Original

Acceptance of Textured Soybean Protein in Indonesian Dishes and Its Effects on Energy in Overweight Women

Indri Kartiko Sari[1]*, Diah Mulyawati Utari[2], Mitsutaka Kohno[3], Ryuji Yamaguchi[4], Shigeru Yamamoto[1]

[1]*Asian Nutrition and Food Culture Research Center – Jumonji University, Japan*
[2]*Public Health Nutrition Department, Faculty of Public Health, University Indonesia*
[3]*Fuji Science Innovation Center, Japan*
[4]*Nutrition Japan Public Private Platform, Japan*

ABSTRACT *Background and purpose:* The problem of overweight and obesity has been increasing in Indonesia year by year as well as in the rest of the world; it is commonly caused by an unhealthy diet from excessive lipid intake. Increasing fiber intake from plant-based foods is known to control lipid absorption. Meat-like soybean product, Textured Soybean Protein (TSP), is made by extracting oil from soybeans and turning it into dry meat-like textured soybean which is rich in fiber, low in oil, and a high-quality protein source. In this study, TSP was substituted for meat in popular Indonesian meat dishes and its overall acceptance and effect on health with daily consumption were observed. *Methods*: The study was divided into two section: Section A, the overall acceptance of TSP dishes and Section B, the effects of including one TSP dish in the daily food intake of overweight women. In Section A, the subjects (n=17), who were all housewives, sampled 5g of four TSP types with 20 dishes in total and scored the overall taste of the dishes. The Hedonic 5-point scale was used to score overall taste. In Section B, the subjects (n=25), all overweight housewives, consumed one dish of 50g TSP daily for 3 consecutive weeks. Nutrition surveys using 3-day-24-hour recall methods were conducted at the baseline and final for dietary changes during the period of daily TSP consumption. Subjects' tolerance for and opinion of the new foods were assessed by a questionnaire at the final. *Results:* In study Section A, the average overall taste of TSP dishes was scored: Sliced Chicken 3.6, Minced Chicken 4.4, Sliced Beef 4.7, and Minced Beef 4.4. The overall evaluations were considered better than Good (above 4) with no significant differences found among the four types of TSP ($p>0.05$). In study Section B, 20 subjects completed the study. There were significant decreases in total energy and lipid intakes and significant increases in protein and fiber intakes ($p<0.001$). Questionnaire results shows that 70% of subjects felt satisfied during the study, 80% felt 50g/day was an appropriate daily amount, and 85% had no problem during the 21days of consumption. *Conclusion:* TSP dishes were well accepted overall by Indonesian women; TSP could be used as a meat substitute, could supply more protein and fiber, and could decrease energy and lipid intakes in overweight women.
Key words: soybean, food acceptance, overweight women, energy,

INTRODUCTION

High prevalence of overweight and obesity is known to be one cause of lifestyle-related diseases such as stroke, heart disease, etc. Excessive lipid intake is one factor that causes overweight problems. More fiber intake is known to help in reducing the risk of lifestyle-related diseases (1-5). It has also been found effective in weight control (6,7). If the intake of a sufficient amount of dietary fiber is continuously followed, this can be expected to improve or prevent these diseases by providing greater nutritional balance (2,3). The challenge is that dietary fiber is also one of the nutrients that is difficult to consume in sufficient amounts.

Plant-based diet is becoming popular in the movement to reduce global meat consumption (8). There are many alternatives for a plant-based diet, including the development of meat-textured plant-based foods in order to get more meat eaters to consume more plant-based foods. (9). Soybeans are commonly used as plant protein source in many countries; it is processed into foods like tofu, tempeh, miso, natto, etc (10-12). Textured Soybean Protein (TSP) is soybean textured like meat and purposely developed to have an appearance similar to real animal meat. TSP is made by extracting the oil from soybeans and then turning the soybeans into dry material. Since it is made from soybeans, this meat-like plant product is rich in fiber (13.6g/100g dry matter), low in oil, and also a plant-protein source (56g/100g dry matter).

According to a previous study on dietary intake in Indonesian women living in Jakarta, it was found that their dietary patterns included 29% fried animal protein such as fried meat, fried egg, etc., and also 6% tempura (13). Sixty-one percent of these women were overweight and obese, with nutrient intakes results

*To whom correspondence should be addressed:
indri.kartiko@yahoo.com

showing a high lipid intake of 87g/day and a low fiber intake of about 10g/day (13). This suggested the importance of shifting to a better dietary habit of consuming more fiber and less lipid. When delicious main dishes using TSP can be developed, this may lead to higher intake of fiber so the total fiber intake in a day can be increased without any difficulty.

TSP has no attributes other than it is meat-textured, easy to chew, has a light bean taste and does not have any smell or stickiness, making it suitable for various recipes. There are different shapes/forms of TSP that can be used for a variety of cooking. Therefore, we decided to utilize TSP as the main ingredient in Indonesian dishes and developed low-fat high-protein and high-fiber alternative foods which could be expected to have beneficial effects on health. The approach of TSP utilization consists of two sections. The first section was to develop Indonesian dishes suitable for replacing the main ingredient with TSP and evaluate the overall scores of the dishes. The second section was to clarify nutrient intake changes with TSP as a daily substitute for meat in long period of consumption with expectation that it can be an alternative for a new healthy food culture for Indonesians

METHODS

There were two sections in this study. Section A: The overall acceptance of TSP dishes. Ten recipes were chosen based on the previous nutrition survey conducted in overweight women (13). These ten recipes were specifically chosen based on popularity, relatively have no bulky attribute, a meat-based main ingredient, and ease of cooking. The cooking process for each dish required only TSP and seasoning. TSP was first soaked in boiling water for 1 minute and then drained before stirring and mixing with the seasoning. The seasonings were spices blended into one spice mixture. The spice mixture of the nine recipes were Rendang, Sambal Goreng, Semur, Lada Hitam, Gulai Ayam, Gulai Sapi, Bumbu Rujak, Bumbu Bali, Bumbu Balado, and Opor Ayam.

There were four types of TSP with different shapes that were used to replace the meat in dishes. These TSPs were separated into two categories, Beef-like and Chicken-like (Figure 1), along with specific recipes (Table 1). In total, there were 20 dishes used in this study (Table 1). The cooking process for the TSP is shown in Figure 2. The lists of original recipes, TSP dishes, and ingredients are shown in Table 3. In a duration of three days, TSP sample dishes with 5g dry ingredients were tasted and evaluated by 17 pre-elderly women to evaluate overall scores the sliced and minced forms of TSP. A 5-level hedonic scale was used with 1= “very poor”; 2= “poor”; 3= “neither good nor poor”; 4= “good” and 5= “very good”. Then, after finishing Section A, the study continued to Section B for acceptance consumption in longer period.

Section B: The assessment of TSP dishes acceptance in daily dietary meals. There were 25 healthy overweight women (BMI≧25kg/m2) who participated in this step. The subjects were randomly selected from community health centers, in a peri-urban area in Jakarta. The subjects were asked to eat 50g of TSP every day for 3 weeks consecutively. A different TSP menu was prepared and delivered daily to the subjects. A nutrition survey (3 non-consecutive days) at the baseline (normal intake) and final (with TSP intake) was conducted to assess the change in their daily diet during the consumption of TSP. At the end of the study, a questionnaire was created to interview the subjects about their tolerance for and opinion about the new foods (Table 4). Statistical analyses were conducted with Microsoft Excel 2013.

Fig 1-1 Sliced Beef Fig 1-2 Minced Beef Fig 1-3 Sliced Chicken Fig 1-4 Minced Chicken

Figure 1. Four types of TSP

Table 1 Total dishes of TSP (20 dishes)

Sliced Beef	Minced Beef	Sliced Chicken	Minced Chicken
1.Rendang	6.Rendang	11.Bumbu Rujak	16.Bumbu Rujak
2.Sambal Goreng	7.Sambal Goreng	12.Bumbu Bali	17.Bumbu Bali
3.Semur	8.Semur	13.Bumbu Balado	18.Bumbu Balado
4.Lada Hitam	9.Lada Hitam	14.Opor Ayam	19.Opor Ayam
5.Gulai Sapi	10.Gulai Sapi	15.Gulai Ayam	20.Gulai Ayam

Figure 2-1. Heating the spice mixture (seasoning)

Figure 2-2 Mixing boiled TSP with seasoning evenly

Figure 2-3 TSP dish ready to be served

Figure 2. Cooking process of TSP dishes

Table 3. List of 10 recipes and ingredients of spice mixture (seasoning).

Recipe	Ingredients	Recipe	Ingredients	Recipe	Ingredients
 **Rendang**	1. Beef-like TSP (50g) 2. Rendang seasoning (candlenut, garlic, red chili, shallot, chili, ginger, turmeric, galangal, coriander, salt, nutmeg)	 **Bumbu Balado**	1.Chicken-like TSP (50g) 2.Balado seasoning (chili, red chili, garlic, shallot, galangal, daun salam,lemongrass)	 **Opor Ayam**	1. Chicken-like TSP (50g) 2. Opor seasoning (garlic, coriander, candlenut, ginger, turmeric, salt, galangal, brown sugar, tamarind)
 **Semur**	1. Beef-like TSP (50g) 2. Semur seasoning (Shallot, tomato, red chili, ginger, candlenut, pepper, lemongrass, clove, nutmeg, salt, sweet soy sauce, oil)	 **Bumbu Rujak**	1.Chicken-like TSP (50g) 2.Bumbu Rujak seasoning (shallot, garlic, red chili, chili, ginger, laos, turmeric, salt, sugar)	 **Lada Hitam**	1. Beef-like TSP (50g) 2. Lada hitam (Sweet soy sauce, oyster sauce, sesame oil, onion, red chili, black pepper, corn starch, sugar, salt)
 **Sambal Goreng Ati**	1.Beef-like TSP (50g) 2.Sambal goreng ati seasoning (chili, shallot, garlic, candlenut, ginger, galangal, daun jeruk, brown sugar, salt, sugar, lemongrass,)	 **Gulai Ayam**  **Gulai Sapi**	1.Chicken-like TSP (50g) or Beef-like TSP (50g) 2.Gulai seasoning (Garlic, shallot, red chili, ginger, candlenut, sugar, galangal,turmeric, lemongrass, daun salam, daun jeruk, asam kandis, salt)	 **Bumbu Bali**	1.Chicken-like TSP (50g) 2.Bumbu Bali seasoning (tomato, galangal, daun jeruk, daun salam, tamarind, sweet soy sauce, salt, sugar, shallot, garlic, red chili, candlenut, ginger, lemongrass, terasi)

Table 4. TSP dish tolerance and opinion questionnaire

QUESTIONNAIRE		
Q1. (Satisfaction) Can you describe whether 50g TSP in 1 dish is enough to eat daily for three consecutive weeks? A. Too much. B. Enough. C. Too little.	*Q2. (Amount Suggestion) Do you have any suggestion on the amount that should be served daily?* A.Higher than amount served B.The same as amount served C. Less than amount served	*Q3. (Problems during Consumption) Do you have any problem after consuming TSP for 21 days?* A. No particular problem B. Yes, it was … (please explain)
Thank you for your cooperation!		

RESULTS

Table 5 shows the overall hedonic scores for chicken-like TSP dishes. The average scores for the five TSP dishes of sliced chicken and minced chicken were 4.2 and 4.2 points for Rujak, 4.5 and 4.1 for Balado, 4.1 and 4.3 points for Bumbu Bali, 3.9 and 4.6 points for Opor, and 3.6 and 4.4 points for Gulai, respectively. The overall scores of TSP dishes were close to each other and there was no different found ($p>0.05$). Highest overall score was found for Minced Chicken with Opor seasoning (4.6±0.8). Lowest overall scores was found for Sliced Chicken with Gulai seasoning.

Table 6 shows the overall hedonic scores for beef-like TSP dishes. The average scores for the five TSP dishes of sliced beef and minced beef were 4.2 and 4.2 points for Rendang, 4.5 and 4.1 for Semur, 4.1 and 4.3 points for Sambal Goreng, 3.9 and 4.6 points for Lada Hitam, and 3.6 and 4.4 points for Gulai, respectively. The overall scores for TSP dishes were close to each other ($p>0.05$), but there was a significant different found for Gulai ($p<0.05$). Highest overall scores were found for Sliced Beef with Gulai seasoning (4.7±0.8). Lowest overall scores were found for Minced Beef with Semur seasoning. Figure 3 shows the overall scores for four types of TSP using the same seasoning, Gulai of Sliced Beef, Minced Beef, Sliced Chicken, and Minced Chicken were scored 4.7, 4.4, 3.6, and 4.4 respectively. There was no difference between TSP types.

Table 5. Overall Evaluation Scores for Chicken-like TSP

Seasoning	Sliced Chicken (mean±SD)	Minced Chicken (mean±SD)	p-value
Rujak	4.2±1.3	4.2±1.1	0.99
Balado	4.5±1.0	4.1±1.2	0.23
Bumbu Bali	4.1±1.4	4.3±1.1	0.38
Opor	3.9±1.6	4.6±0.8	0.09
Gulai Ayam	3.6±1.7	4.4±0.9	0.07
Average	4.1±0.9	4.3±0.9	0.13

Table 6. Overall Evaluation Scores for Beef-like TSP

Seasoning	Sliced Beef (mean±SD)	Minced Beef (mean±SD)	p-value
Rendang	4.4±0.9	4.4±1.2	0.75
Semur	4.3±1.3	4.0±1.3	0.14
Sambal Goreng	4.6±0.7	4.4±1.1	0.48
Lada Hitam	4.5±0.8	4.5±0.9	0.58
Gulai Sapi	4.7±0.8	4.4±0.9	0.02*
Average	4.5±0.8	4.3±0.9	0.13

***Significant differences ($p<0.05$)**

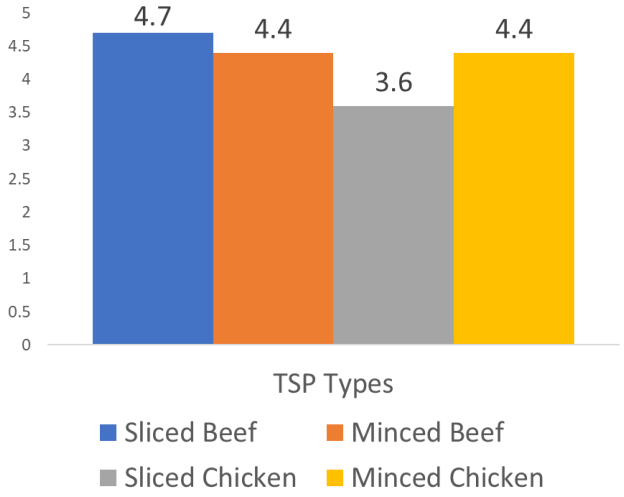

Figure 3. Overall scores of four types TSP

Table 7 shows the average age, weight, and BMI of the subjects and the final measurement of the subjects. There were 20 subjects who finished the study, all overweight women (28.3±2.5kg/m^2) with average age of 56±5years old.

Table 7. Characteristics of the subjects (n=20)

Characteristics	Value (mean±SD)
Age (years)	56 ± 5
Height (cm)	149.5 ± 4.9
Weight (kg)	62.6 ± 7.5
BMI (kg/m^2)	28.3 ± 2.5

Table 8 shows the energy and nutrient intakes in the daily diet for 3 weeks of 50g TSP consumption. There were significant decreases in total energy (kcal/day) from baseline 2037 to final 1666 and lipid intake (g/day) from 94 to 54. There were significant increases in protein (g/day) from baseline 47 to final 60 and fiber intake (g/day) from 10 to 16 ($p<0.001$). There was no significant difference found in carbohydrate intake (g/day) from baseline 267 to final 248.

Figure 4 shows the tolerance of TSP dishes after 3 weeks of 50g TSP consumption. Figure 4-1 shows the answers for Q1 about satisfaction of 50g/day TSP consumption; 70% (n=14) felt satisfied and 30% (n=6) felt that the amount was too much. Figure 4-2 shows the suggestion of an appropriate amount for daily TSP consumption; 80% (n=16) felt 50g/day would be appropriate, 15% (n=3) felt 50g/day was too much, and 5% felt the amount could be more than 50g/day (n=1). Figure 4-3 shows the answers for Q3 about any problems during the daily 50g/day consumption. 85% (n=16) felt no particular problem and 15% (n=4) felt there was a problem. We asked for explanations and descriptions of the problems. These subjects had gout problems and eating TSP made them feel tingly when they didn't drink enough water.

Table 8. Energy and nutrient intakes in the daily diet for 3 weeks of 50g TSP consumption.

Energy and Nutrient	Baseline (n=20)	Final (n=20)	p value
Energy (kcal/day)	2037±185	1666±152	<0.001*
Protein (g/day)	47±12	60±54	<0.001*
Lipid (g/day)	94±18	54±14	<0.001*
Carbohydrate (g/day)	267±35	248±38	0.08
Fiber (g/day)	10±3.6	16±3.7	<0.001*

* Significant differences ($p<0.05$)

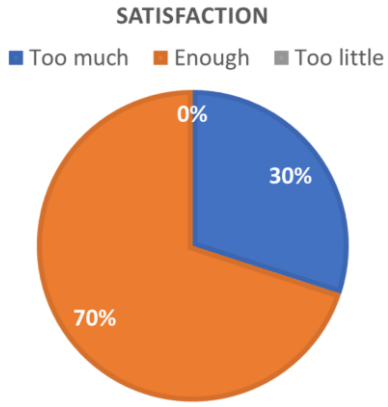

Figure 4-1 Satisfaction (Q1)

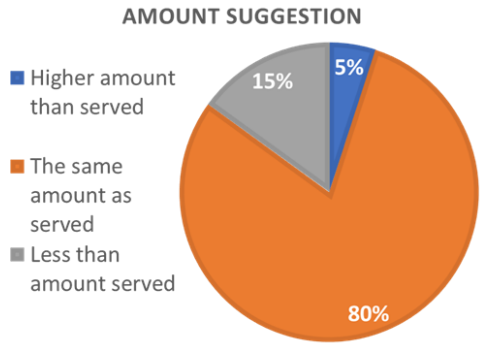

Figure 4-2 Amount Suggestion (Q2)

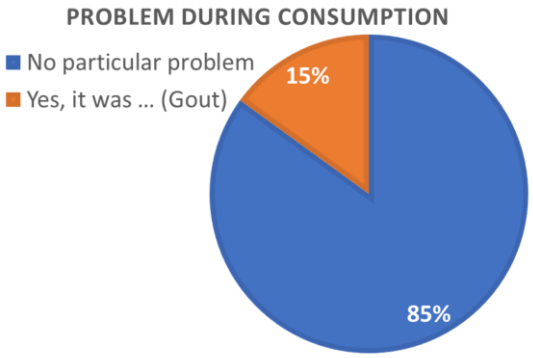

Figure 4-3 Problem during Consumption (Q3)

Figure 4 shows the tolerance of TSP dishes after 3 weeks of 50g TSP consumption

DISCUSSION

In the first step, we found that TSP dishes using Indonesian traditional recipes in which the main ingredient is meat were highly evaluated with overall scores of more than 4, which is better than good. In the next step of the study. There were significant decreases in energy of 371kcal/day and in lipid intake of 40g/day, while protein and fiber intake were increased by 13g/day and 6g/day, respectively, compared with their normal diet. These results showed that TSP can be a meat substitute in Indonesian meat dishes and have beneficial effect on health by improving nutritional balance in daily life.

The overall scores showed results of better than good, which means that the taste of these TSP dishes was acceptable. Selected recipes in this study, Gulai and Opor, include coconut milk as a soup base in the traditional recipes. Then, we modified the recipe without using coconut milk. Exclusion of coconut milk as the soup base made the TSP Gulai and Opor had much lower calorie than the traditional recipes, in our attempt to develop low-fat high-protein high-fiber food alternative. By this exclusion, variation of an acceptable low-fat high-protein high-fiber food alternative could be developed and be introduced to Indonesian food culture.

Indonesia has a culturally long-established tradition of a plant-based protein food: tempeh. Other than tempeh, other plant-based protein such as tofu and mushrooms are also commonly found in Indonesian cuisine. Unfortunately, due to the economic development of Indonesia, plant-based protein often considered as `the food of the poor` since it is not as fancy as animal protein like meat (11,12). With the continuous increase in lifestyle-related diseases, dietary habits are important in assuring a healthy life (1-3). Previous research showed that in total, 35% of housewives` food intake comes from fried foods, which mostly included fried animal protein such as fried eggs, fried chicken, etc (13). It was also found that vegetable intake was just 83g/day. The Indonesian government recommendation for vegetable and fruit intake is 400g/day in total, so the amount of 83g/day was less than half of the recommendation (14,15). Moreover, with this vegetable intake, fiber could only be supplied at 9.5g/day, much lower than the recommendation of 30g/day (13-16)

The recommendation is intended to establish a healthier life for people (14,16). While vegetables and fruits are good sources for micronutrients such as vitamins and minerals, vegetable and fruits also provide fiber, which is effective in prevention of lifestyle-related diseases (1-3). Studies focusing on higher vegetable intake have proven it effective in controlling lifestyle-related diseases; this may be the result of intake of fiber from vegetables (7, 17, 18). Consumption of high-fiber pre-germinated brown rice (PGBR) could also reduce blood glucose level and body weight (6). Other research also found that increasing fiber intake from a tofu side product, Okara, can decrease glucose levels of subject[s] with diabetes mellitus (19). For these reasons, fiber in any form can have beneficial effects on health.

Even though there was a successful study on weight reduction and lipid profiles improvement in Indonesian overweight women with high vegetable intake, it is still difficult to take more fiber only from vegetables (7). When the approach is shifted to a plant-based protein such as tempeh, people still haven't realize the beneficial effects of eating more plant-based foods (11,12). There are many variations of tempeh recipes in Indonesian traditional cuisine, but society is already too familiar with tempeh taste and tends to look at tempeh as food for the poor (11,12). Therefore, the application of meat-like, TSP in Indonesian traditional recipes can provide more variation of plant-based foods, especially with its fiber content and its possibility to increase fiber intake.

From many dishes that include meat as the main ingredient in Indonesian cuisine, our selected dishes which meat were substituted with TSP had the results of averagely high overall scores. The results were compared with tempeh acceptance in Japanese dishes, which replace the main ingredient like meat, fish, and dairy products in Japanese dishes (10). It was scored 3.5 points for overall taste (10). If fiber intake was compared, tempeh study can increase fiber by 2g/day, while TSP in this study could increase fiber by 6g/day. Similar results were found on Okara study (6g/day) and PGBR study (7g/day) (6,19).

The decrease of energy intake found in this study might result from the combination of higher fiber intake and lower lipid intake. First, higher fiber intake is commonly associated with increase of satiety, meaning that subjects feel full longer, which eventually reduces hunger and leads to an energy intake decrease (20-23). Digestion and absorption of fiber are slow, resulting in longer stimulation of nutrient receptors in the gastrointestinal tract, prolonging the feedback signal to the satiety center and thus reducing hunger(20,21). In controlling body weight, fiber might also have effects through multiple pathways, including through insulin secretion modulation and satiety control (24-26).

Second, in terms of lipid intake, some studies have shown that diets resulting in lower energy intake including protein from vegetables can significantly reduce lipid intake and LDL cholesterol levels (27-31). A Mediterranean diet that focusses on carbohydrate and protein sources from legumes and soy is associated with lower risk of coronary artery disease progression(28,29). In this study, the TSP dishes that included only TSP and spice mixtures showed the best effect of TSP consumption by using minimal ingredients in the recipe. The TSP dishes were changed daily and had a 10-day menu-cycle, so boredom with the TSP dishes could be avoided, and the basic effect of TSP could be observed while substituting TSP dishes for regular dishes resulted in lower calorie intake of the subjects.

After three consecutive weeks, the acceptance of TSP dishes for long period of daily consumption showed that 70% of subjects felt satisfied during the study, 80% felt 50g/day was an appropriate daily amount, and 85% had no problem during the three consecutive week's consumption. These suggested that daily consumption TSP dishes in longer term has many possibilities for further researches focusing on its effects on health and also biochemical features.

TSP has no taste or smell, but has attributes of a meat-like texture, which can easily be adapted for various dishes. The utilization of TSP in selected Indonesian traditional cuisine exceeded expectations that it was acceptable as substitute for meat as the main ingredient. A desirable new method of ingesting dietary fiber from main dishes was also found through this study. Long period of consumption also showed properly good satisfaction. More awareness concerning the benefits of plant-based foods for health is expected to a healthier life with lower risk of lifestyle-related disease.

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