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The effectivity of functional drink Keloja in improving nutritional status and immunity of underweight elderly

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ABSTRACT

Backgrounds: One of the most common nutritional problems among the elderly population in Indonesia is malnutrition. Malnutrition in the elderly is caused by a decrease in masticatory function, appetite, and digestive system function due to aging. The result of research on the elderly in senior housing shows that 60 percent of the elderly experience malnutrition.

Aims: This study aimed to determine the effect of Keloja functional drinks that contained cowpeas, corn, and moringa leaves on the immunity, body weight, and nutritional status of the elderly who were underweight and lived in the South Jakarta Nursing Home.

Methods: This study used a quasi-experimental design with 25 samples who met the inclusion criteria. Immunity levels were known by collecting data on CD4, CD8, and the ratio of CD4 and CD8, while body weight and nutritional status data were collected through anthropometric measurements taken before and after the intervention.

Results: The results of the analysis showed that there were significant differences in terms of immunity levels, body weight, and nutritional status of the underweight elderly who consumed the Keloja drinks and control groups. However, there were no significant differences in all variables before and after interventions, both in the intervention and control groups.

Conclusions: It can be concluded that there was a significant effect of giving Keloja functional drinks on immunity levels, body weights, and nutritional status of the underweight elderly who live in the South Jakarta Nursing Home. For further product development, it is recommended to evaluate the composition of moringa leaves and other ingredients by considering the decline in the digestive tract function of the elderly.

KEYWORDS

Keloja, Functional drink, immunity, underweight, elderly.

INTRODUCTION

Old age is a phase when people have reached above 60 years old and experience anatomical, physiological, and biochemical changes in their bodies that affect their quality of life. Currently, Indonesia has begun to enter the aging period with an increase in the number of elderly from 18 million people (7.56%) in 2010, to 25.9 million (9.7%) in 2019. It is estimated that by 2035, the number of elderly people in Indonesia will reach 48.2 million (15.77%)[1]. The phenomenon can have positive impacts if it is balanced with good nutritional status so that the elderly can live independently, healthy, productively, and will not burden the community. However, if there are high percentages of underweight and malnourished elderly, they will only disturb the changes in physiological, cognitive, social, and cultural functions of the elderly population, thus increasing the dependence on the productive society, which is a sign of poor welfare of a nation[2].

Given the different needs of the elderly from those of the productive ones and also the hustle and bustle of the productive population, the government built nursing homes or senior housings as a place to improve the welfare of the elderly and prevent abandonment of the elderly through the fulfilment of their physical, psychological, and social needs

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that may be difficult to meet by their family members. However, several studies show that the highest percentage of malnutrition in elderly come from the nursing homes, compared to the elderly who live with their families[3,4]. A research by Piglowska showed that 60 percent of the elderly who lived in nursing homes were malnourished and only 5 – 10 percent of elderly who lived with their family members were malnourished[4].

The percentage of malnutrition among elderly in Indonesia reaches 31 percent and it will increase further if certain precautions are not taken[3]. Based on the result of previous research on the elderly that lived in the South Jakarta Nursing Home and South Jakarta area, it proved that 71.7 percent of the elderly who lived in the nursing home experienced malnutrition based on their BMI score. Meanwhile, according to their MNA's (Mini Nutritional Assessment) scores, around 56.7 of the elderly who lived in the nursing home had a high risk of malnutrition, 16.7 percent of them were malnourished, and only 26.7 percent of the elderly had good nutritional status[5]. Malnutrition occurs when the body does not get enough energy and other nutrients intake that are needed to carry out physiological and cognitive functions. It is proven by the result of the previous research on elderly people who live in the nursing home that 55.9 percent of them were at risk of malnutrition and 75 percent of the elderly who were not at risk of malnutrition had insufficient energy intake, around 60 percent of the malnourished elderly and 62.5 percent of the elderly who were not at risk of malnutrition had insufficient protein intake, about 61.8 percent of the elderly who were at risk of malnutrition had insufficient fat intake, and also 60 percent of the elderly who were at risk and 76.5 percent who were not had insufficient carbohydrate intake[5]. Undernutrition and malnutrition in the elderly can be caused by various factors, including changes in eating habits, reduced appetites, decreased masticatory functions due to the teeth loss, decreased sensitivities to smells and tastes, digestive disorders, and also degenerative diseases such as Alzheimer's and Parkinson's diseases. Reduced appetites combined with consuming foods that have poor nutritional qualities will lead to an imbalance in energy and nutrients intakes, decreased muscle mass and body weight, and exacerbate the decline in the immune response and functions due to aging. In addition, malnutrition in the elderly is also associated with increased risk of mortality regarding acute and chronic diseases, decreased physical abilities that affect daily activities and quality of life, and also contributes to the development of geriatric syndromes among the elderly population[6].

Therefore, strategies are needed to prevent an increase in the prevalence of malnutrition amongst the elderly, especially for the older people who live in social institutions, in order to ensure that the aging period in Indonesia can be utilized properly and not increase the burden of the productive population. One of the ways is by increasing the energy and nutrients intakes of the elderly. Supplementation is an effective way to increase the energy and nutrients intakes of the elderly. To optimize the food intake of the elderly, increasing the frequencies of meal time is done by giving drinks with certain energy and nutrients content between their main meals. In a study by Ngadiarti, it was reported that supplementary food in liquid form had the same effectiveness as mashed food in terms of improving nutritional status[7].

The supplementary foods provided should be high in energy, protein, vitamin, and minerals, and also have other additional benefits such as increasing immunity to protect the consumers from infections. Research by Ismayanti and Hariyono tried to formulate bean sprout flour, cowpea, and corn flour that were proven to be accepted by the community[8]. Ngadiarti did the same by formulating a beverage made from cowpeas, corns, and moringa leaves that were proven to improve nutritional status[9].

Cowpeas (*Vigna unguiculate*) is one of the legume species with the appearance that resembles soybeans and is cream, red, or brown in color. It is a good source of proteins with up to 23.4 percent of protein and low in fatty acid (1.3%)[10]. Protein in cowpeas consists of at least 17 types of amino acid, most of which are essentials or can not be produced in your body. The largest amino acid is lysine at 7.3 – 8.74 grams per 100 grams of protein and leucine at 6.45 – 8.5 grams per 100 grams of protein. Epidemiological evidences show that consumption of cowpeas can provide protective effects for several chronic diseases such as gastrointestinal disorders, cardiovascular diseases, hypercholesterolemia, obesity, diabetes mellitus, and several types of cancer because they contain several types of antioxidants such as polyphenols and anthocyanins, vitamin B complex, resistant starch, amylose, and dietary fibers. On the other hand, cowpeas contain several antinutritional substances and are low in methionine that can be overcome with the right cooking methods[11].

In certain areas such as Madura and East Nusa Tenggara (NTT), maize is the staple food and it replaces rice, also it is the second staple food after rice in other areas of Indonesia[12]. Besides being easy to grow anywhere, maize also has many benefits, especially in reducing the risk of chronic diseases. This is because maize contains various vitamins (A, B, E, and K), minerals (magnesium, potassium, and phosphorus), high in fiber, phenolic acids and polyphenols, sterols, carotenoids, and other phytochemicals that act as antioxidants for the body[13].

Moringa leaves (*Moringa oleifera*) are one of the typical Indonesian plants that are very beneficial, but rarely used for functional health product. Moringa leaves contain various nutrients, one of which is protein that reaches 6.7 grams per 100 grams of fresh leaves and 23.78 grams per 100 grams of dried leaves. Furthermore, the amount of crude protein and amino acid in moringa leaves are comparable to soybeans. In addition to protein, moringa leaves also contain vitamins (A,C,

and vitamin B complex) as antioxidants, calcium that prevents osteoporosis, potassium to increase appetite, iron, phosphorus, and other bioactive compounds[14].

This study aims to determine the effect of consuming Keloja functional drinks on the nutritional status and immune conditions of the elderly with malnutrition. The result of this study is expected to optimize the utilization of local foods, namely cowpeas, corn, and moringa leaves, which are affordable and easy to find, to produce formulas and other products that can prevent malnutrition in the elderly, reducing the prevalence of malnutrition in Indonesia, and improving the elderly's immune systems to protect them from SARS-CoV-2 infection.

METHODS

This study used a quasi-experimental design characterized by the presence of a control group and an intervention group with randomization. Samples who fell into the control group got regular packaged drinks, while the intervention group got the cowpeas, moringa, and corn-based formula drinks as much as 2 packs every day. The research was conducted from February to November 2021 with the survey on the elderly conducted at a nursing home in South Jakarta, while the development of Keloja at the Food Technology and Taste Test Laboratory of the Nutrition Department of the Health Polytechnic Ministry of Health Jakarta II, the Bogor Agro Industry Center Laboratory, and the IPB SEAFAST Laboratory in Bogor. The research sample was 25 elderly people with undernourished status assessed from their BMI scores and screening by Mini Nutrition Assessment (MNA) and also had met the inclusion criteria. The samples was determined using purposive sampling technique from the entire population of the elderly in the South Jakarta Nursing Home. The inclusion criteria in this study were that the elderly must be between 56 – 70 years old, had poor nutritional status (underweight and severely underweight) based on BMI assessment and MNA screening, and were willing to sign the informed consent form. Exclusion criteria in this study were elderly people who suffered from complication of infectious diseases and were allergic to nuts.

The independent variables of this study were the treatments given during the study period, namely the Keloja formula consisting of cowpeas, moringa leaves, and corn. While the dependent variables in this study were body weight, nutritional status, and immunity levels based on the numbers and percentages of CD4 and CD8. The characteristics of the samples included gender, namely male and female, and the age of the sample which were divided into the early elderly group (56 – 60 years), late elderly (55 – 65 years), and seniors (66 – 70 years). The selected samples were first asked to sign an informed consent form to express their willingness to participate in the study and had any data related to them to be collected. The baseline data collected included anthropometric data, nutritional status, and physical activity levels of the samples. Anthropometric data were collected by measuring body weight, height, upper arm circumference, and calf circumference, while the nutritional status was a quantitative data obtained from BMI results and validated using the results of MNA screening that were categorized into normal (12 – 14 points), at risk of malnutrition (8 – 11 points), and malnutrition (0 – 7 points). Physical activity level was measured through interviews using the Physical Activity Scale for the Elderly (PASE) form. All anthropometric measurements and interviews were conducted by trained enumerators using PPE and health protocols. The data were collected twice, before treatment and 6 weeks after the treatments, namely 2 packets of commercial or functional drinks per day for both control and intervention groups.

Functional drink efficacy data was quantitative data obtained by comparing data before and after the samples consumed functional drinks as much as 2 packets per day for 45 days. Efficacy data related to energy and nutrients intake, body weight, and nutritional status were obtained through measurements and interviews as previously described. Immune function was assessed based on the numbers and percentages of CD4 and CD8 T-cells, which was done by drawing blood by experts and then processed using the flow cytometry method by Prodia Clinical Laboratory.

The data of this study were analysed using SPSS. Normality test was conducted using the Saphiro wilk formula for each dependent variable. In addition, homogeneity test was conducted on CD4 and CD8 data, body weight, and nutritional status data. The normality test was conducted to determine whether all variables were normally distributed, while the homogeneity test was conducted to determine the difference in variance between the control and interventions groups before and after the treatments. The results of univariate analysis were in the form of percentages of each category of samples' characteristics, namely gender and age. Bivariate analysis was carried out using the paired sample t-test to see the average difference between the two groups, the interventions and control groups, while independent sample t-test was carried out to show the difference between variable with the provisions if the sig. value (2-tailed)<0.05 then there was a significant difference between the variables tested. This study had received ethical approval by the Jakarta II Health Research Ethics Commission with the letter number of LB.02.01/I/KE/31/224/2021.

RESULTS

Based on Table 1 regarding the characteristics of samples, it can be seen that the samples were divided into the intervention group consisted of 13 people and the control group consisted of 12 people. The results of univariate analysis showed that 17 samples (68%) were male and only 8 samples (32%) were female. The male elderly samples were divided into 9 people in the intervention group and 8 people

Table 1. Sample Characteristics

Characteristics	Intervention Group (n=13)		Control Group (n=12)		Total	
	n	%	n	%	n	%
Gender						
a. Male	9	69.2	8	66.7	17	68
b. Female	4	30.8	4	33.3	8	32
Age						
a. Early Elderly: 56 – 60 years	2	15.4	0	0	2	8
b. Late Elderly: 55 – 65 years	2	15.4	3	25	5	20
c. Seniors: 66 – 70 years	9	69.2	9	75	18	72

in the control group, while the female elderly were evenly divided into 4 people per group. Out of the 25 samples, most of them or 18 samples (72%) were in the seniors group with an age range of 66 – 70 years old, followed by the late elderly group (55 – 65 years old) with 5 people (20%), and the early elderly group (56 – 60 years old) with only 2 people.

The results of the normality test for each variables, both in the intervention and control groups, showed values of more than 0.05 (p>0.05). This indicates that all variables are normally distributed. The results of the homogeneity analysis show that p values of the CD8 variables before treatments and percentage of CD8 and CD4:CD8 ratio before and after treatments are less than 0.05 (p<0.05) which means that there are differences in variance between the control and intervention groups before and after treatments. The varibales of CD4, percentage of CD4, body weight, and nutritional status before and after treatments as well as the CD8 after treatments showed p values of more than 0.05 (p>0.05), indicating that there were no differences in variance between the intervention group and the control group before and after treatments.

The results of bivariate analysis between variables are shown in Table 2, 3, 4, and 5. Based on the results of the analysis in Table 2 regarding the results of the immunity levels and body weight before and after treatments using the dependent t-test, it is known that there are significant differences in the variables of CD4, % CD4, CD8, % CD8, ratio of CD4 to CD8, and body weight in the intervention group before and after the treatment (p<0.05). The significant differences are indicated by the differences in the average data of each variables before and after the treatment, from 838.83 cells/UL to 770.17 cells/UL for CD4, 33.26% to 33.1% for the percentage of CD4, 543.83 cells/UL to 463.83 cells/UL for CD8, 22.31% to 22.19% for the percentage of CD8, 1.80 to 1.78 for the ratio of CD4 to CD8, and 44.18 kg to 44.78 kg for body weight. Those results indicate that there is an effect of Keloja functional drink consumption on immunity components and body weight of the underweight elderly. However, there were no significant differences in the data of CD4, % CD4, CD8, % CD8, and ration of CD4 to CD8 variables in the control group before and after the treatment (p>0.05). In addition, the only significant change in the control group was shown in the body weight variable with a p value of less than 0.05 (p=0.000) which was characterized by a significant reduction of the average body weight from 44.01 kg before the treatment to 43.52 kg after the treatments. These results indicate that without intervention in the form of functional drink supplementation with nutritious ingredients, the immune function of the elderly cannot change and the weight of the elderly will decrease overtime.

Table 3 shows the differences in nutritional status before and after treatments using the paired sample t-test. Based on these results, it is known that there is a significant difference in the nutritional status of samples in the intervention group before and after the treatment with a p values of 0.020 (p<0.05). The average BMI of samples in the intervention group after consuming the Keloja drinks reached 18.13 kg/ from 17.87 kg/ before the treatment. However, there was no significant difference in the nutritional status of samples in the control group before and after treatment (p>0.05). These results indicate that consumption of Keloja functional drinks can have a significant effect on the nutritional status of the elderly who are underweight.

Table 4 shows the results of the independent sample t-test on variables before and after treatments, both for the intervention and control groups. It is shown that there are no significant differences in the average CD4, percentage of CD4,

Table 2. Differences in Immunity Components and Body Weight Before and After Treatments

Variables	Groups	Before Treatments		After Treatments		Average Differences	p-value
		Min-Max	Mean ± SD	Min-Max	Mean ± SD		
CD4	Intervention	443 – 1169	838.83 ± 279.52	314 – 1144	770.17 ± 287.07	68.66	0.020
	Control	433 – 860	637.33 ± 156.48	399 – 771	540.17 ± 127.09	97.16	0.083
% CD4	Intervention	27 – 39,50	33.26 ± 5.47	25.10 – 40.7	33.1 ± 6.19	0.16	0.016
	Control	29.6 – 43.2	35.78 ± 4.77	32.9 – 44.4	36.33 ± 4.28	0.55	0.072
CD8	Intervention	223 – 901	543.83 ± 279.77	246 – 759	463.83 ± 204.94	80	0.012
	Control	297 – 605	441.83 ± 121.45	215 – 499	370.5 ± 100.9	71.33	0.114
% CD8	Intervention	13.15 – 29.95	22.31 ± 6.54	14.82 – 28.15	22.19 ± 5.69	0.12	0.000
	Control	19.76 – 25.39	22.72 ± 1.90	18.48 – 24.05	22.15 ± 2.01	0.67	0.123
CD4: CD8	Intervention	1.14 – 3.28	1.80 ± 0.87	1.17 – 3	1.78 ± 0.17	0.02	0.000
	Control	1.17 – 1.86	1.48 ± 0.22	1.17 – 1.86	1.50 ± 0.29	0.02	0.134
Body Weight	Intervention	32.4 – 61.30	44.01 ± 8.45	32.8 – 53.80	43.53 ± 7.17	0.48	0.000
	Control	32.4 – 53.35	44.18 ± 6.92	32.4 – 56.7	44.78 ± 7.34	0.6	0.000

Analyzed using dependent t-test.
The difference is said to be significant if the p-value < 0,05.

Table 3. Differences in Nutritional Status Before and After Treatments

Variable	Groups	Before Treatments		After Treatments		p-value
		Min-Max	Mean ± SD	Min-Max	Mean ± SD	
Nutritional Status	Intervention	15.16 – 19.92	17.87 ± 1.53	15.16 – 21.47	18.13 ± 1.96	0.020
	Control	14.16 – 23.21	17.81 ± 2.38	13.85 – 20.08	17.66 ± 2.04	0.701

Analyzed using dependent t-test.
The difference is said to be significant if the p-value < 0,05.

and body weight before and after treatments in both groups, which is characterized by *p* values greater than 0.05. Similar results are shown in Table 5 regarding the results of the independent sample t-test on data regarding nutritional status of the elderly before and after treatments in both groups. There were no significant differences in the average nutritional status, in the form of BMI scores, before and after treatments between the intervention and control groups as indicated by *p* values of more than 0.05.

DISCUSSIONS

Based on Table 2, it is known that the consumption of Keloja functional drink made of cowpeas, corn, and moringa leaves has significant effects on the components of immunity (CD4, CD8, %CD4, % CD8, and CD4:CD8) and body weights of the underweight elderly. Keloja drink contains cowpeas, corn, and moringa leaves which have various nutrients that are beneficial to the body. The ingredients contain various phytochemicals such as polyphenols, flavonoids, tannins, phytic acid, and anthocyanins as antioxidants to overcome reactive oxygen species (ROS) that can be generated from external pollutions or as a by-product of metabolic processes, thus reducing inflammation and improving immune systems. In addition, cowpeas contain lectin and also trypsin and chymotrypsin inhibitors, which are known to have anti-tumor, anti-inflammatory, and immune-strengthening properties[15].

Table 4. Mean Differences of Immunity Components and Body Weight between Intervention and Control Groups

Variables	Groups	Min-Max	Mean ± SD	p-value
CD4 Before	Intervention	443 – 1169	838.83 ± 279.52	0.190
	Control	433 – 860	637.33 ± 279.52	
CD4 After	Intervention	314 – 1144	770.17 ± 287.07	0.129
	Control	399 – 771	540.17 ± 127.09	
% CD4 Before	Intervention	27 – 39.50	33.26 ± 5.47	0.639
	Control	29.6 – 43.2	35.78 ± 4.77	
% CD4 After	Intervention	25.10 – 40.70	33.1 ± 6.19	0.274
	Control	32.9 – 44.4	36.33 ± 4.28	
Body Weight Before	Intervention	32.4 – 53.35	44.18 ± 6.92	0.600
	Control	32.4 – 61.30	44.01 ± 8.45	
Body Weight After	Intervention	32.4 – 56.7	44.78 ± 7.34	0.940
	Control	32.4 – 53.80	43.53 ± 7.17	

Analyzed using the independent t-test.
The difference is said to be significant if the p-value < 0,05.

Table 5. Mean Differences in Nutritional Status between Intervention and Control Groups

Variables	Groups	Min-Max	Mean ± SD	p-value
Nutritional Status Before	Intervention	15.16 – 19.92	17.87 ± 1.53	0.943
	Control	14.16 – 23.21	17.81 ± 2.38	
Nutritional Status After	Intervention	15.16 – 21.47	18.13 ± 1.96	0.565
	Control	13.85 – 20.08	17.66 ± 2.04	

Analyzed using the independent t-test.
The difference is said to be significant if the p-value < 0.05.

They also contain dietary fibers, including resistant starch that acts as prebiotic to promote the growth of beneficial microorganisms in order to maintain a healthy digestive system. A healthier digestive system will increase the body' ability to absorb nutrients from food, which can help to improve weight and nutritional status. Corn as one of Keloja's ingredients contains vitamin C, vitamin E, carotenoids, and xantophyl as antioxidants to protect cells from free radicals and improve immune function by increasing communication between immune-related cells[13]. It is also high in carbohydrates and fibers that improve digestive function and nutrients absorption, thus helping to increase body weight. Moringa leaves contain phytochemicals such as niaziminin and apigenin which act as immunomodulators and antioxidants that can protect cells from ROS and pollutions[16]. In addition, moringa leaves also contain various minerals that play a role in growth and development, such as calcium which can prevent osteoporosis, iron which plays a role in overcoming anemia, and zinc which plays a role in DNA and RNA synthesis[17].

The result of the intervention by consuming Keloja drink in improving the function of immune systems is in line with another study on HIV patients where supplementation in the form of moringa leaves powder is proven to improve patients' immune function based on the increasing number of CD4[18]. In other studies on the elderly, it has been shown that drinks with probiotic and probiotic supplementation can improve cel-

lular immune function and resistance to respiratory infection[19,20]. Keloja functional drink in this study was shown to have an immune-boosting effect without side effects, such as bloating or diarrhea, that can be experienced by the elderly with sensitive digestive systems from consuming probiotics. The result of the intervention in the form of increased body weight after consuming Keloja functional drinks is in line with the result of research on toddlers who consumed moringa leaves extract for 30 days was shown an increase in their body weight for 0.420 kg[21]. These results prove that the effect of increasing body weight after consuming products with moringa is not a one time-phenomenon, but also applies to the older age group, which is the elderly. The treatments, both the commercial packaged drink and Keloja functional drink, caused equally significant results in increasing body weight. This similarity can be caused by the additional amount of energy consumed, both from the commercial drink in the control group and Keloja functional drink in the intervention group. This additional energy intake can contribute to the weight gain in elderly samples.

Based on Table 3, it is known that consuming Keloja drinks can have a significant effect on the nutritional status of the elderly with average BMI scores that increased. The result is in line with another research that used moringa leaf powder on toddlers with z-score <-2SD. That study concluded that there was a significant effect of consuming 10 grams of moringa leaf powder daily on the index of BMI according to age of toddlers[22]. In adult population, the similar result was shown with moringa powder supplementation on HIV patients who took antiretroviral drugs for 6 months, which caused an increase in the mean BMI score[23]. Those results can prove that products containing moringa can affect the nutritional status of various age groups, ranging from toddlers, adults, to the elderly. Cowpeas are known to be rich in protein that makes up almost 16 – 31% of it, fats with polyunsaturated fatty acids as the largest constituent, carbohydrates, and fiber[24]. They are also high in lysine and although the methionine level is quite low, it is still higher when compared to cereals. These nutrients are useful to fulfil the nutritional needs of the elderly that have not been met previously due to lack of intake because of decreased appetite or masticatory ability. In addition to macronutrients from cowpeas, corn contains various phytochemicals and antioxidants such as beta carotene and xanthophyll that play a role in protecting cells from free radicals and reducing inflammation due to ROS. With reduced inflammation, the nutrients can be better absorbed and utilized for physiological functions, including cells development that contribute to weight gain and nutritional status. Moringa leaves are known to contain various essential amino acids that can improve the growth and quality of muscles and other tissues that will contribute to weight gain and improve nutritional status[25]. It can be concluded that the three main ingredients of Keloja functional drink have various benefits regarding improving nutritional status.

Based on Table 4 and 5, it is known that there are no significant differences in various variables, including CD4, % CD4, body weight, and nutritional status in the form of BMI scores, between the control and intervention groups. It can be caused by various factors, mainly the condition of the ability of organs and digestive systems of the elderly who have been reduced due to aging. In the digestive organs that produce certain enzymes, such as pancreas, there is a decrease in the volume and concentration of enzymes including lipase, chymotrypsin, and amylase. Aging is also related to a decrease in insulin effectivity which causes higher fasting and postprandial glucose levels. Decreased enzymes secretion can affect the process of food digestion so that the nutrients contained in food cannot be absorbed optimally. The amino acid availability is known to be affected by increased amino acid utilization in the gastrointestinal tract and liver in the elderly population. Regarding the absorption of vitamins and minerals, it is known that there is malabsorption of vitamin B12 and calcium that often happens in the elderly due to their age. Malabsorption of vitamin B12 may stems from reduced secretion of pepsin and gastric acid, while reduce absorption of calcium may be caused by reduced gastrointestinal response to $1,25(OH)_2D_3$ which contributes to negative calcium balance and bone fragility. In terms of hormones secretion, there is an altered postprandial response to CCK which promotes secretion of digestive enzymes from the pancreas as well as gallbladder contraction and ghrelin which increases food intake, fat storage, and growth hormone secretion[26]. Reduced appetite is caused by decreased in the ability of masticatory-related muscles and saliva secretion that lead to reduced food intake which will result in a decrease in the amount of energy and nutrients absorbed by the body. In the elderly population, it is also known that there is also decrease in the diversity and stability of the microbiota in gastrointestinal tract which can lead to reduced production of short-chain fatty acids (SCFA) that play a role in reducing inflammation and fermentation of food waste.

In this study, there are some limitations, mainly the lack of sample compliance in consuming the drinks given to them as treatments, both in the control and intervention groups, which is due to the incompatibility of samples' taste to the drinks given and decrease in appetite. In addition, there was no compulsion for the elderly who were chosen as samples to consume the drinks, so oftentimes, they chose not to drink them. It was also difficult to rely on nurses and the elderly companions at the nursing home to ensure and monitor the samples' compliances due to their busy daily activities.

CONCLUSION

Based on the results of the research that has been carried out, it can be concluded that there is significant effects of consuming Keloja drinks on the immunity and nutritional status of the undernourished elderly in South Jakarta nursing home, compared to the elderly who were only given com-

mercial packaged drinks. However, there is no significant difference between the immunity and nutritional status of the elderly before and after consuming the commercial drinks and Keloja functional drinks.

SUGGESTIONS

For further products development, the compositions of moringa leaves and other ingredients need to be evaluated further by considering the condition and function of the digestive tract of the elderly who have decreased due to aging. Certain conditions such as malabsorption and decreased absorption of nutrients need to be considered in determining the amount of moringa leaves and other ingredients to be used. For future researches in the elderly population, it can be considered to conduct them on the elderly who live in the community or with their family members to observe the conditions of the elderly who live in different environments.

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