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Production of Kaeng Liang Soup (Thai Style Spicy Mixed Vegetable Soup) Powder Using Foam-mat Drying

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Abstract

Kaeng Liang is an ancient local Thai soup that has been reported to have many benefits along with the popularity of powdered food seasonings having increased significantly in Thailand. The aim of this study was to investigate the factors affecting the foam-mat drying of Kaeng Liang soup powder. The physical, chemical, microbiological, nutritional, and sensory properties of the sample were studied. Three Kaeng Liang soup recipes were selected to study sensory acceptability. The best formula was selected to produce Kaeng Liang soup powder by foam-mat drying. Then, the optimum level of egg white protein (EWP) at three levels namely 2%, 4%, and 6% for use in foam-mat drying was studied. The best level condition of egg white power was selected to study drying at 60°C, 70°C, and 80°C further. It was shown that using 6% EWP and drying at a temperature of 80°C for 480 min meant that the water activity content was in accordance with the standards set forth in the instant community product standards, including the water solubility index and water reabsorption index. Moreover, the microbiological qualities are in accordance with the community product standards. As for the nutritional value of Kaeng Liang soup powder, it contains carbohydrates, proteins, fats, phosphorus, and calcium respectively. The acceptance of the product by 100 consumers was established by the high sensory score in the range of extremely liked as a score of 3.82-3.91 (1-dislike extremely to 5-like extremely). Therefore, the application of foam-mat drying can be used to produce Kaeng Liang soup powder.

Keywords*: *Kaeng Liang soup powder; foam-mat drying; egg white protein

1. Introduction

Kaeng Liang is a clear spicy mixed vegetable soup. Its curry paste contains very few spices and each of them is made from local herbs with a pungent odor like basil leaves, which have an indispensable identity in Kaeng Liang. The traditional Kaeng Liang recipe does not add dried shrimp or dried fish. Later, the recipe was adapted for a better flavor, so dried fish or dried shrimp were added to the curry paste to enhance the flavor and mouthfeel of the soup. Thai food culture experts believe that Kaeng Liang is an ancient soup that local Thais have traditionally eaten before starting to have coconut milk curry. According to Thai traditional medicine texts, Kaeng Liang is used as food to increase the mother's milk after giving birth. This is because there is banana blossom in it, which has the property of increasing the production of milk, as well as hot herbs that help stimulate the circulatory system, such as Krachai, Fingerroot or Chinese ginger and pepper in curry paste, etc. (Sri-Ngernyang, & Samret, 2013). In addition, Kaeng Liang menu is suitable for those who need to control weight and fat because of low calories. It contains various vegetables as the main ingredients and a lot of fiber which helps you to feel full and your digestive system. From the joint research of Ponguttha et al. (2011), it was found that Kaeng

Liang has an effect on the production of NAD(P)H enzymes, specifically hepatic quinone reductase and the inhibition of colon cancer in Wistar rats. The researchers explained that colon cancer is one of the most common diseases in the world's population yet there is a tendency for this to be increased more in Thailand. The cause of cancer comes from changing consumption habits. It is evident that consuming a diet high in fruits and vegetables can help reduce the risk of colon cancer. The consumption of Kaeng Liang, which is a Thai food enriched with vegetables and herbs, and low-energy spices, contains nutrients and plant essences such as carotene and dietary fiber that are beneficial to health.

Nowadays, the popularity of powdered food seasonings has increased significantly in Thailand and the marketing of this type of food is expanding rapidly. Entrepreneurs have begun to develop a variety of seasonings to meet the needs of consumers. Instant powdered seasonings have increased in demand because they have become popular among groups who want to cook quickly for home consumption or to serve more customers in restaurants. In terms of the food product industry, the process of sterilization and drying in order to keep the product for a long time can increase the growth opportunity in the market. In particular, when exporting products to foreign countries, this can reduce the difficulty of procuring raw materials when looking to cook authentic recipes. Research on ready-made condiment products will make cooking a standard recipe more convenient and bring the reputation of Thai food to the world quickly (Poonnakasem, 2019). At present, foam-mat drying is the drying process used for liquid or semi-liquid foods which plays a role in the development of new products causing dry food to form foam. The advantage of foaming food first is that it speeds up the drying rate of the food because the structure of the foam is porous which causes an increase in surface area. As a result, the water evaporates more easily and faster. When food is exposed to heat for a short time, it reduces the loss of food quality, especially the odor, flavor, and use of the foam-mat drying method such as with bananas (Thuwapanichayanan et al., 2008), pineapple (Kadam et al., 2012), tamarind (Phaechamud et al., 2012), pickled garlic juice (Tulardilok, 2009), and chili sauce (Poonnakasem, 2019). In the drying process, a foaming agent is used, which is a protein with functional properties that goes through a drying process and is ground into powder. Egg white protein (EWP), as an excellent foaming agent, is a classic foaming material in foods and in the food industry, EWP is the most important foaming agent for example, in meringues and cake batters (Li et al., 2020). Moreover, EWP has many functional properties, including gelling, coagulating, keeping water, and antioxidant properties (Li et al., 2021). Moreover, using foam-mat for development in Thai curry still lacking, especially in Kaeng Liang soup. Therefore, the objective of this study was to develop Kaeng Liang soup powder, a new product that an easy to transport and store, using the foam-mat drying method by determining the physical, chemical, and microbiological including sensory acceptability from consumers.

2. Objectives

The objective of this study was to investigate (1) the effect of shrimp paste and fish sauce quantities on consumer preference, (2) the effect of EWP quantities on foaming properties, stabilities, and microstructure, and (3) the effect of foam drying temperatures on physical, chemical, nutritional, and microbiological qualities and consumer acceptance of Kaeng Liang soup powder.

3. Materials and methods

3.1 Raw materials

All ingredients (shallots, shrimp paste, white pepper, dried shrimp, fish sauce, and raw material of chicken stock) of Kaeng Liang production were purchased from the local market (Bangkok, Thailand).

3.2 Study of the basic recipe of Kaeng Liang

Chicken soup was prepared using chicken carcass (17.57%), white radishes (10.98%), onions (5.49%), salt (0.07%), and water (65.59%). All ingredients were cleaned and cut and chicken carcass was precooked before being added in hot water (80±2ºC) for 45 min and filtered through a mesh sieve. Then, the filtrate was used for preparing Kaeng Liang soup.

Table 1 Kaeng Liang soup recipes

Ingredients (%w/w)	**Formulas**		
	1	**2**	**3**
Shallots	8.32	8.32	8.32
Shrimp paste	1.66	1.46	1.86
White pepper	0.21	0.21	0.21
Dried shrimp	5.00	5.00	5.00
Fish sauce	1.66	1.86	1.46
Chicken stock	83.16	83.16	83.16

The Kaeng Liang soup preparation, shallots, shrimp paste, white pepper, and dried shrimp were homogenized by blender (Sharp EM-Ice Powder, Japan) for 10±2 min until the ingredients were homogeneous and then, the mixture was dissolved with chicken soup and heated at 98±2ºC for 15 min then fish sauce was added. Then, Kaeng Liang soups were served to the panelists using 12 experts with a 9-point hedonic scale as 1 (dislike extremely), 2 (dislike very much), 3 (dislike moderately), 4 (dislike slightly), 5 (neither like nor dislike), 6 (Like slightly), 7 (like moderately), 8 (like very much) and 9 (like extremely). The preference rating score of Kaeng Liang product was evaluated in terms of color, odor, flavor, mouthfeel, and overall acceptability (Meilgaard et al., 2007).

3.3 Study of the optimum conditions for the production of Kaeng Liang soup powder by foam-mat drying method

3.3.1 Foam production process

Using a foaming agent, the EWP had 3 different levels of variation at 2%, 4%, and 6% by weight, and carboxymethyl cellulose was used (Caboxymethycellulose: CMC) at 1% by weight (modified method of Poonnakasem, 2019) as a substance to increase the stability of the foam. Then, all ingredients were mixed at a speed of 220 rpm for 4 min to form the foam by the mixer (Kenwood Chef XL, England) before monitoring the foam's physical quality.

3.3.1.1 Foam density

Here, 100 ml of Kaeng Liang foam was put into a measuring cylinder (at room temperature), the sample was weighed, and the density of the foam was calculated using the following equation (Affandi et al., 2017).

$$\text{Foam Density} = [\text{Foam Weight (g)}]/[\text{Foam volume (cm}^3)]$$

3.3.1.2 Stability of foam

Here, 100 ml of Kaeng Liang foam was put into a measuring cylinder. The volume of the foam was measured after it was placed at room temperature for 2 hours (Affandi et al., 2017). The foam stability was calculated using the following equation:

$$\text{Stability of foam (\%)} = [\text{Foam size after 2 h (cm}^3)]/[\text{Initial foam volume (cm}^3)] \times 100$$

3.3.1.3 Foam expansion

Foam expansion was calculated to determine the amount of air incorporated into the liquid (Affandi et al., 2017).

$$\text{Expansion of foam (\%)} = [\text{Difference of final foamed volume and initial liquid volume (cm}^3)]/[\text{Initial liquid volume (cm}^3)] \times 100$$

3.3.1.4 Microstructure of foam

Analyzing the digital images of foam was done using the Image J program (ImageJ 1.52a, National Institutes of Health, Bethesda, M.D.). This was started by preparing a sample of Kaeng Liang foam on a microscope slide wherein the samples were photographed under a microscope (ICS KF2, Zeiss, Oberkochen, Germany) at 40x magnification. Then, the structure of the foam was analyzed including the bubble structure was recorded in terms of the number of bubbles per unit area, average bubble size, and bubble to total area ratio (Poonnakasem et al., 2015; Gallo et al., 2022).

Optimum conditions for the production of Kaeng Liang foam were selected for use in the next experiment by considering the foam density, foam stability, foam expansion, and the microstructure of the foam.

3.3.2 Foam drying process

The Kaeng Liang foam was spread onto trays at a thickness of 2 mm, and placed in an oven (Model 100-800, Memmert, Germany) at 60°C, 70°C, and 80°C for 480 min (modified method of Poonnakasem, 2019), ground by blender (Sharp EM-Ice Powder, Japan) and sifted through a 60-mesh sieve, and then the physical quality of the Kaeng Liang was monitored by measuring the powder as follows:

3.3.2.1 Percentage of production

Calculating the percentage of yield of Kaeng Liang powder following equation (Poonnakasem, 2019):

Yield (%) = [Sample powder sifted through a sieve (g)]/[Whole sample powder (g)]×100

3.3.2.2 Density

To calculate density, 100 ml of Kaeng Liang powder was put into a measuring cylinder (at room temperature). The sample was weighed (Affandi, Zzaman, Yang, & Easa, 2017) by calculating the density of the Kaeng Liang powder using the following equation:

$$\text{Density} = [\text{Powder weight (g)}]/[\text{Powder volume (cm}^3)]$$

3.3.2.3 Color value

The color of Kaeng Liang soup powder was measured using a colorimeter (CR-400, Konica Minolta, Inc., Osaka, Japan), lightness (L*), redness (a*), and yellowness (b*). Then, calculated the browning index using the following equation (Kasim, & Kasim, 2015):

$$\text{Browning index} = [(X - 0.31)/0.17] \times 100$$

$$\text{Where } X = [a^* + 1.75L^*]/[5.645L^* + a - 0.3012b^*]$$

3.3.2.4 Water activity value (a_w)

Kaeng Liang soup powder was packed into a laminated aluminum foil bag and the a_w value was measured using a water activity meter (TH-500, AW sprint novasina, Neuheinatrasse, Switzerland).

3.3.2.5 Moisture content

The moisture content of the Kaeng Liang soup powder was measured and calculated followed by AOAC (2005).

3.3.2.6 pH value

For this test, 1g of Kaeng Liang soup powder samples were added to 15 ml of distilled water (modified method of Öztürk et al., 2019) at 50°C. The pH of the Kaeng Liang was measured after dissolving the water using a pH meter (FiveEasy Benchtop F20, METTLER TOLEDO, Switzerland).

3.3.2.7 Water solubility and water reabsorption index

Here, 3 g of Kaeng Liang soup powder samples were added to 30 ml of distilled water at 50°C, and placed in a water bath for 30 min (WNE Series, Memmert, Germany). The sample solution was centrifuged at 3,500 rpm for 10 min (HERMLE Z 206 A, Wehingen, Germany) before the precipitate was separated to dry at a temperature of 100°C (Model 100-800, Memmert, Germany) overnight (Affandi et al., 2017). This was calculated using the equations below:

Water solubility index (%) = [Dry weight after centrifugation (g)]/[Initial dry weight (g)]× 100

Water reabsorption index (%) = [Wet weight after centrifugation (g)]/[Initial dry weight (g)] × 100

3.4 Study on sensory acceptability and the microbiological and nutritional properties of Kaeng Liang soup powder product

3.4.1 Microbial quality

The selected Kaeng Liang soup powder product was analyzed for microbial content according to the total viable count (TVC), yeast, and mold, as well as *Escherichia coli* and coliform bacteria (Food and Drug Administration (FDA), 2001).

3.4.2 Nutritional value

The selected Kaeng Liang soup powder product was analyzed for fat, protein, carbohydrate, fiber, and ash content and the calculated energy was based on carbohydrates, proteins, and fats (AOAC, 2005).

3.4.3 Sensory evaluation

The selected rehydrated Kaeng Liang soup powder was dissolved and boiled in water, 98±2°C at a ratio of 1.5:100 w/v for 5 min, the ratio was adjusted based on the total solid content of the selected Kaeng Liang soup recipe (data of solid content of Kaeng Liang soup recipe not shown), before, being served to the panelists (15 ml). The sensory acceptability scores of the sample were evaluated in terms of appearance, color, odor, flavor, and overall acceptability by 100 consumers using a 5-point hedonic scale of 1-dislike extremely, 2-dislike slightly, 3-neither like nor dislike, 4-like slightly, and 5-like extremely (Meilgaard et al., 2007). This research was considered for ethical approval in human research. From Human Research Ethics Committee, Rangsit University (COA. No. RSUERB2021-051).

3.5 Statistical analysis

The experiment was designed as a completely randomized design (CRD). The data was subjected to analysis of variance (ANOVA). A comparison of the means was carried out using Duncan's multiple-range tests. Significance was declared at $p<0.05$ using SPSS software.

4. Results

4.1 The acceptability of Kaeng Liang soup recipe

The sensory acceptability was assessed by 12 experts who were teachers specializing in Thai cooking or who had been cooks in an establishment for at least 10 years, both male and female. They had knowledge about Kaeng Liang soup and their results were rated on a 9-point hedonic scale. The results show that the basic formulas (1, 2, and 3) of Kaeng Liang soup are significantly different ($p<0.05$) in terms of flavor, mouthfeel, and overall liking while their color and odor is not different significantly ($p\geq0.05$). The experts rated their liking scores of Kaeng Liang soup formula 1 in all attributions between moderate like and extremely like (7.50 to 8.80) which is the highest score while the other formulas showed a ranged score between slightly like and very much like (6.30 to 7.80) and the result was shown in Table 2. Moreover, from the expert suggestion, Kaeng Liang soup formula 1 provides a better odor and flavor which may be due to the ratio of ingredients of each formula, especially shrimp paste and fish sauce. Therefore, the researchers considered choosing Kaeng Liang soup formula 1 as the result of the sensory acceptability for study in the next step.

4.2 Factors affecting the foam-mat drying of the Kaeng Liang soup powder

For the selected basic formula of Kaeng Liang soup (Formula 1) to be used in this study, the level of foaming agent is EWP which is different at the 3 levels of 2%, 4%, and 6% by weight. For physical quality, it was found that increasing the level of added EWP significantly decreases the foam density at the 95% confidence level as shown in Table 3. The results in this stage are consistent with the foam expansion in which the foam of Kaeng Liang soup with 6% EWP was added the most. Moreover, this study found that adding EWP more than 6% (added 8% and 10%, data not shown) affected the excessive viscosity of the products and was not suitable for analysis in the physical properties and the next experiment. However, the stability of the foam of Kaeng Liang soup at the 2% EWP addition level is less than that at the other levels (Figure 1), indicating that the foam in the Kaeng Liang solution foam at the EWP addition level of 2% is large. If there is insufficient protein, it will affect the stability of the air bubbles and high product porosity (Thuwapanichayanan et al., 2008).

Table 2 Sensory acceptability of Kaeng Liang soup by the expert's liking test

Sensory evaluation	Basic Kaeng Liang soup recipes		
	Formula 1	**Formula 2**	**Formula 3**
Color^{ns}	7.50±0.53	7.20±0.79	7.00±0.94
Odor^{ns}	7.00±0.82	7.80±0.63	7.30±0.82
Flavor	7.50±0.53^{a}	6.70±0.67^{b}	6.35 ± 0.43^{b}
Mouthfeel	8.80±0.42^{a}	6.00±0.67^{b}	6.30±0.95^{b}
Overall liking	8.60±0.52^{a}	6.20±0.63^{b}	6.70±0.67^{b}

$^{a-b}$ means different characters on the same horizontal line are significantly different ($p<0.05$); ^{ns} means no statistically significant difference ($p<0.05$); Values are represented as mean ± standard deviation (n=12).

When considering the microstructure of the Kaeng Liang foam, it was found that the foam of the Kaeng Liang solution with a 6% addition of EWP had the highest number of air bubbles per area, equal to 103.33 cm^{-2}. It is significantly different from the 2% and 4% at the 95% confidence level as shown in Table 4. From Figure 1, shows that the foam of the Kaeng Liang solution with a 6% EWP addition was quite uniform. The average bubble size is smaller than that of the EWP at 2% and 4%. The ratio of air bubbles per area increased with the increasing amount of EWP which is consistent with the density data and foam expansion. When the number of bubbles per area and the ratio of air bubbles per area increases, it will result in more foam expansion and the density of the foam decreases. This has a positive effect on the drying process (Hart et al., 1963) as it reduces the drying time and temperature, allowing the product to dry faster. This will have a positive effect on the nutritional quality of the product.

Based on the above information, the researchers chose to add 6% EWP to Kaeng Liang as a foaming agent for the next experiment.

For the foam drying, Kaeng Liang basic Formula 1 had 6% EWP added and 1% carboxymethyl cellulose (CMC) to produce Kaeng Liang foam with variable degrees of foam drying in an oven at 60°C, 70°C, and 80°C for 480 min and based on our study using a temperature of more 80°C for 480 min found out the samples were overcooked and could not be used for testing in the next step for sensory evaluation. The result showed that drying by hot air at 80°C has a moisture content and lowest water activity representing 4.27% and 0.26%, respectively, as shown in Table 5. As a result, the product trials are in accordance with the standard for instant Kaeng Liang Community Products (No. 1022/2548) which stipulates that the product must not contain more than 8% moisture by weight and the water activity must not exceed 0.6. The moisture content and water activity at the drying temperature of 80°C were significantly different from the drying temperature of 70°C and 60°C. The level of EWP affects the water content activity which is statistically. In foam-mat drying, it is significantly reduced because it allows more air to penetrate into the structure of the foam. This increases the porosity of the foam structure, reducing the drying rate and drying time for Kaeng Liang soup powder that uses EWP at a high level. The pH of Kaeng Liang soup powder was measured and it was found that the pH at the drying condition of 80°C was the lowest. This is different from the drying conditions at 70°C and 60°C resulting in higher acid values. The water solubility index and water reabsorption index of the Kaeng Liang soup powder at 80°C drying condition were the highest and different from the drying conditions at 70°C and 60°C with statistical significance. In relation to the analytical results following the measuring of the color values of the Kaeng Liang soup powder in all 3 conditions, at 60°C, 70°C, and 80ºC, it was found that the lightness (L*), redness (a*), yellowness (b*) and the browning index (BI) showed a significant difference. The redness, yellowness, and browning index values increased while the lightness of the Kaeng Liang soup powder decreased following the increase in the temperature of drying. When considering the results of the production of Kaeng Liang soup powder using the foam-mat method in various quality aspects (yield percentage, density, moisture content, water activity, pH value, and water solubility index). The optimum condition for foam-mat drying at 80°C was selected, although the drying condition of 80°C yields less than other drying conditions. Moreover, the drying condition at 80ºC has the moisture value and water activity value in accordance with the community product standards (No. 1022/2548), including the highest water solubility index and water reabsorption index. Thus, this condition was selected to use for further experiments on the physical, chemical, microbiological, and nutritional properties.

Table 3 Physical quality of the foam of Kaeng Liang soup at different EWP levels

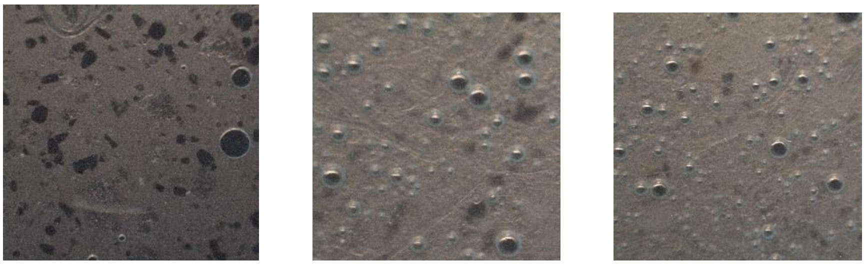
Physical quality of foam	**EWP (%)**		
	2	**4**	**6**
Foam Density (g/cm^3)	0.977 ± 0.005^a	0.960 ± 0.004^b	0.876 ± 0.008^c
Foam Stability (%)	96.33 ± 0.58^c	97.67 ± 0.58^b	99.33 ± 0.58^a
Foam expansion (%)	94.24 ± 1.05^b	95.48 ± 1.63^b	101.46 ± 2.04^a

$^{a-c}$ means within a row with different letters are significantly at the 95% confidence level ($p<0.05$). Values are represented as mean ± standard deviation (n=3).

Table 4 Microstructures of Kaeng Liang foam at different levels of EWP

Microstructure of foam	EWP (%)		
	2	4	6
Number of air bubbles per area (cm^{-2})	10.67±1.53^{c}	21.67±2.08^{b}	103.33±4.04^{a}
Average bubble size (mm^2)	0.32±0.07^{a}	0.22±0.07^{b}	0.12±0.01^{c}
Air bubble to total area ratio (%)	7.60±0.62^{c}	11.97±0.80^{b}	26.54±1.59^{a}

$^{a-c}$ means in the same row refers to a statistically significant difference at the 95% confidence level (p<0.05). Values are represented as mean ± standard deviation (n=3).



(a) (b) (c)

Figure 1 Microstructure of Kaeng Liang foam (40x magnification) at the EWP levels of 2% (a), 4% (b), and 6% (c)

Table 5 Physical quality of Kaeng Liang soup powder dried at different temperatures

Physical characteristic	Drying temperature		
	60°C	70°C	80°C
Yield (%)	89.45±0.11	88.81±0.69	87.99±0.34
Density (g/cm^3)	0.83±0.00^{a}	0.76±0.020^{b}	0.79±0.008^{c}
Color value			
Lightness (L^*)	70.20±0.34^{a}	69.42±0.25^{b}	63.33±0.27^{c}
Redness (a^*)	4.87±0.07^{c}	5.81±0.04^{b}	9.91±0.13^{a}
Yellowness (b^*)	19.60±0.68^{c}	23.64±0.11^{b}	24.90±0.54^{ab}
Browning index (BI)	7.74±0.19^{c}	9.37±0.05^{b}	14.98±0.25^{a}
Water activity	0.55±0.004^{a}	0.45±0.001^{b}	0.26±0.007^{c}
Moisture content (% wet basis)	13.04±0.28^{a}	8.88±0.04^{b}	4.27±0.07^{c}
pH	6.92±0.01^{ab}	6.90±0.01^{b}	6.61±0.08^{c}
Water solubility index (%)	20.15±0.44^{ab}	21.73±1.18^{bc}	25.15±1.87^{c}
Water reabsorption index (%)	6.63±0.21^{c}	6.96±0.13^{bc}	7.51±0.20^{a}

$^{a-c}$ means within a row with different letters are significantly at the 95% confidence level (p<0.05). Values are represented as mean ± standard deviation (n=3).

Table 6 Physical, Chemical, and Microbiological properties of the selected Kaeng Liang soup powder obtained by foam mat drying, using EWP with 1% CMC under drying conditions at 80°C

Physical properties	Chemical properties	Microbiological properties	
L^* = 63.33±0.27	Moisture value (%) = 4.27±0.07	Aerobic Plate Count, cfu/g	= 24.6
a^* = 9.91±0.13	Water Activity = 0.26±0.007	Yeasts and Molds, cfu/g	<10
b^* = 24.90±0.54		Coliform, MPN/g	<3
BI = 14.98±0.25		*E. coli*, MPN/g	Not found

Values are represented as mean ± standard deviation (n=3).

(a) (b) (c)

Figure 3 The presence of the selected Kaeng Liang soup powder (99×103 pixel) adding 6% EWP and 1% CMC and drying temperatures at 60°C (a), 70°C (b), and 80°C (c)

Table 7 Nutritional value of the selected Kaeng Liang soup powder

Nutritional value	Nutrient content (per 100 g of powder)
Total energy (kcal)	608.01
Carbohydrates (g)	3.19
Protein (g)	80.47
fat (g)	9.93
Dietary fiber (g)	0.35
Phosphorus (mg)	370
Calcium (mg)	2,276
Ash (g)	0.83

Table 8 Sensory acceptance scores of the selected rehydrated Kaeng Liang soup powder

Sensory characteristics	Sensory scores (number of consumers)					Mean scores
	1	2	3	4	5	
Appearance	-	2	10	85	2	3.89 ± 0.45
Color	-	3	15	72	10	3.89 ± 0.60
Odor	-	6	22	56	16	3.82 ± 0.77
flavor	-	4	19	63	14	3.87 ± 0.69
Overall liking	-	4	13	71	12	3.91 ± 0.64

Values are represented as mean ± standard deviation (n=100).

4.3 Physical, chemical, and microbiological properties, nutritional value, and sensory qualities of the selected Kaeng Liang soup powder

The Kaeng Liang soup powder obtained from the basic recipe, Formula 1, was added to EWP in the amount of 6% and 1% CMC to produce Kaeng Liang foam. The drying conditions at 80°C were used to analyze the microbial quality of the products before storage in the package which contained the total number of microorganisms shown in Table 6. The above quantity is in accordance with the standard of instant Kaeng Liang community products (No. 1022/2548). The standard requires that the total number of microorganisms must not exceed 1×10^4 colonies per 1 g sample, yeast and mold must not exceed 100 colonies per 1 g sample, and *E. coli* and coliforms must be less than 3 MPN/g sample. This shows that the Kaeng Liang soup powder is safe for consumers which confirms that the production process used in this study is effective at killing or reducing the amount of spoilage-causing microorganisms to be in the acceptable range. In addition, Kaeng Liang soup powder has a moisture content of 4.27% and water activity of 0.26. This conforms to the community product standards set. The moisture value must not exceed 8% by weight and the water activity must not exceed 0.6, which has a positive effect on prolonging the shelf life, slowing down the spoilage from microorganisms. The lightness (L*), redness (a*), yellowness (b*), and browning index (BI) were 63.33, 9.91, 24.90, and 14.98, respectively, indicating that the Kaeng Liang soup powder is less bright and brownish as shown in Figure 3.

The nutritional value of the selected Kaeng Liang soup powder obtained by foam-mat drying using EWP and 1% of CMC in the drying condition at 80ºC had an energy result of 608.01 kcal and carbohydrates, protein, and fat amounting to 39.1990.47 and 9.93 g, respectively. In addition, the dietary fiber content is 0.35 g, and calcium and phosphorus are 370 and 2,276 mg respectively, including 0.83 g of total ash as shown in Table 7. To sum up, the nutritional value of the selected Kaeng Liang soup powder contains beneficial nutrients. It is authentic Thai food and when used as a ready-made meal, vegetables and meat must be added which is healthy and good for consumers. The sensory qualities of the selected Kaeng Liang soup powder are shown in Table 8. The results show that the sensory scores from all samples ranged between 3.82 and 3.91. In addition, the result of the sensory scores pointed out that the consumers accepted the Kaeng Liang soup powder product produced using foam-mat drying.

5. Discussion

Kaeng Liang soup in Formula 1 provided the highest score in flavor, mouthfeel, and overall liking of sensory evaluation and was selected to study in foam-mat drying. Kaeng Liang foam with the addition of 6% EWP shows the greatest expansion due to the properties of the protein in the egg white. It has the property to reduce the surface tension of the solution and result in foam (Prins, 1988). It is consistent with the study by Sangketkit et al. (2017) indicating the production of Bai-ya-nang powder by foam-mat drying. The use of 5% EWP does not cause foam but foam can be formed when using 10% and 15% EWP. Likewise, the study by Poonnakasem (2019) supports that the chili sauce foam at the level of adding 6% EWP has the greatest expansion. In addition, the study by Thuwapanichayanan et al. (2008) shows that the increase in the concentration of egg white foam by 5 - 10% results in a 3% decrease in the density of the banana foam. This range of concentration is the optimum range for the solubility of the EWP in solution. The foam of Kaeng Liang solution for the 6% addition of EWP has the highest number of air bubbles per area equal to 103.33 cm^{-2}. This is significantly different from the 2% and 4% addition at the 95% confidence level as shown in Table 4. This finding also indicates that the foam of the Kaeng Liang solution with the addition of 6% EWP was quite uniform. The average bubble size is smaller than that of the EWP at 2% and 4%. The ratio of air bubbles to area increases with the increased amount of EWP addition, consistent with the density data and foam expansion. When the number of bubbles per area and the ratio of air bubbles per area increases, it will result in more foam expansion, reducing the foam density which has a positive effect on the drying process (Hart et al., 1963).

As shown in Table 5, it was found that the water activity at the drying temperature of 80°C is significantly different from the drying temperatures at 70 and 60°C at the 95% confidence level. This is consistent with the study by Nimitkeatkai, & Potaros (2020) indicating that the moisture content of the product was 4.75-5.50%, and the water activity of all experimental batches was 0.33-0.41, with the level of EWP having a statistically significant effect on the water activity at the 95% confidence level. When the concentration of EWP is higher, the soup powder has a lower water activity and moisture content. This is consistent with the findings of Abbasi, & Azizpour (2016) who reported that increasing the amount of EWP significantly reduces the time of foam-mat drying because it allows more air to penetrate into the structure of the foam and increases the porosity of the foam structure, reducing the drying rate and drying time. Therefore, when using the same drying time to make Kaeng Liang soup powder by using EWP at a high level, it has lower water activity and moisture content than using at low levels. The difference in drying temperature related to the higher acid values of the sample according to the research by Alam et al. (2013), there was a statistically significant difference in the pH of food in the range of 3.21-5.41, which was during the acidic period. It also indicates that food when dried often has significantly different acids in the range of 5.56-8.66. The ability to disperse is related to the solubility of the food powder. It depends on the chemical composition, particle size, shape, and particle density including physical states such as melting temperature, the dispersion of powdered food in water, and its solubility, including denatured proteins in the drying process at high temperatures (Baldwin, & Pearce, 2005). The brightness of the Kaeng Liang soup powder decreased following the increase in temperature of drying. This is consistent with the research by Iqbal et al. (2018), who investigated the drying of powdered lemonade beverages using the foam-mat method at two levels of temperatures, 60ºC and 70ºC, for 90 min was found to reduce brightness.

The number of microorganisms in the selected Kaeng Liang soup powder (Table 6) was in accordance with the standard of the instant finished Kaeng Liang community product (No. 1022/2548), which requires that the total number of microorganisms must not exceed 1×10^4 CFU/g sample and that the yeast and mold must not exceed 100 CFU/g sample. The amount of *E. coli* and coliform must be less than 3 MPN/ g sample. This indicates that Kaeng Liang soup powder is safe for consumers. In addition, the Kaeng Liang soup powder developed has a moisture content of 4.27% and a water activity of 0.26 in line with the standard for instant Kaeng Liang community products where the moisture content must not exceed 8% by weight and water activity. The brightness (L*), redness (a*), yellowness (b*) and browning index (BI) were 63.33, 9.91, 24.90 and 14.98 respectively that was shown that Kaeng Liang soup powder has less lightness and a brownish color. The nutritional value of Kaeng Liang soup powder (Table 7) is 608.01 kcal of energy, including carbohydrates, proteins, and fats of 39.19, 90.47, and 9.93 g, respectively. In addition, the dietary fiber content was 0.35 grams, calcium, and phosphorus were 370 and 2,276 mg, respectively, and there was a total ash content of 0.83 g. The raw material used in the preparation of Kaeng Liang soup powder is white pepper, which is rich in Piperine, an important substance that acts to stimulate gastric acid secretion, increase the rate of blood flow, reduce fat and blood sugar levels, and reduce inflammation. Piperine also increases the dosage and absorption rate of drugs and food, affecting the drug level in the blood. There are many nutrients found in Kaeng Liang such as vitamin C, calcium, potassium, phosphorus, and magnesium (Boonpleng, & Temsiririrkkul, 2015). Regarding the nutritional value of Kaeng Liang soup powder, the calcium content is the highest followed by phosphorus because it mainly consists of shrimp paste, dried shrimp, and chicken stock. Calcium is important for the body, which is a component of bone, and it also performs other functions such as helping in blood clotting and the functioning of the nervous system muscles. This causes the general contraction of muscle cells including the heart muscle. In addition, calcium stimulates the activity of proteins that help in the process of bone formation and breakdown and, most importantly, it helps to control the acid balance in the body as well (Insel et al., 2002). Meanwhile, phosphorus is a mineral that works with calcium. It is responsible for the structure of bones and teeth and other functions such as stimulating the nervous system and muscle contractions (Grovenor, & Smolin, 2002).

6. Conclusion

Based on the results of this study, the characteristics of the foam-mat drying production of Kaeng Liang using 2%, 4%, and 6% of EWP and 1% of CMC dried at 60°C, 70°C, and 80ºC found that the best drying condition was 80ºC for 480 min. The microbiological properties of the selected Kaeng Liang soup powder are in accordance with the community product standards. The nutritional value of the selected Kaeng Liang soup powder contains carbohydrates, proteins, fats, phosphorus, and calcium respectively. The acceptance of the product by 100 general consumers using the 5-point hedonic scale (1-dislike extremely to 5-like extremely) in terms of appearance, color, odor, flavor, and overall acceptability received an accepted score in the range of extremely like as a score of 3.82-3.91. In conclusion, applying foam-mat drying can be used to produce Kaeng Liang powder. Therefore, the investigation of the shelf life of Kaeng Liang soup powder products needs to be further studied.

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8. References

Abbasi, E., & Azizpour, M. (2016). Evaluation of physicochemical properties of foam mat dried sour cherry powder. LWT - *Food Science and Technology*, *68*, 105-110. https://doi.org/10.1016/j.lwt.2015.12.004

Affandi, N., Zzaman, W., Yang, T. A., & Easa, A. M. (2017). Production of Nigella sativa beverage powder under foam-mat drying using egg albumen as a foaming agent. *Beverages*, *3*(1), Article 9. https://doi.org/10.3390/beverages3010009

Alam, M. S., Gupta, K., Khaira, H., & Javed, M. (2013). Quality of dried carrot pomace powder as affected by pretreatments and methods of drying. *Agricultural*

Engineering International: CIGR Journal, *15*(4), 236-243.

AOAC. (2005). Official Methods of Analysis (18 ed.). *Association of Official Analytical Chemists*, Washington DC: AOAC International.

Baldwin, A., & Pearce, D. (2005). Milk powder. In Onwulata, C. (Ed.), *Encapsulated and Powdered Foods* (pp. 387-434)., New York, US: Taylor and Francis Group.

Boonpleng, U. & Temsiririrkkul, R. (2015). *Kaeng Liang food is medicine*. Retrieved April 10, 2023, from https://pharmacy.mahidol.ac.th/knowledge/files/0263.pdf

Food and Drug Administration (FDA) (2001). *Bacteriological Analytical Manual (BAM) online*. Silver Spring, MD.

Gallo, V., Romano, A., Ferranti, P., Auria, G., & Masi, P. (2022). Properties and in vitro digestibility of a bread enriched with lentil flour at different leavening times. *Food Structure*, *33*, Article 100284. https://doi.org/10.1016/j.foostr.2022.100284

Grovenor, M. B. & Smolin, L. A. (2002). *Nutrition From Science to Life*. California, US: Harcourt College Publishers.

Hart, M. R., Graham, R. P., Ginnette, L. E., & Morgan, A. I. (1963). Foams for foam-mat drying. *Food Technology*, *17*(10), 90-92.

Insel, P., Turner, R.E., & Ross, D. (2002). *Nutrition*. Massachusetts, US: Jones and Bartlett Publishers.

Iqbal, J. M., Abbas, A., Rafique, H., Nawaz, M. F., & Rasool, A. (2018). A review paper on foam-mat drying of fruits and vegetables to develop powders. *MOJ Food Processing & Technology*, *6*(6), 465-467. https://doi.org/10.15406/mojfpt.2018.06.00207

Kadam, D. M., Wilson, R. A., Kaur, V., Chadha, S., Kaushik, P., Kaur, S., ... & Rai, D. R. (2012). Physicochemical and microbial quality evaluation of foam- mat-dried pineapple powder. *International Journal of Food Science & Technology*, *47*(8), 1654-1659. https://doi.org/10.1111/j.1365-2621.2012.03016.x

Kasim, R., & Kasim, M.U. (2015). Biochemical changes and color properties of fresh-cut green bean (*Phaseolus vulgaris* L. cv. gina) treated with calcium chloride during storage. *Food Science and Technology*, *35*(2), 266-272. https://doi.org/10.1590/1678-457X.6523

Li, X., Murray, B. S., Yang, Y., & Sarkar, A. (2020). Egg white protein microgels as aqueous pickering foam stabilizers: bubble stability and interfacial properties. *Food Hydrocolloids, 98*, Article 105292. https://doi.org/10.1016/j.foodhyd.2019.105292

Li, X., Wang, Y-M., Sun, C-F., Lv, J-H., & Yang, Y-J. (2021). Comparative study on foaming properties of egg white with yolk fractions and their hydrolysates. *Foods, 10*, Article 2238. https://doi.org/10.3390/foods10092238

Meilgaard, M.C., Civille, G.V., & Carr, B.T. (2007). *Sensory Evaluation Techniques* (4 ed.). Florida, US: CRC Press: Taylor and Francis Group.

Nimitkeatkai, H., & Potaros, T. (2020). Effect of foaming agents on properties of instant pumpkin soup powder using foam mat drying. *Thai Journal of Science and Technology, 28*(5), 790-798. https://doi: 10.14456/tstj.2020.64

Öztürk, F., Kalkan, S., Elmas, E., Elmas, S., Bariş, P., & Demir, Ö. (2019). Some quality parameters of powdered soups prepared from different fish species. *Food Science and Technology, 62*, Article e19180365. https://doi:org/10.1590/1678-4324-2019180365

Phaechamud, T., Sarunyakasitrin, K., & Choncheewa, C. (2012). Instant powder of Malabar tamarind fruit extract prepared by foam-mat method. *Advanced Materials Research*, 506, 351-354. https://doi.org/10.4028/www.scientific.net/AMR.506.351

Ponguttha, S., Charoenkiatkul, S., Jitjamrunchokchai, J., Angkasirisan, W., & Butadej, D. (2011). *Kaeng Liang*. Retrieved September 23, 2021 from https://www.gotoknow.org/posts/420677

Poonnakasem, N., Chaiwanichsiri, S., & Laohasongkram, K. (2015). Influence of hydrocolloids on batter properties and textural kinetics of sponge cake during storage. *Journal of Food Quality*, *38*(6), 441-449. https://doi.org/10.1111/jfq.12167

Poonnakasem, N. (2019). *Production of instant chili sauce powder using foam mat drying* [Research project]. Food Technology, School of Culinary Arts, Suan Dusit University, Thailand.

Prins, A. (1988). Principles of foam stability. In: Dickinson, Stainsby, G. (Eds.), *Advances in food Emulsions and Foams* (pp. 91-122). New York, US: Elsevier Applied Science.

Sangketkit, C., Sangyojarn, P., & Kiatsakared, P. (2017). *Yanang (Tiliacora triandra Colebr. Diels) powder production by foam-mat drying.* Retrieved April 8, 2023 from http://www.foodnetwork solution.com/wiki/word/0277/dehydration

Sri-Ngernyang, Y. & Samret, C. (2013). *Thai Curry* (1 ed.). Bangkok, Thailand: Sangdad Book.

Thuwapanichayanan, R., Prachayawarakorn, S., & Soponronnarit, S. (2008). Drying characteristics and quality of banana foam mat. *Journal of Food Engineering*, *86*(4), 573-583. https://doi.org/10.1016/j.jfoodeng.2007.11.008

Tulardilok, K. (2009). *Production of Pickled Garlic powder by Foam-mat Drying* [Master degree]. Chiang Mai University, Thailand.