mangunkusumo General Hospital, Jakarta 10430, Indonesia

ABSTRACT

Introduction: Burn patients need a high nutritional requirement to increase healing process, especially protein. Catfish flour is one of the foods that are high in protein, and Moringa flour is a food that is high in antioxidants. The purpose of this study was to characterize nutrients from high-protein liquid food formulas containing catfish flour and mori nga leaf flour. **Methods:** Liquid food formula consists of 45 grams catfish flour, 18 grams Mori nga leaf flour, 24 grams soy flour, 18 grams egg white flour, 48 grams full cream milk, 60 gram skim milk, 7.5 ml catfish oi I, 12 ml olive oil, 44 grams sugar powder, and 2 ml pandan flavoring, and 1.5 grams salt. All powdered ingredients were mixed using a dry mixer. Then during the process, catfish oil, olive oil, and pandan flavor were adsorbed using a sprayer into the powdered ingredients. The chemical characterization that analyzed in instant liquid food formula was proximate analysis and mineral analysis. **Results:** The results of this study were; the formula of high protein liquid food contains 5.79% wb water content, 4.84% wb ash content, protein 28.25% wb, fat 14.99% wb, copper 35.58 mg/kg wb, selenium 56.56 mcg/1 00gram wb, zinc 3.44 mg/100 wb gram, calcium 1381.22 mg/100 grams wb, and iron 7.38 mg/100 grams wb. Also, this liquid food has an osmolality of 481 mOsmol/kgH_2O. **Conclusion:** The liquid food qualifies as a high protein liquid food to fill the nutrients needed for burn patients.

Keywords: Burn, Catfish, Liquid food formula, *Moringa oleifera*

Corresponding Author:
Mia Srimiati, PhD
Email: mia@binawan.ac.id
Tel: +62-80880882

INTRODUCTION

Burn patients will experience hyper-catabolism; therefore, nutritional support is one of the vital aspects that can improve the healing process of burns. Nutrition intake is essential to repair tissue damaged by burns. If the nutrition requirement is not fulfilled, it will result in loss of muscle mass, decreased immunity, increased sepsis, and inhibited the wound healing process (1).

The nutrients needed by burn patients include carbohydrates, fats, proteins, vitamins, and minerals. Carbs are necessary as the primary energy source in wound healing to save protein; it contributes to preventing the decrease of muscle mass (2). Burn patients need a complete supply of macro and micronutrients with the right composition and adequate amounts (3). However, the problem is that most burn patients with moderate to severe degrees will have difficulty receiving solid food intake due to difficulty chewing and digesting (4). Therefore, burn patients need to consume nutrient-dense foods that are easily digested and absorbed. One solution to meet the high nutritional needs of burn patients is to provide liquid food.

Catfish contain a high protein, and it is expected to meet the needs of macronutrients in burn patients. The primary function of protein is to repair damaged body tissue in burn patients (5). Meanwhile, Moringa leaves have a high content of polyphenols and trace elements. The primary function of poly phenol is to prevent oxidation, while the trace element functions to help the process of epithelial growth (6). The combination of catfish flour and moringa leaf flour is expected to meet the nutritional needs of both macro and micronutrients in burn patients. This study aimed to characterize nutrients from highprotein liquid food formulas containing catfish flour and mori nga leaf flour for burn patients.

MATERIALS AND METHODS

Formulation

Instant liquid food formula was obtained from the

selected formula in a previous study (7). The formula of Marta was 48 grams of full cream milk powder, 60 grams of skim milk powder, 22 grams of granulated sugar, 24 grams of soy flour, 45 grams of catfish flour, 18 grams of moringa leaf flour, 18 grams of egg-white flour, 12 grams of olive oil, 7.5 grams catfish oil, 1.5 grams of salt. The liquid formula was prepared by boiling the catfish flour, moringa leaf flour, with the addition of four strands of pandan leaves, and one tablespoon of lime juice in the 600 mL of water. Then, the formula was filtered. Separately, egg-white flour, soy flour, salt, olive oil, and catfish oil were brewed with boiled water.

Then, the decoction of catfish flour and Moringa leaves was mixed with ingredients that have been blended and added boiled water becomes 1000 ml. This formula was homogenized by a homogenizer of 8000 rpm for 10 minutes to get a homogeneous mixture. The formula then placed into sterile bottles and sprayed using a spray dryer machine. Unmixed ingredients such as full cream milk powder, skimmed milk powder, and sugar were mixed using dry mixing techniques.

In this research, the granulated sugar was replaced with powdered sugar to make it easier to homogenize, and the amount of sugar was increased to reduce the bland taste of liquid food than before. Pandan leaves were replaced with commercialized pandan or vanilla flavor for a more straightforward manufacturing process. The composition of liquid food formulas from previous studies that have been modified is presented in Table I.

Table I: Composition of liquid food formula from previous study that modified

Materials	Weight
Full cream milk flour (g)	48.0
Skim milk flour (g)	60.0
Powdered sugar (g)	44.0
Soy flour (g)	24.0
Catfish flour (g)	45.0
Moringa leaf flour (g)	18.0
Egg white flour (g)	18.0
Olive oil (ml)	12.0
Catfish oil (ml)	7.5
Salt (g)	1.5
Flavor (pandan/ vanilla) (ml)	2/4

The process of making liquid food

The materials that we used to make liquid food products were catfish flour, soy flour, moringa leaf flour, full cream milk flour, skim milk flour, sugar powder, egg-white flour, salt, olive oil, catfish oil, and pandan or vanilla flavor. Mineral mix that contains zinc and selenium is added to fulfill the requirement of the mineral of the burn patient. High-protein liquid food products based on catfish flour and moringa flour have been developed previously by boiling catfish flour and moringa leaf flour first to temperature 100°C, so the product was liquid and then processed into an instant form using a spray dryer. The process of drying liquid products using a spray dryer can be at risk of the nutritional loss due to the high temperature used in the spray dryer process.

Since most of the ingredients were a powder, so the process of production of the liquid formula was improved by using the dry mixing process for all the ingredients. We did manually by placing the material in transparent plastic with a thickness of 20 microns, then tied and shaken by hand. The purpose of this method was to increase the yield of the product and maintain the content of heat-sensitive nutrients such as unsaturated fatty acids and antioxidants. The process of making liquid food using the dry mixing method is shown in Fig 1.

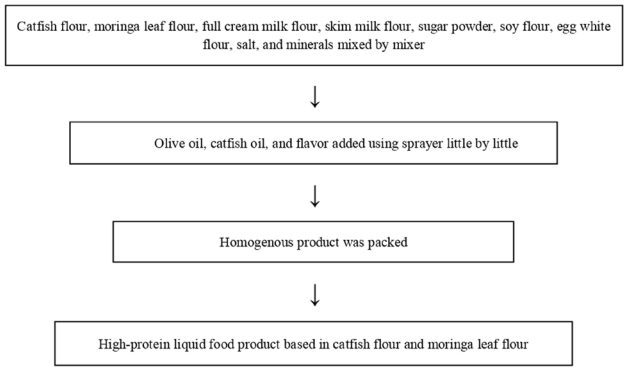

Figure 1: Process of making the liquid food product. The liquid food product is made using the dry mixing method in which all dry ingredients are mixed, and wet ingredients are sprayed to it.

Proximate analysis

Nutrient content was determined by proximate analysis. There are five contents of proximate analysis; ash, moisture, total fat, protein, and carbohydrate contents. Ash content was determined by carbonization and incineration of samples in a muffle furnace at 550°C for 4 hours based on Indonesian National Standard (SNI) 01-2891-1992 Point 6.1 SNI food and beverage analysis. Moisture content was determined by the gravimetric method with oven drying at 105°C for 3 hours based on the Indonesian National Standard (SNI) 01-2891-1992 Point 5.1 SNI Food and Beverage Analysis. Total fat content was determined by the gravimetric method based on Indonesian National Standard (SNI) 01-2891-1992 Point 8 Analysis of Food and Beverage using the gravimetric method with hydrolysis method (Weibull) for sample preparation. Protein content by the Kjeldahl total nitrogen method based on Indonesian National Standard (SNI) 01-2891-1992 Point 7.1 SNI Food and Beverage Analysis. In this procedure, we used ammonium sulfate as a conversion factor of total organic nitrogen, and the conversion factor was 6.25. Then, carbohydrate content was determined using by difference method based on SNI 01-3775-2006 Attachment B point B.6 (Test methods for quality requirements for corned beef) (8).

The samples were measured with duplicate analysis and only one sample for every analysis.

Mineral analysis

Method for testing levels of copper (Cu), selenium (Se), zinc (Zn), calcium (Ca) and iron (Fe) is using Atomic Absorption Spectrophotometer (AAS) based on Standard National Indonesia (SNI) 7854:2013 using the principle of the determination of the number of metal elements carried out by atomic absorption spectrophotometer. The metal element (copper, zinc, and iron) are released from the sample matrix by wet or dry destruction. Wet destruction using strong concentrated acids and potent oxidizing agents, while dry destruction using oven or microwave heat. The resulting destruction is atomized in flames originating from air and acetylene (9). We measured every sample with duplo analysis and only one sample for every analysis.

Osmolality analysis

Osmolality is a measurement of concentration from total dissolved particles in a solution without regard to the density, electric charge, configuration, and size of particles. The instrument that use to measure osmolality is Osmometer by using the freezing point depression method. The sample is placed in a cooling chamber and then chilled to a temperature that less than the freezing point. After that, the sample is stirred with wire until it crystallizes. This process produces heat, which makes the sample temperature equal to the freezing point. Measurement of freezing point allows the concentration to be determined with the highest accuracy (10). The osmolality measurement uses 58 grams of sample powder that brewed with 250 ml of water. We measured osmolality, and only one sample for the analysis.

RESULTS

Nutrient contents that analyzed in instant liquid food formula are proximate analysis and mineral analysis, mainly mineral that burns patient needs such as selenium, zinc, calcium, copper, and iron to maintain the metabolism and oxidative condition of the burn patient. Result of the analysis shown in Table II.

Table II Nutrient content of instant liquid food formula

Nutrient content	Unit	Value
Water	% wb	5.79
Ash	% wb	4.84
Protein	% wb	28.25
Lipid	% wb	14.99
Carbohydrate	% wb	46.15
Copper	mg/kg	35.58
Selenium	mcg/100 g	56.56
Zinc	mg/100 g	3.44
Calcium	mg/100 g	1381.22
Iron	mg/100 g	7.38

Liquid food formula contained 5.79% wb of water, 4.84% wb of ash, 28.25% wb of protein, 14.99% wb of lipid, 46,15% wb of carbohydrate, 35.58% wb of copper, 56.56% wb of selenium, 3.44% wb of zinc, 1381.22% wb of calcium, and 7.38% wb of iron.

Compared with other high protein food such as egg and low lactose milk that usually used at Cipto Mangunkusumo General Hospital, instant liquid food formula is higher in protein and minerals. The comparison of nutrient content is shown in Table III.

Table III shows the nutrient content comparison of instant liquid food formula and other food. Instant liquid food formula has a higher protein (29.98% db) than low lactose milk (10.8% db) and egg (12.4% db). Moreover, instant liquid food formula is also higher in mineral content such as copper (37.77 mg/kg db), zinc (3.65 mg/100 g db), calcium (1466.11 mg/100 g), and iron (7.83 mg/100 g) than low lactose milk and egg. Instant liquid food formula has lower lipid and carbohydrate than low lactose milk but higher than the egg.

Table III Nutrient content comparison of instant liquid food formula and other food

Chemical characteristics	Unit	Instant liquid food formula	Low lactose milk	Egg
Protein	% db	29.98	10.8	12.4
Lipid	% db	15.91	24.5	10.8
Carbohydrate	% db	48.98	60.8	0.7
Copper	mg/kg	37.77	1.6	1.3
Selenium	mcg/100 g	60.04	-	-
Zinc	mg/100 g	3.65	1.8	1.4
Calcium	mg/100 g	1466.11	385	54
Iron	mg/100 g	7.83	6	1.6

The physical characteristic of the instant food liquid formula that analyzed was osmolality. Osmolality is the number of solute particles in 1 kg of water. More dissolved substances made high in the osmolality of a product (11). One serving size of instant liquid food formula (57.8 gram) was diluted with warm water until 250 ml. Osmolality analysis result of that liquid food formula is 481 mOsmol/kgH_2O, this value complies with the liquid food osmolality standard. Liquid foods in hospitals with balanced nutrient content generally have an osmolality of around 600 mOsmol/kgH_2O (12). The osmolality of the World Health Organization (WHO) F100 formula is 419 mOsmol/kgH_2O, and the F135 formula is 508 mOsmol/kgH2O. Liquid food osmolality with previously developed catfish flour was 442.5 mOsmol/kgH_2O (13).

DISCUSSION

Instant liquid food formula can be categorized as high protein food (14) because it contains protein more than 35% of recommended dietary allowances for general

people (15). Copper, selenium, calcium, and iron content of instant liquid food formula can be categorized as high, because of copper, selenium, calcium, and iron content of instant liquid food formula contain more than 30% of recommended dietary allowances for general people. The zinc content of instant liquid formula can be categorized as a source because it contained formula more than 15% of recommended dietary allowances for general people based on nutrition label reference (14). It might be due to the ingredients we added to the product, such as catfish flour and Moringa leaves flour. Catfish flour contains 58.73% protein (16), while moringa leaf powder contains 27.1 gram protein and 2003 mg calcium per 100 gram (17), both of these ingredients contribute to the nutritional content of the product.

Protein, lipids, carbohydrates, and minerals are essential nutrients to improve the recovery process of burn patients. Protein is an essential nutrient for burn patients because of hyper catabolism conditions that occur in the burn patient. More than 150 grams/ day protein was catabolized in burn patients (18). Critically burn trauma patients can lose total body protein up to 16% over the first 21 days after injury, and skeletal muscle is the most area of protein loss (19). Protein requirements for critically burned trauma patients are 50% higher than the healthy subject; therefore, the recommendation of protein for critically burned trauma patient is 1.5 - 2 g/kg/day (20). Protein synthesis can be facilitated with higher protein intake in burn patients, and it will reduce protein negative balance.

Levels of free fatty acid for oxidation will be high, and glycerol release for gluconeogenesis will increase as a part of metabolic response to injury. Burn patients need lipid because of the increase in lipolysis. The recommendation of lipid for critically ill burned patients is 1.0-1.5 g/kg/day (20) and should not exceed 30% of energy (19). Lipid contains omega-3 and omega-6 fatty acids that have a beneficial effect on burn patients in the inflammatory response (20). The addition of catfish oil as one of the ingredients in the manufacture of instant liquid formula is expected to provide omega three and omega six needed by burn patients.

Carbohydrate is a significant energy source for the burn patient. Glucose from carbohydrates can be a cellular fuel for the healing process of wounds and inflamed tissue. The recommendation of carbohydrate for critically ill burned patients is 5-7 g/kg/day and should not exceed 1400-1500 kcal/day for maintaining blood glucose levels, but intravenous insulin supplement is still required (20).

Copper, selenium, zinc, and iron are the trace mineral element that required for a burn patient because of low blood concentration (both in serum and plasma) of that trace element. Inflammation has a significant impact on trace elements circulating in the blood. Copper is a mineral that important for collagen maturation, while zinc is essential for immunity and cell replication (19). Copper and zinc are also antioxidant that plays a significant role against oxygen species, while the plasma activity of superoxide dismutase (SOD) is decreased after significant burns. Selenium is a mineral that plays an essential role in glutathione peroxidase activity, which is one of the endogenous antioxidants. Iron is a mineral essential for immunity (21). The recommendation of copper, selenium, and zinc for critically ill burned patients is 4.0-5.0 mg, 300-500 mcg, and 25-40 mg per day (20).

Catfish flour is high in protein, nutrient content of catfish flour are 58.73% protein, 9.965% lipid, and 18.87% carbohydrate. Moringa leaf powder contains 27.1% of protein, 2.3% of lipid, 38.2% of carbohydrate, 2003 mg/100 g calcium, 0.57 mg/100 g copper, and 28.2 mg/100 g iron (17).

This formula will meet the requirement of burn patients who installed with Naso Gastric Tube (NGT) by administering 600 grams of product (10 packs) a day. However, this is not recommended because the patient requirement will be better if it filled with nutrients that come from various food sources. So, our product will be more suitable if it used as supplementary food, equal with 30% nutrient requirement (750 Kal/day ~ 180 grams product).

Burn patients need a supply of macro and micronutrients with a complete composition and an adequate amount (3). Catfish is one type of food with high protein content so that it will meet the needs of macronutrients in burn patients, especially protein. The primary function of protein is to repair body tissue damage in burn patients (5). Meanwhile, Moringa leaves are a food that has a high content of polyphenol and trace elements. The primary function of polyphenol is to prevent oxidation, while the trace element functions are to help the process of epithelial growth (6). The combination of catfish flour and moringa leaf flour is expected to meet both macro and micro nutritional needs in burn patients.

CONCLUSION

Based on osmolality analysis, this product can be categorized as liquid food. Moreover, this product is rich in protein, copper, selenium, iron, and calcium. It also can be claimed as a source of zinc. That characteristic makes instant liquid food formula as an ideal food supplement for a burn patient, especially to increase the healing process of burn patients.

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