Cookies Prepared using Peanuts, Pregerminated Soybean, and Moringa Leaf Flour Improve Food Intake and Nutritional Status in Malnourished Patients

Widodo P.[1,2], Budiningsari D.[1,*], Susetyowati[1]

[1]Nutrition and Health Department, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada.
Farmako Street, Sekip Utara, Yogyakarta, Indonesia 55281
[2]Waluyo Jati Hospital, Probolinggo, East Java, Indonesia
*Corresponding author: budiningsari@ugm.ac.id

Abstract   Meals provided to patients in hospitals is an essential part of their treatment. The meals of malnourished patients have been observed to be devoid of basic nutrients that support patient recuperation. This study examined the effect of consumption of a energy-rich and high-protein cookie, called *Pronisi,* prepared using peanuts, pregerminated soybean, and Moringa leaf flour, on patients' food acceptance, food intake, and nutritional status. This was a quasi-experiment study with pretest-posttest with a control group design conducted. The subjects were malnourished-at-risk adult inpatients, divided into intervention group and the control group. The Independent T-test analyses were used to analyze the differences between two groups. Patients' acceptance of *Pronisi* is significantly higher in comparison to green bean porridge (p < 0.001). Energy and protein intake from in-between meals in the intervention group was significantly higher (100.68±9.79 kcal; 35.41 ± 0.71 g, respectively) compared to the control group (3.75±0.21 kcal; 2.83±0.22, respectively). There was significantly high reduction in body muscle mass percentage in the control group in comparison to the intervention group (-0.51;-0.43, respectively, p< 0.001). There was a significant difference in SNST (Simple Nutrition Screening Tool) scores in the intervention group in comparison to the control group (0.68 ; 0.63, respectively; p<0.001). Food acceptance, nutritional intake, and nutritional status of malnourished-at-risk patients was high with the provision of *Pronisi*.

Keywords: Food acceptance, nutrient intake, nutritional status; hospitalized patients; snack between meals, peanuts, soybean and Moringa

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1. Introduction

Inadequate food intake among hospitalized patients is a common problem that can lead to malnutrition associated with increased risk of complications, longer hospital stay leading to increased cost, frequent readmission, and mortality [1,2]. More than half (51.8%) of patients experienced a lack of intake during the first three days of hospitalization [3], leading to higher risk of undernutrition in hospitals. Worldwide, malnutrition affects up to 40% hospitalized patients [4], with the prevalence is higher in developing countries (47-50%) compared to developed countries (20-46%) [5]. In Vietnam and Indonesia, the prevalence of malnutrition in hospitals are 55.7% and 44-51.5%, respectively. Whereas in Singapore, the prevalence of malnutrition in hospitals is 29% [6].

Assessment of the initial nutritional status of patients admitted to hospital is very important because it can describe the nutritional status of patients at that time,

detect patients who are at risk of malnutrition and identify specific nutrients according to the needs of patients, so that nutrition intervention can be immediately given [7]. Simple Nutrition Screening Tool (SNST) is an easy, fast and valid screening tool to detect patients at risk of malnutrition in Indonesian hospitals [6].

Patients at risk of malnutrition need in-between meals, including high energy and high protein rich snacks, to meet the nutritional needs of patients [8]. However it has been shown, that snacks between meals are not eaten by patients and are not served adequately [8,9]. Patients' food acceptance influenced by appearance and palatability of foods that are strong determinants of nutritional intake, thus it is essential to provide optimized snacks between meals to reach their nutritional requirements [9].

Pronisi, a high energy and high protein cookie, was produced from peanuts *(Arachis hypogaea L.)* flour, pregerminated soybean *(Glycine max)* flour, and Moringa *(Moringa oleifera)* leaf flour. Moringa contains lot of minerals that are essential for growth and development, provides 7 times more vitamin C than oranges, 10 times

more vitamin A than carrots, 17 times more calcium than milk, 9 times more protein than yoghurt, 15 times more potassium than bananas and 25 times more iron than spinach [10]. *Pronisi* has a protein content of 20.77 g, 38.32 g fat, 35.31 g carbohydrate and energy value of 569.2 kcal per 100 g. *Pronisi* has been tested in vivo for 20 days in malnourished white mice *(Rattus norvegicus strain wistar)* and showed improved nutritional outcomes (11). The organoleptic results of *Pronisi* on 100 panelists showed that 93% panelists liked the aroma, taste, and texture of *Pronisi* [11]. Thus, we aimed to investigate the effect of consumption of *Pronisi,* produced from peanuts, pregerminated soybean, and Moringa leaf flour, on patients' food acceptance, food intake, and nutritional status.

2. Materials and Method

2.1. Study Design

An experimental research study was carried out through a quasi-experiment with pretest-posttest design and control group over a two month period. The control group were patients at risk of malnutrition who were given green bean porridge as the normal in-between meals provided by hospital while the intervention group had patients at risk of malnutrition who were given *Pronisi* (Figure 1). We used a quasi-experiment design because it was not logistically feasible and not ethical to conduct a randomized controlled trial since the allocation of control and intervention group was based on the patients' ward.

Group A	O1	X	O2

Group B	O1	O2
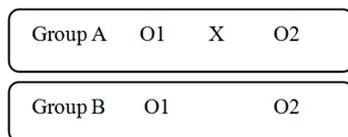
Figure 1. Pretest-posttest with control group design. Group A = intervention group; Group B = control group. O1 = Initial observation was assessment of nutritional status before the subjects were given in-between meals. O2= Subsequent observation was assessment of nutritional status and caloric and protein intake after the subjects were given *Pronisi* (Group A) or green bean porridge, as the normal in-between meals in hospital (Group B). X = *Pronisi*

2.2. Pronisi

Pronisi is produced using minimal technological equipments. Instead of milk, the major composition of *Pronisi* are beans (peanuts and pregerminated soybean). The other ingredients of *Pronisi* are refined sugar, soybean oil, coconut oil, red cultivar Moringa flour, and egg white.

Pronisi provides amino acids that are easily absorbed, so it can improve intestinal histology.The protein content of peanuts has a high biological value because it contains almost all essential amino acids, especially leucine and alanine. Peanuts are also a good source of fat and are important in providing the energy needed under malnourished conditions. Soybean is also commonly used to overcome malnutrition because it contains high protein at an

affordable price for most of the world's population. Each piece of *Pronisi* weighings 10 g containing 63.2 kcal energy and 2.3 g protein.

The production flow of *Pronisi* consisted of several steps as follows [11]: a)The production of peanuts flour (Figure 3); b)The production of pregerminated soybean flour (Figure 4); c)The production of Moringa leaf flour (Figure 5); d)The production of *Pronisi* (Figure 6).

2.3. The Subjects

The subjects were all patients admitted to hospital who were selected by purposive sampling. Inclusion criteria of participants were: 1) adult patients aged 18-59 years old; 2) compos mentis; 3) risk of malnutrition based on SNST; 4) oral diet; and 5). minimum three days of hospital stay with nine mealtimes. The exlusion criteria of subjects were: 1). diagnosed as having diabetes, high ureum and creatinin; 2). nut allergy: and 3). refusal to participate in the study. Written informed consent was obtained from all eligible subjects. Ethical approval was granted by the Medical and Research Ethics Committee of Universitas Gadjah Mada, Yogyakarta, Indonesia, No. KE/FK/ 0422/ EC/2019.

The calculation from comparing two groups indicated that a minimum sample size of 44 patients for two groups was required in order to detect a mean difference in dietary energy intake between two groups of 382 kcal (given the within group standard deviation [SD] 159 kcal). This sample size will also allow the detection of 8 g difference in dietary protein intake (given the within group SD 2 g) with 80% power and type I error probability of ≤0.05 and a mean difference in nutritional status of 4.8 (given the within group SD 3.4 g) [9].

2.4. Description of Intervention

The following provision of in-between meals were applied: 1). Standard portion of green bean porridge containing 125 kcal and 4.6 g protein were given two times a day contributing 250 kcal energy and 9.2 g protein; 2). Each piece of *Pronisi* weighings 10 g containing 63.2 kcal energy and 2.3 g protein were given two times a day contributing 253 kcal energy and 9.2 g protein (2 pieces of *Pronisi* were served to the patients once in-between meals). Picture of *Pronisi* and green bean porridge showed in Figure 2.

a   b

Figure 2. In-between meals for intervention and control group (a) *Pronisi*, cookies produced from peanuts, soybean, and Moringa leaf flour, b) Green bean porridge, usual in-between meals provided by hospital kitchen)

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┌─────────────────────────────┐
│       Peeled Peanuts        │
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               ↓
┌─────────────────────────────┐
│          Sorting            │
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│  Baking (150⁰C,15 minutes)  │
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               ↓
┌─────────────────────────────┐
│ Peeling epidermis skin of peanuts │
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│       Milling/Grinding      │
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│        Peanuts flour        │
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┌───────────────────────────────────────────────┐
│ Packing in polyethylene bags and tightly closed containers and stored │
│   at room temperature (27 ± 2⁰C) until ready for use   │
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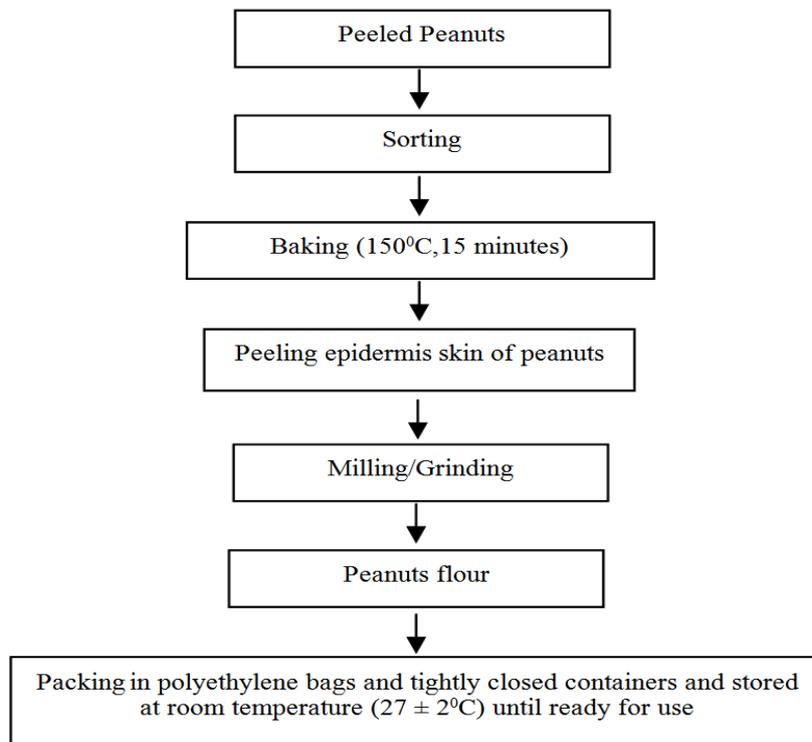
Figure 3. The production of peanuts flour

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┌─────────────────────────────┐
│      Sortated soybeans      │
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┌─────────────────────────────┐
│     Soaking for 12 hours    │
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│    Boiling for 10 minutes   │
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│  Peeling epidermis skin of  │
│          soybeans           │
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│   Baking (65⁰C, humidity    │
│            10%)             │
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│       Milling/Grinding      │
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│     Pregerminated soybean   │
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               ↓
┌───────────────────────────────────────────────┐
│ Packed in polyethylene bags and tightly closed containers and │
│   stored at room temperature (27 ± 2⁰C) until ready for use   │
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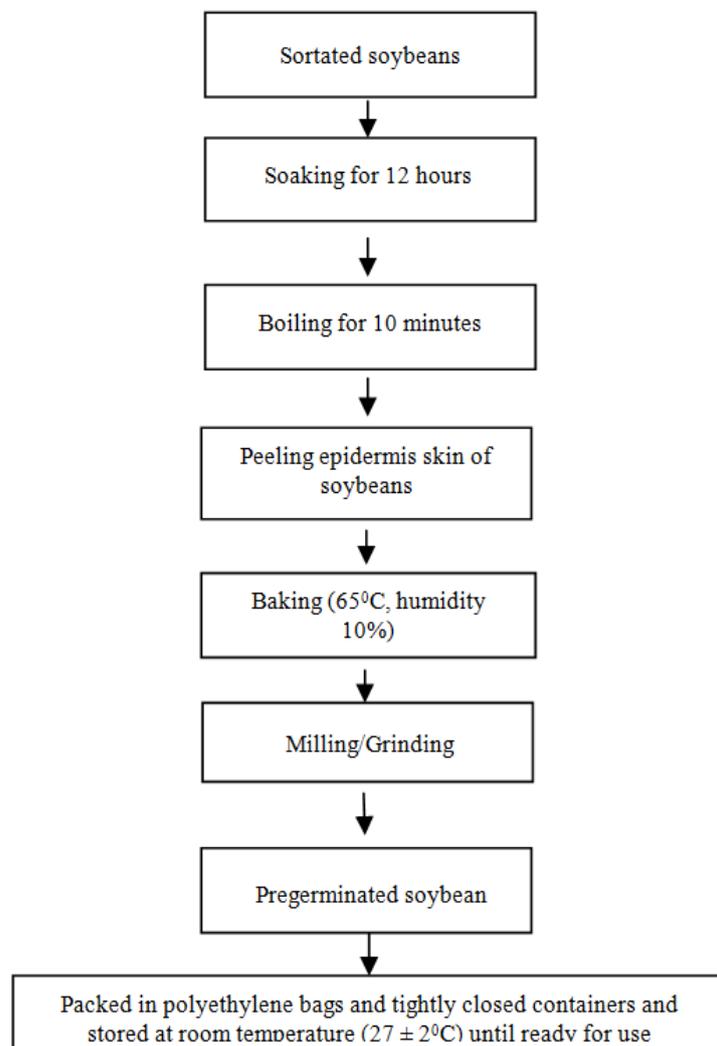
Figure 4. The production of pregerminated soybean flour

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┌─────────────────────────────┐
│   Moringa oleifera leaves   │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│          Sorting            │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│         Cleaning            │
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│ Steam blanching (97±1⁰C, 10 minutes)   │
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│  Soaking in ice water for 1 minutes    │
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│          Draining           │
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│    Drying (40⁰C, 4 hours)   │
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┌─────────────────────────────┐
│       Milling/Grinding      │
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│      Moringa leaf flour     │
└─────────────────────────────┘
              │
              ▼
┌──────────────────────────────────────────────────────────┐
│ Packed in polyethylene bags and tightly closed containers │
│  and stored at room temperature (27 ± 2⁰C) until ready    │
│                      for use                              │
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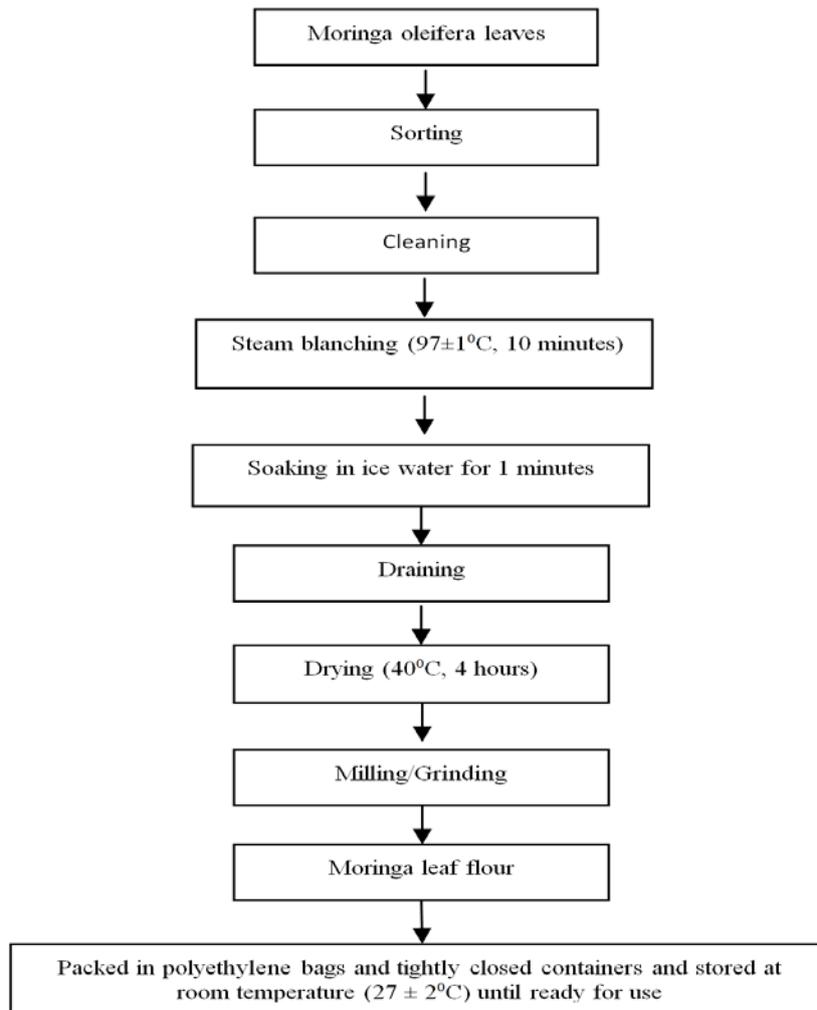
Figure 5. The production of Moringa leaf flour

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┌──────────────────────────┐
│      Peanuts flour       │─────────────┐
└──────────────────────────┘             │
┌──────────────────────────┐             │
│ Pregerminated soybean    │─────────────┤
│         flour            │             │   ┌──────────┐
└──────────────────────────┘             ├──▶│          │
┌──────────────────────────┐             │   │  Mixing  │
│     Refined sugar        │─────────────┤   │   well   │
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│    Moringa leaf flour    │─────────────┤        │
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┌──────────────────────────┐             │        │
│       Egg whites         │─────────────┤        │
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│   Coconut oil and        │─────────────┘        │
│     soybean oil          │                      │
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┌──────────────────────────┐                      │
│ Shaping (10 g for each   │◀─────────────────────┘
│        cookie)           │
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│ Baking (160⁰C for 15     │
│      minutes)            │
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│        *Pronisi*         │
└──────────────────────────┘
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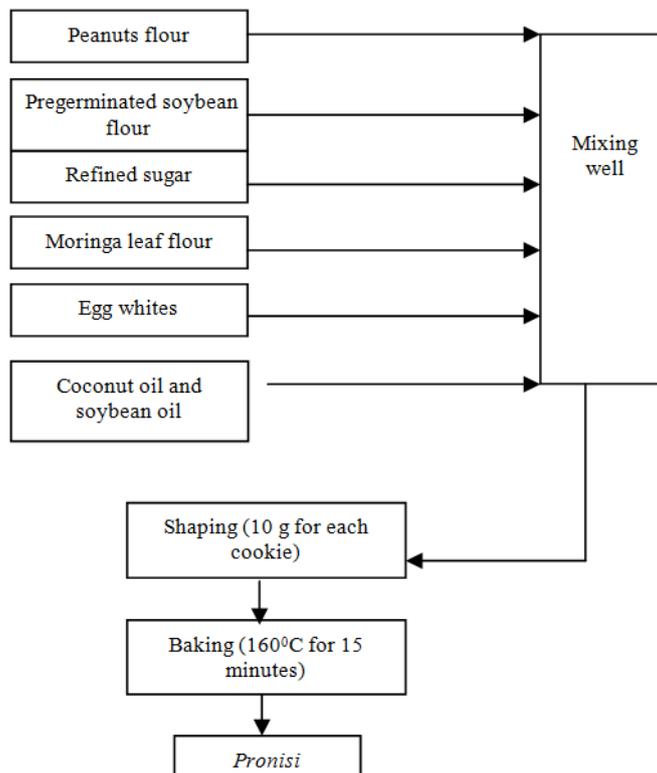
Figure 6. The production of *Pronisi*

2.5. Data Collection

Demographic data from subjects, including gender, age, and education level, as well as kind of disease (infection or non-infection) were collected. Food acceptance is the average of consumption rate of patients which was measured through the differences in uneaten meals after meal time, measured using an electronic kitchen scale (accuracy to $\pm$ 1 g) with automatic calibration. It was calculated using the following formula:

$$\text{Food acceptance} = \frac{\left(\text{Serving weight} - \text{Leftover weight} \times 100\%\right)}{\text{Serving weight}} \quad (1)$$

Food acceptance is categorized into three groups of acceptability: good if consumption rate more than 80%, moderate if consumption rate ranged between 20%-80%, and bad if consumption rate less than 20%.

Energy and protein intake is determined from patients' consumption of three main meals and two in-between meals in one day. Food and drink provided by hospital kitchen was measured by a 6-scale visual Comstock estimation, and converted to gram. If the patients consumed food and drink obtained from outside the hospital kitchen, food recall method was applied to incorporate total energy and protein intake of patients.

Nutritional status was assessed based on both percentage differences of body muscle mass and SNST scores between the measurement at 24 hours patients were admitted to the hospital and after three days of patients stay in hospital. Body muscle mass percentage was measured using *Bioelectric Impedance Analysis* (BIA). The increasing in body muscle mass percentage was categorized as good, and decrease of body muscle mass percentage was categorized as bad nutritional status.

According to local standards, all patients were sreened for nutrition risk on the first 24 hours of admission. The Simple Nutrition Screening Tool (SNST) is a newly-developed nutritional screening tool in Indonesian hospitals that is simple, quick and valid to identify patients at risk of malnutrition in hospital settings. SNST scores ranged from 0 until 6, if scoreds 0-2 the patients are not at risk of malnutrition, and if scored more than 2 the patients are at risk of malnutrition [6]. The decreased scores of SNST on the third day of patients' hospital stay was categorized as good and the increase or unchanged scores of SNST was categorized as bad nutritional status. All data was collected with assistance from the dietitians in the hospital.

2.6. Data Analysis

Distribution of energy and protein intake data was described as mean $\pm$ standard deviation (SD). Chi-square test analysis was performed to compare the distribution of patients' characteristics and food acceptance between two groups. The independent T-test was used to determine the mean differences of energy and protein intake as well as nutritional status between the control and intervention groups. A statistical analysis was performed with a Windows statistical program package (version 20, SPSS Inc., IBM Corporation, Armonk, NY, USA).

3. Results

3.1. Characteristics of Subjects

Most of the subjects in this study were women in the intervention and control group (63.4% and 54.6%, respectively), above the age of 41 years (63.4% and 77.3%, respectively), junior and senior high school (54.8% and 59.1%, respectively), infection disease for intervention group and non-infection disease for control group (54.6% and 63.4%, respectively), and average SNST values was 5.13 $\pm$ 0.46 and 5.27 $\pm$ 0.45, respectively). There were no differences in characteristics between the two groups of patients (Table 1).

Table 1. Characteristics of Subjects

Variable	Intervention		Control		P
	(n)	(%)	(n)	(%)	
	n=22		n=22		
Gender					
Male	8	36.6	10	45.4	0.55
Female	14	63.4	12	54.6	
Age					
19-40	8	36.6	5	22.7	0.50
41-59	14	63.4	17	77.3	
Education Level					
Elementary	8	36.6	8	36.6	
Junior and senior high	12	54.8	13	59.1	0.62
Diploma/Bachelor	2	9.06	1	4.9	
Disease					
Infection	12	54.6	8	36.6	0.23
Non-Infection	10	45.4	14	63.4	
SNST Scores (Mean±SD)	5.13±0.46		5.27±0.45		

3.2. Patients' Food Acceptance

As shown in Table 2, the majority of patients' food acceptance when given *Pronisi* (intervention group) was categorized into the medium and good in the same proportion (n=11, 50%, respectively), while almost 90% (n=19) in the control group who were given green bean porridge categorized into the medium category. These differences was statistically significant (p = 0.008).

Table 2. Food Acceptance of In-Between Meals

Category of Food Acceptance	*Pronisi*		Green bean porridge		P*
	n=22	%	n=22	%	
Good (>80%)	11	50	3	13.6	
Medium (20%-80%)	11	50	19	86.4	< 0.001
Bad (<20%)	0	0	0	0	

3.3. Energy and Protein Intake

Energy and protein intake from snack between meals in the intervention group was higher (100.68±9.79 kcal; 35.41 $\pm$ 0.71 g, respectively) compared to the control group (3.75±0.21 kcal; 2.83±0.22 g, respectively). There were significant differences in energy and protein intake from snacks between two groups (p <0.001). As shown in Table 3, overall energy and protein intake from all main meals and *Pronisi* in the intervention group was also higher (1337.9 $\pm$ 32.81 kcal; 35.41±0.71 g, respectively) compared to the control group (1283.17±27.30 kcal; 30.82 ±1.53g, respectively). There were significant differences in overall energy and protein intake from the hospital between two groups (p <0.001).

Table 3. Average of Nutrient Intake between Two Groups

Variable	Intervention Mean ± SD	Control Mean ± SD	diff	p*
Energy Intake (kcal/day)				
Main meals	1301.15±33.16	1229,51±31.72	71.6	< 0.001
In-between meals	100.68±9.79	76±8.56	24.7	< 0.001
Outside of hospital food	36.06±4.10	77.65±9.43	41.6	< 0.001
Overall Energy	1337.9±32.81	1283.17±27.30	54.7	< 0.001
Protein Intake (g/day)				
Main meals	31.17±0.68	27.26±1.54	3.9	< 0.001
In-between meals	3.75±0.21	2.83±0,22	0.9	< 0.001
Outside of hospital food	0.48±0.14	0.73±0,13	0.2	< 0.001
Overall Protein	35.41±0.71	30.82±1,53	4.6	< 0.001

3.4. The Changes of Nutritional Status

As shown in Table 4, both groups experienced the decrease in muscle mass percentage in the day three of patients' hospital stay. However, there were significantly higher decrease in muscle mass percentage in the control group in comparison to the intervention group who were given *Pronisi* (-0.51 VS -0.43, respectively, p< 0.001).

Table 4. The Differences in Body Muscle Mass Percentage between Two Groups

Groups	Muscle Mass Percentage (Mean ± SD)		Diff	P*
	Pre*	**Post****		
Intervention (*Pronisi*)	24.5±4,37	24.1±4.41	-0.4	< 0.001
Control (Green bean porridge)	24.5±5,07	24.0±5.52	-0.5	< 0.001

*Pre = being assessed in the first 24 hours at the patients' admission of hospital; **Post = being assessed in the day three of the patients' hospital stay

Based on SNST scores, there was significant reduction in SNST scores in both groups after three days of hospital stay that showed good changes of nutritional status. However, higher differences in SNST scores in the intervention group than that in the control group (0.68 VS 0.63, respectively; p<0.001) showed that there was a greater reduction of malnourished-at-risk patients after three days of hospital stay for the group who were given *Pronisi* (Table 5).

Table 5. The Differences of SNST Scores Between Two Groups

Groups	SNST Scores (Mean ± SD)		diff	p*
	Pre*	**Post****		
Intervention (*Pronisi*)	5.1±0.46	4.5±0.50	0.7	< 0.001
Control (Green bean porridge)	5.3±0.45	4.6±0.49	0.6	< 0.001

*Pre = being assessed in the first 24 hours at the patients' admission of hospital; **Post = being assessed in the day three of the patients' hospital stay

4. Discussion

The main findings of the present study underline the necessity of using innovative in-between meals to improve energy and protein intake in malnourished-at-risk patients. Subsequently, the study demonstrates that *Pronisi* as a snack between meals could improve patient nutritional status, as indicated by significantly lower reduction in body muscle mass percentage and a significant reduction in SNST scores after three days of hospital stay. This was supported by our data that food acceptance of patients who were given *Pronisi* was better in comparison to another group who were given green bean porridge as the current standard snack between meals provided by hospital.

The lower acceptance of green bean porridge may be due to the coconut milk contained in this food, which has a tendency to trigger nausea and vomiting in patients, along with other fatty foods, sweet foods and drinks, strong odors, foods with wet textures, and fishy foods [12]. This finding may confirm our data that patients in the control group obtained more food from sources outside hospital. Nevertheless, overall energy and protein intake in the intervention group was significantly higher in comparison to control group, with differences of 54.7 kcal energy and 4.6 g protein.

In contrast, *Pronisi* was easier to consume since it is a coin- shaped energy and protein-dense small sized cookie. *Pronisi*'s taste and aroma, which are sweet-savory, similar to that of traditional community peanut cookies, proved to be more acceptable to panelists based on previous organoleptic test results [11]. Pronisi crumbs (fragile) but can still be chewed, and do not break when they enter the mouth. This organoleptic test results showed that panelists liked the aroma, taste, and texture of *Pronisi*.

Pronisi is a potential snack between meals for hospital inpatients with good acceptance because it has the following characteristics: 1) the taste is good, the texture is soft and the flavor are not strong, which can stimulate nausea; 2) the size is small, yet the snack is nutrient-dense, so that it can meet the nutritional needs of patients; and 3) it can be eaten at any time in small portions but also consumed often. This results were in line with a study that gave a NutriMat bar to chemotherapy patients in Sanglah Hospital, Denpasar, Bali, Indonesia, who found lower food waste (28.9% ±8.5) in the intervention group than in the control group, which was given standard hospital food (46% ± 4.7) [13].

The nutritional composition of *Pronisi* has many more distinctions. The protein content of *Pronisi* comes from skinless peanuts, pregerminated soybean flour, Moringa leaf flour, and egg white. The protein contribution from peanuts has a high biological value because it contains almost all essential amino acids, especially leucine and alanine [14]. Peanuts are also a good source of fat and are important in providing the energy needed under conditions of malnutrition. Soybean is also commonly used in food formulations to overcome malnutrition because it contains high protein at an affordable price [15]. Both of these materials make a large contribution to the nutritional value of *Pronisi* because they account for 65% of the weight of the constituent material of this food.

Pronisi also has high digestibility based on the protein quality nitrogen balance method, i.e. a digestibility (DC) of 97.07%, biological value (NB) of 88% and net protein utilization (NPU) value of 85.54% [11]. This is because the peanuts have undergone the processes of seeds sorting, heating, and exfoliation of the seed coat, thereby reducing the content of anticoagulants. Sorting is performed at the beginning of the selection of ingredients because in local beans, the anti-nutrient tannin compounds are concentrated in the seed coats, especially those with dark colors [16].

The pregerminated soybean flour used in the formulation also decreases anti-nutrient contents and increases bioavailability of nutrients. The germination process causes the hydrolyzed nutritional components to become simpler compounds so that they are easily digested and reduces phytic acid which is an anti-nutrient compound in legumes. Seed germination also increases the vitamin contents, especially vitamin E and a-tocopherol which function as antioxidants [17]. The handling of soybeans occurs in pregermination process wherein the soybeans have high protein and amino acid contents because the pregermination process can improve their nutritional quality without sprouting, which can reduce sensory acceptance. In addition, as much as 5% of the total weight of the material is used.

Moringa oleifera is an exteremely common and well-known species. *Moringa oleifera* is known by various names in different locations all over the world. The leaves, foliage, seeds and every part of the Moringa plant are nutrient dense and of food value to both animals and humans [18]. We used a red-leaved Moringa cultivar which contains much higher magnesium, vitamin C and phenol than other cultivars. The magnesium content is important for nutrient absorption process so this element is very beneficial in malnutrition conditions characterized by impaired absorption of nutrients due to changes in the structure of the digestive tract, especially the small intestine [19]. Higher vitamin C and phenol contents are also very beneficial because these compounds can be powerful antioxidant agents. High levels of antioxidants from food are very important in managing malnutrition. Antioxidants are scavengers of free radicals (reactive oxygen species (ROS), which are produced in excess under malnutrition due to metabolic stress [20].

Antioxidant activity increases whith the increased content of vitamin E in pregerminated soybean flour. The egg whites used in *Pronisi*, in addition to being a binding material, also contribute animal proteins with high biological value. Egg white contains 10.8% protein and 73% albumin (of total protein) [21]. This high protein content profile supports the improvement of malnutrition conditions.

The results showed that both the control and intervention groups experienced a decrease in body muscle mass percentage. The decreased body muscle mass was inevitable because malnourished-at-risk patients tend to show reduced physical activity and food intake that does not meet their nutritional requirements [22]. Depletion of skeletal muscle mass is the most important change in malnourished patients [23]. Nevertheless, there was a significantly higher decrease in muscle mass percentage in the control group than in the intervention group who were given *Pronisi*.

This was in accordance with significantly higher differences in SNST scores in the intervention group than in the control group, even though both groups experienced a decrease in SNST scores after three days of hospital stay. This finding indicated that *Pronisi* has the potential to reduce the number of malnourished-at-risk patients. The serving of well-accepted snacks between meals seems to have an important role in clinical outcomes, as highlighted by previous studies [8,9]. Nevertheless, a greater reduce in SNST scores may be achieved if we could extend observation to the seventh or longer term. This was one of our study limitations because the average length of stay of patients in Indonesian hospitals is only three days, due to the health insurance provision.

Another limitation was that we could not include surgery patients because it was difficult to obtain surgery patients who accepted a normal diet orally; thus, the results may not be representative of the general population of hospitalized patients. Future research should continue the observation of nutritional outcomes until patient discharge from the hospital to measure the significant changes in patient nutritional status.

The potential strengths of our study is include the utilization of local resources to produce an optimized nutrient-dense snack between meals for hospitalized patients with good acceptability and thus sustainability. Furthermore, the feasibility of producing these cookies in other hospitals is high because the required equipment is available in hospital kitchens.

5. Conclusions

We concluded that food acceptance, nutritional intake and nutritional status of patients at risk of malnutrition who were given *Pronisi* was better than that of similar patients receiving green bean porridge, which is the usual snack between meal given in hospitals.

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