

EFFECTIVENESS OF FOOD INNOVATION FOR OLDER PERSONS WITH MILD DYSPHAGIA

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Abstract

This two-group pretest-posttest quasi-experimental design study aimed to investigate the effectiveness of food innovation for older persons with dysphagia. The subjects were 64 older persons with dysphagia who were selected using purposive sampling. They were assigned to the experimental group and the control group, with 32 subjects in each group. The experimental group tested food products, including 1) cooked mixed rice, 2) smoked grilled fish ball, or fish maw soup jelly, 3) banana in coconut milk puree, or snake fruit in syrup puree, once a day for three months. When comparing nutrition between before and after the experiment of the experimental, results showed that 1) hemoglobin, calcium, albumin, and body mass index after the experiment were higher than that of before ($p < 0.01$, $p < 0.001$, $p < 0.001$, and $p < 0.001$ respectively). When comparing between the experimental and control group, it was found that the experimental group had significantly higher hemoglobin, hematocrit, and albumin than the control group ($p < 0.05$, $p < 0.05$, and $p < 0.001$ respectively). This research result indicated that all food products had nutritional values that helped to increase the levels of hemoglobin, hematocrit, calcium, albumin, and body mass index. Thus, they should be used for enhancing nutrition in older persons with dysphagia.

Keywords: Food innovation, dysphagia, older person

Introduction

The number of older population is rapidly increasing compared to other age groups. This situation can be seen in almost all countries worldwide. In Thailand, it was found that the proportion of older persons rose from 6.8% in 1994 to 10.7 in 2007, 12.19 in 2011, and 16.5 in 2016. It is estimated that there will be 20.5 million older persons in 2040, accounting for 32.13 or approximately one-third of the country's population (Foundation of Thai Gerontology Research and

Development Institute, 2017). The rise in older population results from an increase in life expectancy and a significant decrease in birth rate. Longer life is associated with decline of organ functions such as problems with dental health and difficulty chewing (Gregory *et al.*, 2014), as well as dysphagia, choking, and changed tastes (Karen, 2017). According to the National Survey on Health of Thai older persons, it was found that 37.4 percent of subjects has permanent teeth less than 20 (Bureau

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of Health Promotion, Ministry of Public Health, 2013). Dysphagia was reported by 7.13% of older adults aged 65 years and over (Kawashima, *et al.*, 2004; Roy *et al.*, 2007; Holland *et al.*, 2011) and 26.7% of those aged 76 years and older (Baijens *et al.*, 2016) who also had chronic diseases, especially multimorbidity. Surveys from many countries showed similar findings that older persons faced multicomorbidity, accounting for 49.4-89.0% (Barnett *et al.*, 2012; Violan *et al.*, 2014; Afshar *et al.*, 2015; Gu *et al.*, 2017; Harrison *et al.*, 2017). Both factors led to malnutrition in older adults.

Dysphagia was defined objectively as an abnormal delay in transit of a liquid or solid bolus during the oropharyngeal or esophageal stages of swallowing (Abdel-Jalil *et al.*, 2015) that is caused by physiological changes or diseases affecting swallowing process. Aging changes include the decreases in number of teeth, tongue strength, saliva production, as well as reduced ability to chew and swallow resulting from weakness of muscle and esophagus (Dajpratham, 2013). Morbidity, such as stroke and Parkinson's disease, cause muscle weakness and discoordination (Karen, 2017). Moreover, the use of certain drugs, such as anticholinergic and antihistamine drugs, can lead to dysphagia in older persons and cause xerostomia (Leslie *et al.*, 2005). From a survey, it was found that the prevalence of dysphagia was as high as 68% in older persons in care centers, followed by those in hospitals (30%) and in community (13-38%) (Sura *et al.*, 2012). The significant impacts of dysphagia on older persons comprised nutrition problems and risks of malnutrition (Sura *et al.*, 2012). Malnutrition was found in 18.6% of older persons with dysphagia (Serra-Prat *et al.*, 2012), and 16-40% of those with stroke and dysphagia (HSFO, 2002). Additionally, older persons with dysphagia were two times more likely to have malnutrition than those without dysphagia (Park *et al.*, 2013). In a study of malnutrition in older persons with dysphagia in community by Sriraksa (2016), 33.5% of older persons with dysphagia had malnutrition. Another study of malnutrition in 88 older adults with dysphagia in Thammapakorn Social Welfare Development Center for Older Persons Chiang Mai and Lampang Provinces, and in Wai Thong Niwet Home for the Aged by Chintanawat *et al.* (2017) using body mass index (BMI) demonstrated that 27.5% of older persons had malnutrition (BMI <18.5 kg/m²). Laboratory test results also showed low hemoglobin in 71.3% and low albumin in 56.3% of the subjects.

The type of food for older persons with dysphagia should be appropriately modified to have puree and semi-solid texture, as well as should be safe without causing coughing or choking.

However, food with various and liquid textures should be avoided because it leads to choking easily. The type of food can be categorized into 1) thick puree no liquid, such as thick porridge, cream yogurt, boiled mashed vegetables, and mashed pumpkin, for persons who start eating orally or cannot chew coarse food or swallow liquid food; 2) thick and thin puree and thick liquid, such as boiled rice puree, fruit smoothies, ice-cream, and cream soup, for persons who can chew but cannot swallow liquid food; 3) mechanical soft thick liquid, such as thick rice soup and steamed egg, for persons who still have difficulty chewing and swallowing, have no teeth, or wear denture; 4) mechanical soft diet, such as vegetable soup, well-cooked vegetables, soft desserts, fruit smoothies, and soup, for persons who have mild dysphagia, can chew soft food or swallow liquid food, or wear denture; and 5) regular diet, such as fried food and crackers, for persons who can swallow normally but should avoid food that is hard to swallow (National Food Institute, 2013). Recently, food products for persons with dysphagia, such as sticky rice with mango puree, chicken coconut soup, and riceberry rice, have been produced by Faculty of Public Health, Mahidol University and smiling vegetable products by the Institute of Food Research and Product Development, Kasetsart University using technology to process vegetable to have soft texture and easy for chewing for older persons with dysphagia. Three types of vegetables for processing included Chinese chives, stink beans, and kale using hydrocolloids and modified to have shapes similar to unprocessed vegetables. Both of these studies focused on modifying the food texture to be appropriate for declined chewing and swallowing abilities (Wisetsuwannaphum, 2018). Nutritional jelly for persons with oral cancer who had difficulty chewing and swallowing contained nutrients, including protein carbohydrate, and fat. It had two flavors of mango and milk tea. Other food products for older persons with chewing and swallowing difficulty also included vegetarian riceberry rice jelly that was high in protein and energy (Tasiri *et al.*, 2015), as well as mango puree for older persons with dysphagia (Choichuedee *et al.*, 2018). Recipes have also been developed for older persons with chewing problems, including stir-fried kale in oyster sauce, stir-fried squid with sweet basil, stir-fried Chinese chives with pork, and stir-fried stinky beans with pork, made from vegetables and formed meat that had firm and soft texture, easily chewable, and maintain shape after heating. When tested with older persons, it was found that older persons had the highest preference in the color, softness, and taste of the food products (Trakoontivakorn *et al.*, 2015).

The Faculty of Nursing, in cooperation with the Faculty of Agro-Industry, Chiang Mai University, has developed prototype food products for older persons with dysphagia. 1) Cooked mixed rice was developed from three varieties of rice that consisted of brown jasmine rice 105 (32.63%), black rice (51.17%) and Doi Saket black glutinous rice (16.20%). The rice-to-water proportion for cooking was analyzed to provide appropriate texture for older persons with dysphagia. It is packed in a vacuum-sealed retort pouch, each containing 250 g of the product that gives 164 kcal (Utama-ang *et al.*, 2017). 2) Fish maw soup jelly was developed by softening dried fish maw, adding gelatin and seasonings, balancing pH level, and packing in vacuum-sealed retort pouch, each containing 100 g of the product that provides protein. 3) Smoked grilled fish ball was made from mashed tilapia meat added with gelatin dissolved in brine, seasonings, liquid smoke solution, and packed in heat-resistant plastic containers (Jongjareonrak *et al.*, 2018). 4) Banana in coconut milk puree was made by mashing ripen cultivated banana and adding concentrated Vitamin C (0.05%), calcium lactate (0.1%) and mixing well, as well as adding hydrocolloid solutions in the coconut milk. 5) Snake fruit in syrup puree was developed by mixing mashed snake fruit with concentrated Vitamin C (0.05%), calcium lactate (0.1%), and adding hydrocolloid solutions in syrup (Laokuldilok *et al.*, 2018).

Regarding the nutritional values of the developed food products, one serving of cooked mixed rice (1/3 cup or 50 g) gave 180 kcal, 1.5 g of fat, 4 g of protein, 37 g of carbohydrate, 2 g of fiber, 4% of iron, and 6% of Vitamin B1 (Utama-ang *et al.*, 2017). Fish maw jelly (100 g) gave 87 kcal, 7.5 g of protein, 5 g of fat, and 3.5 g of carbohydrate. Smoked grilled fish ball (100 g) contained 20 g of protein, and 2 g of fat, giving 98 kcal (Jongjareonrak *et al.*, 2018). For desserts, one cup or 150 g of banana in coconut milk puree gave 275 kcal, 18.8 g of fat, 36.4 g of carbohydrate, 2.3 g of protein, 1.3 g of fiber, and 6.2 mg of Vitamin C. Snake fruit in syrup puree (100 g) gave 368 kcal, 0.4 g of fat, 0.8 g of protein, 8.4 mg of Vitamin C, 38 mg of calcium, 3.9 mg of iron, and 18 mg of phosphorus (Laokuldilok *et al.*, 2018). These food products were safe and clean, as well as had physical properties (texture) and chemical property (pH) that were appropriate for the severity of dysphagia. When consuming these food products, persons with dysphagia received all required nutrients, including carbohydrate, protein, fat, vitamins, and minerals, thus resulting in improved nutrition.

From the literature review, it was found that the developed food was for persons with dysphagia, desserts, or food made from modified ingredients.

However, there have been no food innovations developed as main dishes. Therefore, the research team from Chiang Mai University developed three food innovations as main dishes that also took into account nutritional values. Rice was the main source of carbohydrate. Fish maw soup and fish balls were food enriched with protein. Moreover, there were favorite and familiar desserts for Thai older persons that underwent development processes to ensure appropriate texture for older persons with dysphagia.

Hence, the research team was interested in investigating the nutritional values of food products for older persons with dysphagia. Nutritional values referred to the nutrition that older persons with dysphagia obtained from consuming the developed food products, which led to better nutritional changes as a result of receiving essential nutrients, including protein, carbohydrate, fat, minerals, and vitamins, as well as specific nutrients such as calcium, iron, and zinc, which improved nutrition in older persons who had malnutrition caused by dysphagia.

Materials and Methods

Study Design

This study was a two-group pretest-posttest quasi-experimental design.

Participants and Setting

The participants in this study were 64 persons aged 60 years and older, 32 of whom were randomly assigned to the experimental group and 32 were randomly assigned to the control group. They had dysphagia and were living in Home for the Aged in Chiang Mai and Lampang Provinces. They were selected using purposive sampling based on the inclusion criteria as follows: 1) able to eat orally; 2) have mild dysphagia assessed by Dysphagia Severity Scale (DSS) Functional Oral Intake Scale with a score of 4-6; 3) ready to swallow; 4) agree to eat food products; 5) no abnormality that causes low levels of blood albumin, including nephrotic syndrome and liver disease; 6) no abnormality that causes anemia, including aplastic anemia, leukemia, or receiving bone marrow suppressants; 7) no history of significant weight loss or gain in the last three months 8) no history of food allergy; 9) no coughing or rapid breathing when tested by swallowing two gulps of 3 ml of water within 30 seconds; and 10) able to perform basic activities of daily living assessed by the Barthel Activities of Daily Living with a score above 4 11) not in the process or upon the completion of other research projects or participated in food research that had been completed for less than one month. Exclusion

criteria were 1) having high metabolic conditions such as fever or being diagnosed hyperthyroidism or 2) being diagnosed malignant or benign tumors. Criteria for termination included 1) having signs and symptoms of allergic reaction 2) having choked during food swallowing 3) hospitalization, or 4) requesting to discontinue the consumption of food products.

Ethical Consideration

This study was approved by the Research Ethics Committee, Faculty of Nursing, Chiang Mai University. The project number was 2560-FULL071 in Approval Letter No. 090/2018 issued on August 10th, 2018. Then, approval was received from the director of Thammapakorn Social Welfare Development Center for Older Person Chiang Mai and Lampang, and Wai Thong Niwet Home for the Aged in Mae Taeng District, Chiang Mai Province.

Instruments

1. Research instruments consisted of five food products for older persons with dysphagia, including 1) cooked mixed rice packed in 250-g retort pouch developed by Utama-ang and colleagues, Chiang Mai University (Utama-ang *et al.*, 2017); 2) smoked grilled fish ball jelly formed into fish shapes packed in 100-g vacuum-sealed packages developed by Jongjareonrak and colleagues, Chiang Mai University (Jongjareonrak *et al.*, 2018); 3) fish maw soup jelly packed in 100-g packages developed by Jongjareonrak and colleagues, Chiang Mai University (Jongjareonrak *et al.*, 2018); and 4) desserts consisted of banana in coconut milk puree and snake fruit in syrup puree packed in 150-g cups developed by Laokuldilok and colleagues, Faculty of Agro-Industry, Chiang Mai University (Laokuldilok *et al.*, 2018). All products were tested for physical properties (texture), chemical properties (pH), and cleanness and safety. The products were assessed for the appropriateness of texture, including hardness-softness, coarseness-fineness, fluid property, taste, and ingredients by two experts, including a senior professional nutritionist and a senior professional occupational therapist. Results showed that all products had appropriate physical properties for older persons with dysphagia. When testing the food products under the supervision of senior professional occupational therapist with five subjects who were similar to the subject, it was found that the subjects were able to swallow the products.

2. Data collection instruments consisted of 1) Nutrition Recording Form including weight, height, arm length, arm circumference, leg circumference, waist circumference, hip circumference, triceps skinfold thickness, and blood test results; 2) digital

balance with weighing capacity of 100 g and weighing range of 150 kg; 3) measuring tape for measuring arm, leg, waist, and hip circumferences in centimeters; skinfold thickness caliper using Holtain skinfold caliper with measuring capacity of 0.1 centimeter; the researchers and the 3 research assistants measured the volunteers' arm length and triceps skinfold thickness with one expert until yielding the same results as those measured by the experts. The researchers and the research assistant were trained by experts in nutrition for measuring triceps skinfold, circumference of arm, leg, waist, and hip in five older persons, and the results were consistent with those performed by the experts in every subject and every time; and 5) blood test instrument including a tool for testing complete blood count (CBC) using Sysmex xn-1000 with RBC count for electrical impedance, a tool for testing albumin using Abbott Architect c8000 with BCG (Bromocresol green), and a tool for testing calcium using Abbott Architect c8000 with Arsenazo III Faculty of Associated Medical Sciences, Chiang Mai University by storing blood samples in standardized containers and temperature, and submitting to the Faculty of Associated Medical Sciences within four hours.

Data Collection

After approval for data collection was received from the care centers, the procedures were performed as follows:

1. The professional occupational therapist primarily screened and assessed persons with dysphagia who met the inclusion criteria for their swallowing readiness. The researchers and the research assistant collected demographic data by measuring weight, height, arm circumference, and triceps skinfold thickness. Blood samples of 5 ml were taken by a professional nurse.

2. Experiment with the experimental group

2.1 The subjects ate the assigned food products at lunch for three months in steps as follows:

1) food preparation was performed by the Faculty of Agro-Industry and transported to each participating care center.

2) for each meal, the staff of the care centers reheated the food products with a microwave using the reheating time and temperature assigned in the manual, and asked the willingness of the subjects to eat each product; banana in coconut milk and snack fruit in syrup were alternatively eaten as well as fish maw soup jelly and smoked grilled fish ball jelly.

3) while eating the food products, the subjects were assisted by the staff of care center who also recorded the amount of products consumed by

each subject. At the end of the third month, the subjects' weight, arm, hip, waist, and leg circumferences and skinfold thickness were measured, and blood samples were taken.

3. For the control group, they ate the regular food prepared by the care center. At the end of the third month, their weight, arm, hip, waist, and leg circumferences and skinfold thickness were measured, and blood samples were taken.

Data Analysis

The demographic data of both groups were analyzed by descriptive statistics. Independent t-test were used to examine the mean differences between the two groups. Prior to running further statistical analyses, assumption of normality was tested and the result showed normal distribution of all outcome data. Independent t-test were used to determine differences in hemoglobin, hematocrit, calcium, albumin, body mass index and subcutaneous fat between the experimental and control groups. Paired t-test was performed for differences in physical fitness within between groups before and after the intervention. Statistical significance was set at $p < 0.05$. Before analysis, assumption of the independent t-test and paired t-test including normality distribution was tested using

Kolmogorov-Smirnov test. The results showed normal distribution of all dependent variables.

Results

1 For demographic data, there were 64 subjects, 32 of whom were assigned to the control group and the other 32 were assigned to the experimental group. There were similar proportions of male and female subjects in both groups. Their mean age was in middle old age, over 75 years old. The proportions of the age range of 70-79 and 80-89 years were similar while a small proportion of subjects were 89 years and older. The majority of them had chronic diseases and took medications for their diseases. Over half of the subjects had fewer than 10 permanent teeth, with approximately one-third of them having 10-20 permanent teeth. A small number of the subjects had more than 20 permanent teeth. When comparing between the experimental and the control groups, no difference was observed in gender, age, chronic diseases, medication, and number of permanent teeth. However, their severity of dysphagia, with the subjects in the control group having level 5 but those in the experimental group having level 6 as shown in Table 1.

Table 1. Number and percentage of the subjects as described by the demographic data and comparison between the experimental and control groups

Demographic Data	Experimental Group (n = 32)		Control Group (n = 32)		p value
	Number	Percentage	Number	Percentage	
Gender					0.616 ^a
Male	14	43.8	16	50.0	
Female	18	56.2	16	50.0	
Age (year) ($\bar{x} \pm SD$)		76.4 $\pm$ 7.378		75.38 $\pm$ 8.761	0.623 ^c
60-69	7	21.9	9	28.1	0.887 ^b
70-79	11	34.4	12	37.5	
80-89	12	37.5	10	31.3	
>89	2	6.2	1	3.1	
Underlying diseases					1.000 ^b
No	2	6.2	3	9.4	
Yes	30	93.8	29	90.6	
Hypertension	20	66.7	26	89.6	0.095 ^a
Coronary artery disease	3	10.0	2	6.9	1.000 ^b
Diabetes	4	13.3	6	20.7	0.491 ^a
Knee osteoarthritis	8	26.7	4	13.8	0.200 ^a
Stroke	6	20.0	1	3.4	0.104 ^b
Current medication					1.000 ^b
No	2	6.2	2	6.2	
Yes	30	93.8	30	93.8	
Health Insurance					1.000 ^b
Universal coverage	31	96.9	31	96.9	
Direct medical Coverage from Civil Service Medical Benefit Schema	1	3.1	1	3.1	
Number of Teeth					0.102 ^b
0-10	18	56.2	23	71.9	
10-20	10	31.3	9	28.1	
>20	4	12.5	-	-	
Severity of Dysphagia					0.045 ^a
Level 5	12	37.5	21	65.6	
Level 6	20	62.5	11	34.4	

Remark ^a Chi Square, ^b Fisher exact test, ^c Independent t-test

2. The effectiveness of food innovation for older persons with mild dysphagia

2.1 After consuming the food products, the experimental group had significantly higher levels of hemoglobin, calcium, albumin, and body mass index than before consuming the food products ($p < 0.01$, $p < 0.001$, $p < 0.001$, and $p < 0.001$ respectively), while all those nutritional indicators of the control group declined after a three months period. However, there was no statistically significant difference in the levels of hematocrit and triceps skinfold thickness as shown in Table 2.

2.2 After consuming the food products, the experimental group had significantly higher levels of hemoglobin, hematocrit, and albumin than the control group ($p < 0.05$, $p < 0.05$, and $p < 0.001$ respectively). However, no statistically significant difference was found in the levels of calcium, body mass index, and triceps skinfold thickness as shown in Table 3.

Discussion

Nutrition in Older Persons with Mild Dysphagia

1. Hemoglobin and hematocrit. Research results showed that after the experiment, the experimental group who consumed the food products had significantly higher levels of hemoglobin and hematocrit than the control group ($p < 0.05$). The control group had significantly lower levels of hemoglobin and hematocrit than before the experiment ($p < 0.001$). This research result indicated that when consuming the food products for three months, older persons with dysphagia had increased levels of hemoglobin and hematocrit because the food products in this study contained sufficient

nutrients for the generation of red blood cells, such as iron in the rice and snake fruit in syrup products, Vitamin B from rice and fish products, folate and Vitamin C from banana in coconut milk products (Utama-ang *et al.*, 2017; Laokuldilok *et al.*, 2018; Jongjareonrak *et al.*, 2018). These products had essential nutrients for generating hemoglobin and hematocrit. Moreover, Vitamin C in banana in coconut milk and snake fruit in syrup products helped to increase iron absorption (Lane and Richardson, 2014). In contrast, the control group who had regular diet had decreased levels of hemoglobin and hematocrit which indicated anemia in older persons caused by the deficiency of essential nutrients, such as iron, folate, and Vitamin 6, 12 (Suwanno *et al.*, 2015). The main causes of such deficiency were dysphagia and aging changes. Thus, malnutrition can lead to the development of anemia in older persons with dysphagia.

2. Calcium. Research result showed that after the experiment, the experimental group who consumed the food products had higher levels of calcium than the control group but this was not statistically significant. Nevertheless, the experimental group had a significantly higher level of calcium than before the experiment ($p < 0.01$). This research result indicated that the food products contributed to the increase in the level of calcium. A possible explanation is that the developed food products contained a high level of calcium that was sufficient to lead to higher levels of calcium in the subjects when consumed. The product of snake fruit in syrup jelly, in particular, contained as high as 38 mg of calcium and black rice had 4.2 mg of calcium. In addition, fish products were good sources of Vitamin D for older persons. Vitamin D stimulates the absorption of calcium in intestine into the blood

Table 2. Comparison of pre and post-test hemoglobin, hematocrit, calcium, albumin, body mass index, subcutaneous fat of the control and experimental groups

Variables	Pre-test		Post-test		t	95% CI (Lower, Upper)	p-value
	$\bar{x}$	S.D.	$\bar{x}$	S.D.			
Control Group							
Hemoglobin	12.04	1.846	11.37	1.652	5.049	0.401, 0.943	<0.001***
Hematocrit	37.47	5.453	34.66	5.104	6.184	1.881, 3.732	<0.001***
Calcium	9.38	0.436	9.23	0.483	2.161	0.008, 0.292	0.039*
Albumin	3.90	0.437	3.58	0.477	8.357	0.265, 0.435	<0.001***
Body mass index	22.42	4.847	21.56	4.848	4.695	0.489, 1.239	<0.001***
Lean body mass	40.90	8.185	40.37	8.650	1.923	-0.032, 1.090	0.064
Subcutaneous fat	16.73	8.130	17.15	6.930	-418	-2.480, 1.636	0.679
Experiment Group							
Hemoglobin	11.88	1.645	12.25	1.664	-3.018	-0.618, -0.120	0.005**
Hematocrit	36.77	4.407	37.19	4.363	-1.106	-1.209, 0.359	0.277
Calcium	9.11	0.438	9.43	0.295	-6.414	-0.416, -0.215	<0.001***
Albumin	3.76	0.372	4.10	0.231	-5.758	-0.470, -0.224	<0.001***
Body mass index	22.43	5.229	23.65	5.233	-4.734	-1.751, -0.696	<0.001***
Lean body mass	39.98	7.711	40.54	7.535	-1.797	-1.798, 0.076	0.082
Subcutaneous fat	15.55	8.463	13.41	8.668	1.570	-0.640, 4.924	0.126

Remark * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3. Comparison of post-test hemoglobin, hematocrit, calcium, albumin, body mass index, subcutaneous fat between the control and experimental groups

Variables	Control group		Experimental group		t	95% CI (Lower, Upper)	P-value
	$\bar{x}$	S.D.	$\bar{x}$	S.D.			
Pre-test							
Hemoglobin	12.04	1.846	11.88	1.645	-0.365	-1.033, 0.714	0.717
Hematocrit	37.47	5.453	36.77	4.407	-0.567	-3.181, 1.774	0.573
Calcium	9.38	0.436	9.11	0.438	-2.518	-0.493, -0.057	0.014*
Albumin	3.90	0.437	3.76	0.372	-1.386	-0.343, 0.062	0.171
Body mass index	22.42	4.847	22.43	5.229	0.006	-2.512, 2.527	0.995
Lean body mass	40.90	8.185	39.98	7.711	-0.465	-4.897, 3.050	0.644
Subcutaneous fat	16.73	8.130	15.55	8.463	-0.568	-5.325, 2.969	0.572
Post-test							
Hemoglobin	11.37	1.652	12.25	1.664	2.126	0.053, 1.710	0.037*
Hematocrit	34.66	5.104	37.19	4.363	2.130	0.155, 4.901	0.037*
Calcium	9.23	0.483	9.43	0.295	1.905	-0.009, 0.391	0.061
Albumin	3.55	0.477	4.10	0.231	5.943	0.368, 0.745	<0.001**
Body mass index	21.56	4.848	23.65	5.233	1.662	-0.426, 4.617	0.102
Lean body mass	40.37	8.650	40.54	7.535	0.082	-3.887, 4.221	0.935
Subcutaneous fat	17.15	6.930	13.41	8.668	-1.907	-7.663, 0.180	0.061

Remark * $p < 0.05$, ** $p < 0.001$

(Gallagher, 2013). Vitamin D is found in Omega-3 which is an essential fatty acid that could be found in the product of smoked grilled fish ball in the present study, which was made from tilapia meat that was high in Omega-3 fatty acid (Phukasmas, 2018).

3. Albumin. Research results demonstrated that after the experiment, the experimental group who consumed the food products had a significantly higher level of albumin than the control group ($p < 0.001$) but the control group had a significantly lower level of albumin than before the experiment ($p < 0.001$). This research result suggested that when consumed, the food products led to a rise in the albumin level of older persons with dysphagia. This can be explained by the diverse protein content in each food product. For example, 100 g of fish maw soup jelly had 7.5 g of protein while 100 g of smoked grilled fish ball had 20 g of protein (Jongjareonrak *et al.*, 2018); 250 g of cooked mixed rice had 4 g of protein (Utama-ang *et al.*, 2017); 150 g of banana in coconut milk puree had 2.3 g of protein and 100 g of snake fruit in syrup puree had 0.8 g of protein (Laokuldilok *et al.*, 2018). The recommended amount of protein for older persons is 0.8 g/kg of body weight/day, which is equivalent to six tablespoons of meat (Suvarnaraksha, 2017). Consumed fish proteins are easy for digestion, have high amounts of essential amino acids and less fat. In the current research, tilapia meat was used to develop the food products. Therefore, when consuming these products, older persons with dysphagia had an increased level of blood albumin.

4. Body Mass Index. Research results revealed that after the experiment, the experimental group who consumed the food products had higher

BMI than the control group but this was not statistically significant. However, after the experiment, the experimental group had significantly higher BMI than before the experiment ($p < 0.001$) but the control group had significantly lower BMI than before the experiment ($p < 0.001$). This research result indicated that when consuming all kinds of food products for three months, older persons with dysphagia had increased body weight. The mean body weight of the experimental group increased from 52.72 kg to 54.68 kg. In contrast, the mean body weight of the control group decreased from 53.42 kg to 51.97 kg. This can be explained by the texture of all the food products that was appropriate for the capacity of oral intake of the subjects who were older persons with mild dysphagia. Cooked mixed rice was made using the rice-to-water proportion of 1:3.5, which led to the texture hardness of less than 5×10^4 N/m² (Level 2 dysphagia). From the hedonic test with 50 older persons, the product was rated as moderately easy to very easy for chewing and swallowing. The subjects chewed 10 g of cooked mixed rice product 14 times on average, and swallowed approximately three times until they finished each portion. No choking was reported during chewing and swallowing (Utama-ang *et al.*, 2017). Fish maw soup jelly and smoked grilled fish ball were developed by adding sodium alginate to yield Level 2 Dysphagia-mechanically altered texture that was easy for swallowing by older persons with mild dysphagia (Jongjareonrak *et al.*, 2018). Banana in coconut milk product was developed by adding agar, and snake fruit in syrup product was added with carrageenan to give proper texture for older persons with mild dysphagia. After testing, it was found that both food products could be easily

Table 4. Number and percentage of the subjects as described by types and amount of food consumption per meal

Food Products	Amount of Consumption per Day (n = 32)		
	Completed	3/4	1/2
Cooked mixed rice	29 (90.63)	2 (6.25)	1 (3.12)
Fish maw soup jelly	22 (68.75)	6 (18.75)	4 (12.50)
Smoked grilled fish ball	23 (71.88)	5 (15.62)	4 (12.50)
Banana in coconut milk puree	32 (100.00)	-	-
Snake fruit in syrup puree	32 (100.00)	-	-

swallowed by older persons with dysphagia, thus allowing the subjects to be able to finish the given proportion of food, especially the banana in coconut milk and snake fruit in syrup that were finished at every meal. While 90.63% of the subjects finished the whole amount of cooked mixed rice, it was found that about two-third (68.75%) of the subjects finished fish maw soup jelly and almost three-fourth (71.88%) of the subjects finished smoked grilled fish at every meal as shown in Table 4, providing them with appropriate energy from food, including 164 kcal from 250 g of cooked mixed rice, 87 kcal from 100 g of fish maw soup jelly, 98 kcal from 100 g of smoked grilled fish ball, and 275 kcal and 386 kcal from 150 g of banana in coconut milk and 150 g of snake fruit in syrup respectively. After consuming these food products for three months, the subjects gained more weight which resulted in increased body mass index.

5. Skinfold thickness. The results showed no effect of the food innovation on triceps skinfold which is an indicator of body fat that is associated with a number of factors such as age, sex, race, food, physical activity and the state of hydration. When comparing between the experimental and control groups in terms of age and sex, the results revealed no differences. However, changes in skin elasticity and thickness, distribution of adipose tissue from subcutaneous fat to intra-abdominal fat and changes in muscle composition that occur with ageing might all have contributed to an underestimation of the amount of body fat when assessed using skinfold thickness measurements. In addition, the difference between those two groups regarding physical activity was not confirmed since the data on physical activity were not collected. Decline in physical activity among older people is commonly found due to the functional decline from physical chronic conditions and muscle mass leading to loss of appetite and decrease food intake. This result was inconsistent with the study by Chen *et al.* (2016) who found that after three months of oral and tube feeding for persons with Alzheimer's disease with dysphagia, their triceps skinfold improved with statistical significance.

The result of this study was consistent with the study investigating the effects of a diet with

products in texture modified diets in elderly ambulatory patients (Luis *et al.*, 2009) conducted in participants with dysphagia aged over 70 years who consumed a texture modified diet supplemented with dehydrated nutritional products for more than three months. They found improvements in weight, fat mass, fat free mass, total proteins, albumin, transferrin, and lymphocytes, as well as significant increases in caloric, protein fat and carbohydrate intakes. Caloric intake corrected by weight improved (26.1 $\pm$ 5.7 cal/kg vs 28.9 $\pm$ 4.5 cal/kg; $p < 0.05$). Quality of life improved significantly (SF 36 score 94.7 $\pm$ 15 points vs 99.3 $\pm$ 10 points; $p < 0.05$). The result was also in line with the study on the effect of novel dysphagia diet which comprised vegetables, fruit, meat, and desserts with three levels of texture (minced diet, minced/pureed diet, and pureed diet) consumed for three months. The results showed that after consuming for six weeks, the experimental group received more energy and nutrients, including protein, carbohydrate, total saturated fat, potassium, magnesium, calcium, phosphorus, zinc, vitamin B1-12, and vitamin D, from the novel dysphagia diet than the control group who had usual diet provided by the nursing home with statistical significance of $p < 0.01$. However, after consuming for 12 weeks, it was found that the experimental group received more nutrients, including total saturated fat, phosphorus, zinc, and vitamin B-2, than the control group with statistical significance of $p < 0.01$, while the energy, protein, fat, potassium, magnesium, calcium, and vitamin D received by the experimental group increased with statistical significance of $p < 0.05$ (Germain *et al.*, 2006).

Limitation of the Study

1. A larger proportion of the control group had level 5 dysphagia than the experimental group while a larger proportion of the experimental group had level 6 dysphagia. This might cause the experimental group to consume more food than the control group, which led to better nutritional status.

2. Nutritional status depends on the type of food, amount of food, and frequency of food consumption. In this study, there was no record of the type and amount of food consumed by the control group each day, which limited the possibility

to calculate the daily energy intake that influences nutritional status. Thus, the study result which was the comparison of nutritional status between the experimental group and the control group may be imprecise.

Conclusions

The developed food and dessert products had been modified to have appropriate texture. After three months of consuming these products, the older persons with mild dysphagia had improved nutrition.

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