



## Development of a Nutritious Instant Soup for the Elderly: Thai Chicken Soup with Coconut and Galangal (*Tom Kha Gai*)

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### Article info

#### Article history:

Received : 27 September 2024

Revised : 21 November 2024

Accepted : 1 December 2024

#### Keywords:

Instant soup, Thai flavor, Elderly, Functional food, Nutrition

### Abstract

This research aims to develop a Thai-flavored instant soup product familiar to Thai seniors. Ranked as the highest on the list of the best chicken soups in the world, Thai Chicken Soup with Coconut and Galangal, or *Tom Kha Gai*, topped the TasteAtlas global food mapping site in 2023 (Bangkok Post, 2023). The ingredients of the soup are primarily vegetables and herbs with high nutritional value, including king oyster mushrooms, enoki mushrooms, straw mushrooms, kaffir lime leaves and galangal. The production process of the instant soup was studied, and the results showed that, among the different drying techniques, the freeze-drying method was able to preserve the sensory characteristics of the soup better than the drum-drying technique ( $p \leq 0.05$ ). The results indicated that the instant *Tom Kha Gai* soup with emulsion powder encapsulated with vitamin B1, B2, B12, and folate had substantially higher levels of these nutrients ( $p \leq 0.05$ ) compared to the instant *Tom Kha Gai* soup without the emulsion supplements, while maintaining similar dietary fiber content. The consumer acceptance test showed a high perceived liking for the instant *Tom Kha Gai* with a score of "Like Very Much" ( $7.4 \pm 1.1$ ). Furthermore, 89% of the consumers accepted the product, and 86% expressed their willingness to purchase it if available for sale. Therefore, the development of the nutritional Thai-flavored instant soup successfully met the demands of elderly and health-oriented consumers.

### Introduction

The World Health Organization (WHO) defines elderly individuals as those aged 65 years or older. The percentage of the global population aged 60 years or older is increasing. In 2019, there were one billion individuals aged 60 or older worldwide. According to the World Health Organization (2023), this number is

projected to rise to 1.4 billion by 2030 and 2.1 billion by 2050. An aging society is beginning to emerge in Thailand. According to the most recent data based on civil registration statistics from the Ministry of Interior, Thailand's population was 66 million. Thirteen million, or 19% of the total population were aged 60 or older (Foundation of Thai Gerontology Research and Development Institute, 2022). The health service and

health food sectors represented the largest share of the market value related to the elderly, estimated to be worth up to 107 billion baht in total for the year 2020 (Bangkokbiznews, 2020). Accordingly, the senior population, having saved a substantial amount of money from their previous employment, can be seen as customers with significant purchasing power. When it comes to senior nutrition it is essential to consume health-promoting products to maintain good health. Additionally, ample food awareness is crucial, as it directly influences the health of the elderly. Several factors, including inadequate dietary intake and altered metabolic processes, contribute to the frequent physical changes experienced by elderly individuals, which may result in their bodies not absorbing essential nutrients effectively. The primary cause of many problems affecting the elderly is these changes in the body. They reduce the need for food consumption due to difficulties in chewing and a decrease in various food perceptions. Consequently, the elderly may become malnourished as a result of these factors. The nutritional needs of the elderly are similar to those of people of various ages, although they are different in terms of energy and quantity. Senior citizens require less energy, due to reduced activity levels. As a result, meals for senior consumers should be highly nutritious but low in energy. Thai senior men and women are recommended to aim for daily caloric intakes of 1740–1790 kcal and 1540–1560 kcal, respectively (Bureau of Nutrition, 2020). Low protein intake affects intestinal function and food absorption in the elderly. Seniors need between 55 and 75 percent of energy from carbohydrates. It is especially important to eat complex carbohydrates to help maintain normal blood sugar levels. In addition to carbohydrates, it is recommended that adults consume 25 to 32 grams of fiber per day for women and 30 to 35 grams per day for men (Stephen et al., 2017).

Due to the natural deterioration of the body among the elderly, eating a nutritious diet is essential for maintaining overall health. Proper nutrition can reduce the risk of developing chronic conditions such as diabetes, high blood pressure, and cardiovascular disease. Functional food is defined as processed food made from functional food ingredients or fortified with health-promoting additives (Aluko, 2012). A growing number of senior citizens are interested in preventive and improvement measures for their health, leading to the development of functional foods enhanced with bioactive ingredients. One common finding emphasizes the

need for developing food products with functional characteristics, which can help rationalize the nutrition of the elderly (Karthikeyan et al., 2021). Inadequate consumption of vitamin B12 and folates can contribute to deficiencies in old age. Vitamin B12 absorption is reduced in elderly individuals due to decreased production of pancreatic and stomach digestive enzymes and salt cavity secretion. Additionally, atrophic alterations in the gastric mucosa further compromise vitamin B12 binding and absorption. Folates are also known for their high-temperature sensitivity (Ahmed & Haboubi, 2010).

It is necessary for senior citizens to continue eating healthy foods to remain active and physically healthy throughout the day. Preventing malnutrition is essential, particularly for the elderly, as it can result in various health issues, including non-communicable diseases (Farzana et al., 2017). Enhancing the food's nutritional quality by adding of macro- and micronutrient sources suitable for the elderly can further improve their overall health. Regarding nutritional value, mushrooms are highly nutritious. According to Karaman et al. (2010), they are low in calories, high in protein containing all of the essential amino acids, and rich in minerals and vitamins, while also being low in cholesterol. They include dietary fiber as well. Several mushroom species have been investigated for their potential to enrich food with minerals essential to human health (Assunção et al., 2012; Rabinovich et al., 2007). *Pleurotus ostreatus*, also known as oyster mushrooms are a good source of antioxidants and nutritional components. The dietary characteristics are impressive, providing total carbohydrates (70–76 g/100 g), protein (19–35 g/100 g), fiber (4–20 g/100 g), and smaller amounts of minerals (Ca, K, Mg, Na, P, Cu, Fe, and Mn) and vitamins (B1, B2, B12, niacin, folate, and ascorbic acid), all with a low lipid level (Mattila et al., 2001). The winter mushroom, also known as enoki, is the fifth most cultivated type of mushroom worldwide and is gaining popularity due to its potential nutritional and medicinal benefits (Tang et al., 2016).

Moreover, undesirable changes in nutrition and sensory characteristics can occur with the direct addition of micronutrients to powdered food. According to Mozuraityte et al. (2015), micronutrients are extremely reactive molecules that are easily oxidized and chelated by other food ingredients. Encapsulation has proven to be an effective alternative for creating a barrier that prevents chemical reactions and controls the release of

components (Dhakal & He, 2020). Arazo-Rusindo et al. (2023) investigated the redesign of an instant lentil soup with enhanced micronutrient bioavailability and suitable sensory characteristics for the elderly. The encapsulation of calcium and vitamin D3 emulsions, along with iron dispersions by spray drying, significantly improved their micronutrient bioavailability at both the particle level and within the food matrix. Mohamed et al. (2020) evaluated the functional instant soup combinations recently developed as nutritional supplements for the elderly, considering their physical, sensory, chemical, and biological properties. Two instant soup mixtures were prepared using lyophilized chickpeas, various vegetables, and some by-products at 5% and 10% concentrations.

It is worth noting that the emulsion encapsulating water-soluble vitamins, including folate, B1, B2, and B12, can be utilized as dietary supplements in functional food for the elderly. *Tom Kha Gai*, a well-known chicken soup, was chosen for its medicinal qualities, high nutritional content, and ideally mellow flavor. It aids in bodily nourishment, inflammation reduction, and digestive system relaxation. This is due to the Thai herbs used in this soup, such as kaffir lime leaves, chili, lemon grass, and young galangal. Thus, an instant soup with a famous Thai flavor was created for the elderly by using this emulsion as a nutritional supplement. It is convenient to prepare and easy to eat, making it a practical meal for seniors. The objective is to develop Thai-flavored instant soup products for the elderly that combine highly nutritious vegetables with beneficial active compounds from herbs to enhance their meals with nutrients. To make the meal age-appropriate and beneficial, an emulsion powder containing vitamins B1, B2, B12, and folate is added. The taste is satisfying to the elderly, and it is easy to eat and swallow.

## Materials and methods

### 1. Materials

*Tom Kha Gai* instant soups were prepared with the following herbs and vegetables cultivated in Thailand: straw mushroom (*Volvariella volvacea*), king oyster mushroom (*Pleurotus eryngii*), enoki mushroom (*Flammulina filiformis*), coriander root (*Coriandrum sativum*), young galangal (*Alpinia galanga* (L.) Willd.), lemongrass (*Cymbopogon citratus* Stapf), kaffir lime leaves (*Citrus hystrix*), lime (*Citrus aurantiifolia* (Christm.) Swingle), and bird's eye chili (*Capsicum frutescens* Linn.).

Additionally, the following components are also used for developing *Tom Kha Gai* instant soup: Hom Mali rice (Khaw Dok Mali 105, cultivated in Sakon Nakorn province, Thailand), UHT coconut milk (AROY-D, Samut Prakan province, Thailand), coconut cream alternative (4care, Bangkok, Thailand), fish sauce (Tiparos, Bangkok, Thailand), chicken breast (Betagro, Samut Sakorn province, Thailand).

The nutritional additive used in this research was an emulsion powder formulated by Sermsthanaswadi et al. (2023), which contains vitamins B1, B2, B12, and folate. Each 25 g of emulsion powder has 5 mg of B1, 4 mg of B2, 700 µg of B12, and 1 mg of folate.

### 2. Formulation of *Tom Kha Gai* soup for the elderly

A formula was developed for instant *Tom Kha Gai* soup powder incorporating high-nutrient vegetables and herbs with beneficial active ingredients. The prototype of *Tom Kha Gai* soup is detailed in Table 1.

#### 2.1 Prototype of *Tom Kha Gai* soup

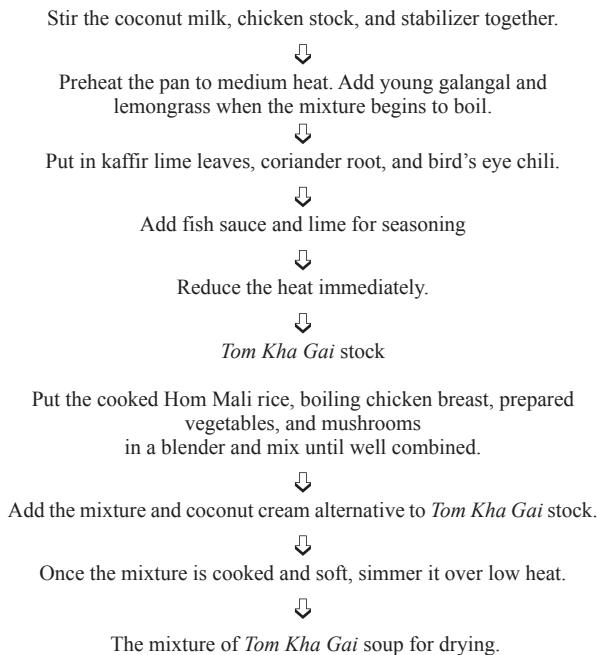
Table 1 The ingredients of the prototype *Tom Kha Gai* soup

Ingredients	Percentage
Ingredients of <i>Tom Kha Gai</i> stock	
Young galangal	9.16
Lemon grass	7.32
Kaffir lime leaves	0.64
Coriander root	0.55
Fish sauce	4.12
Lime	4.58
Bird's eye chili	0.37
Coconut milk	27.47
Chicken stock	45.79
Ingredients of <i>Tom Kha Gai</i> soup	
Hom Mali rice	2.35
Straw mushroom	4.68
Carrot	1.87
Onion	1.12
Chicken breast	7.50
Coconut cream alternative	2.82
<i>Tom Kha Gai</i> stock	79.66

Remark: Modified from School of Culinary Arts (2016)

### 2.2 Preparation of *Tom Kha Gai* soup for drying

There are two steps involved in producing *Tom Kha Gai* soup for drying: making *Tom Kha Gai* stock and preparing *Tom Kha Gai* soup. The soup must be thoroughly boiled and mixed before starting the drying process, as shown in Fig. 1.



**Fig. 1** Preparation of *Tom Kha Gai* soup for drying

### 2.3 Sensory evaluation

Fifty panelists, recruited from Bangkok, Thailand, participated in the sensory evaluation. The target panelists were selected based on their soup consumption frequency, which was at least once a month. Using a 9-point hedonic scale, the panelists rated their liking of the soup samples' appearance, color, aroma, sweetness, saltiness, sourness, spiciness, viscosity, and overall liking (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither dislike nor like, 6 = like slightly, 7 = like moderately, 8 = like very much, 9 = like extremely) (Lawless & Heyman, 1998). The adequacy of seven attributes (color, aroma, sweetness, saltiness, sourness, spiciness, and viscosity) was measured using just-about-right (JAR) scales, ranging from 1 = "much less" to 3 = "much more," with the middle value 2 = "just about right." These scales are used in consumer research to determine whether a particular attribute is perceived in a product at 'too much', 'not abundant', or 'acceptable' levels. The middle point of the scale represents the ideal or acceptable value, while the extreme ends show the level of an attribute that deviates from the ideal point in opposing directions (Rothman & Parker, 2009). Sequential monadic order was followed while serving the samples to each panelist. Between each sample, panelists were also instructed to rinse their mouths with water.

### 3. Process development of *Tom Kha Gai* instant soup for the elderly

The development processes for producing instant soup include drum-drying and freeze-drying. The following are the sample preparation and drying conditions:

#### 3.1 Drum-drying

Each Thai-flavored soup was mixed with xanthan gum (0.5% w/w) using a homogenizer at 5,000 rpm before being subjected to drum-drying (Drum dryer, OFM, DOFM19/26, Thailand). The mixture was then coated onto a drum operating at 130°C at 8 rpm for one min. Drum-dried soup samples were cooled to room temperature, powdered, packed in aluminum foil bags, and stored appropriately for further experiment.

#### 3.2 Freeze-drying

Using a homogenizer set at 5,000 rpm, Thai-flavored soups were mixed with 0.5% w/w xanthan gum. The prepared soup samples were subjected to freeze-drying (Martin Christ, Beta 1-8 LD plus, Germany) at an operating condition of 0.110 mbar and -40°C for 24–48 h (Celik & O'Sullivan, 2013). After drying, the samples were ground into powder, packed into aluminum foil bags, and stored at room temperature.

The following is a comparison of the properties of the powder samples produced by the two drying processes:

#### 3.3 Sensory evaluation

Fifty health-conscious panelists and senior consumers (60 years of age and older) from Bangkok, Thailand's metropolitan area were selected for the sensory evaluation. The target panelists were chosen based on their soup consumption frequency, which was at least once a month. They were asked to score their liking of the soup samples as well as the appearance, color, aroma, sweetness, saltiness, sourness, spiciness, viscosity, and overall liking on a 9-point hedonic scale. The tested samples included freshly prepared soup, freeze-dried soup, and drum-dried soup. To prepare the samples of the freeze-dried, and drum-dried soups, a mixture of 25 g of soup powder and 225 g of boiling water was used.

### 4. Enhancement of nutritional additive in *Tom Kha Gai* instant soup

A functional instant *Tom Kha Gai* soup for the elderly with emulsion powder encapsulated with vitamins B1, B2, B12, and folate was developed. The glycosphingolipid microemulsion was shown to release vitamins in both the simulated stomach and small intestinal fluids, indicating its potential to release enclosed vitamins

when added to food as a nutritional supplement (Sermsathanaswadi et al., 2023). The optimum formula for *Tom Kha Gai* soup was used as the finished product prior to the consumer acceptance test, ensuring it was an acceptable functional food. Subsequently, all aspects of quality, including chemical and physical properties, as well as sensory evaluation, were evaluated (as mentioned in Topic 3).

#### 4.1 Chemical analysis

The proximate analysis (ash, moisture, fat, crude fiber, and protein) was conducted in accordance with the methods of AOAC (2019), and the results were expressed in g/100 g (dry basis). Vitamins and minerals (vitamin A, vitamin B1, vitamin B2, vitamin B12, sodium, calcium, and iron) were determined according to the methods of AOAC (2019). Folate was analyzed using immunoaffinity columns for the analysis of folic acid by HPLC (R-Biopharm).

#### 4.2 Physical properties

Water activity ( $a_w$ ) of soup powders were determined using water activity meter (Sprint Novasina, Switzerland). The viscosity of soup samples (each prepared by mixing 25 g of soup powder and 225 g of boiling water) was measured using a Brookfield viscometer at 120 rpm. spindle no.2 according to the Brookfield manual. The color of soup powders was measured using a colorimeter (CR-410, Konica Minolta, Inc., Japan) by the CIE system ( $L^*$ ,  $a^*$ ,  $b^*$ ) and reported as average individual values marked as  $L^*$  (lightness),  $a^*$  (+a = red, -a = green), and  $b^*$  (+b = yellow, -b = blue). Each measurement was carried out in triplicate.

#### 5. Acceptability test

For a survey focusing on 100 target consumers—including seniors 60 years of age and older and health-conscious individuals who consume soup at least once a month—a questionnaire was used to gather data. Ethical approval was obtained from the Research Ethics Committee, Suan Dusit University Ethics Committee (SDU-RDI-HS 2022-026). The questionnaire included questions on demographics, product preferences rated by a 9-point hedonic scale, and consumer acceptance as determined by a binomial (yes/no) scale.

#### 6. Statistical analysis

Formulation data were calculated in triplicate as the mean liking score with a standard deviation. The results for process development were conducted based on a randomized completely block design, with data presented as the mean liking score with a standard deviation. Data were analyzed using SPSS software version 25 (SPSS

Inc., Chicago, IL, USA). Mean values were compared using Duncan's Multiple Range Test after one-way ANOVA. The frequency (%) and mean liking score of consumers on the developed instant soup were used to represent the acceptance test results. Statistical difference was established at  $p<0.05$ .

## Results and discussion

### 1. The optimum formula of *Tom Kha Gai* soup for the elderly

Table 2 presents the results of the sensory attributes (appearance, color, aroma, sweetness, saltiness, sourness, spiciness, viscosity, and overall liking) evaluated on a 9-point hedonic scale using 50 target panelists. Each of the characteristics of *Tom Kha Gai* soup was rated by the panel as moderately liked with scores ranging from  $7.1\pm1.5$  to  $7.5\pm1.4$ .

Table 2 Mean liking scores of prototype *Tom Kha Gai* soup

Sensory attributes	n=50
Appearance	$7.3\pm0.9$
Color	$7.5\pm1.4$
Aroma	$7.2\pm1.1$
Sweetness	$7.4\pm1.0$
Saltiness	$7.5\pm1.3$
Sourness	$7.2\pm1.2$
Spiciness	$7.3\pm1.5$
Viscosity	$7.1\pm1.5$
Overall liking	$7.3\pm1.2$

Based on the appropriateness of specific attributes using a just-about-right (JAR) scale, it was discovered that some panelists selected a score of 70% or above for each sensory attribute. This indicates that no changes were required, as mentioned in Fig. 2.

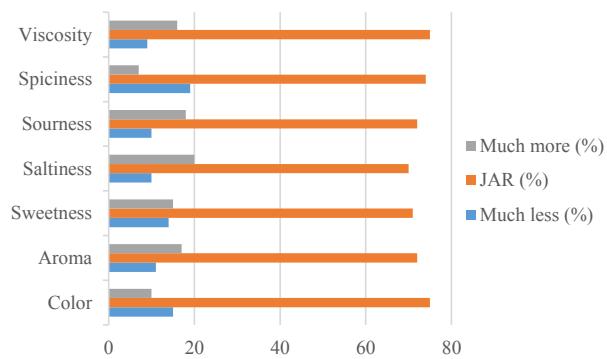


Fig. 2 Just-about-right (JAR) scale percentages of responses grouped in three levels of the prototype *Tom Kha Gai* soup

The researcher provided several kinds of mushrooms, including straw mushrooms, king oyster mushrooms, and enoki mushrooms, known for their high protein and antioxidant content, to the *Tom Kha Gai* soup to enhance the nutritional properties of the prototype formula (Rizzo et al., 2021). The total phenolic compound content of the straw, king oyster, and enoki mushrooms was determined to be  $190.96 \pm 0.89$ ,  $201.4 \pm 0.91$ , and  $12.23 \pm 0.71$  mg GAE/100 g dry weight, respectively, based on the evaluation of all phenolic compounds. Table 3 lists each of the ingredients in the developed nutritional formula of *Tom Kha Gai* soup.

**Table 3** The ingredients of the developed *Tom Kha Gai* soup

Ingredients	Percentage
Ingredients of <i>Tom Kha Gai</i> stock	
Young galangal	9.16
Lemongrass	7.32
Kaffir lime leaves	0.64
Coriander root	0.55
Fish sauce	4.12
Lime	4.58
Bird's eye chili	0.37
Coconut milk	27.47
Chicken stock	45.79
Ingredients of <i>Tom Kha Gai</i> soup	
Hom Mali rice	31.25
Straw mushroom	10.00
King oyster mushroom	10.00
Enoki mushroom	5.00
Chicken breast	6.25
<i>Tom Kha Gai</i> stock	37.50

Following the formula improvement, Table 4 displayed the sensory attribute results (appearance, color, aroma, sweetness, saltiness, sourness, spiciness, viscosity, and overall liking). The sensory characteristics were compared using a 9-point hedonic scale (1 = dislike extremely; 9 = like extremely). It was found that consumers liked every attribute of the nutritionally enhanced *Tom Kha Gai* soup at a 'moderately like' level with scores ranging from  $7.0 \pm 1.3$  to  $7.5 \pm 1.2$ .

**Table 4** Mean liking scores of developed *Tom Kha Gai* soup

Sensory attributes	Mean liking score n=50
Appearance	7.1±1.2
Color	7.3±1.2
Aroma	7.0±1.3
Sweetness	7.3±1.1
Saltiness	7.5±1.2
Sourness	7.2±1.3
Spiciness	7.4±1.4
Viscosity	7.3±1.2
Overall liking	7.3±1.0

## 2. The optimum process of *Tom Kha Gai* instant soup for the elderly

The next process involves using the appropriate formula, where xanthan gum was added as a stabilizer at a level of 0.5% of the total ingredients for drying using the two drying methods: drum drying-and freeze-drying. All three samples for *Tom Kha Gai* soup; fresh *Tom Kha Gai* soup (control sample), instant *Tom Kha Gai* soup from drum drying, and instant *Tom Kha Gai* soup from freeze drying are available for study. Instant soup samples (produced by drum- and freeze-drying) are prepared by mixing 25 g soup powder with 225 g of boiling water and stirring thoroughly. Sensory evaluation was conducted using a 9-point hedonic scale (1 = dislike extremely; 9 = like extremely) (Lawless & Heyman, 1998) with 50 target panelists. The characteristics of *Tom Kha Gai* soup evaluated included appearance, color, aroma, sweetness, saltiness, sourness, spiciness, viscosity, and overall liking, as shown in Table 5.

**Table 5** Mean liking scores of fresh (control), drum-dried, and freeze-dried *Tom Kha Gai* soups

Sensory attributes	Mean liking score		
	Fresh soup (control)	Drum-dried soup	Freeze-dried soup
Appearance	7.3±1.1 <sup>a</sup>	6.8±1.1 <sup>b</sup>	7.3±1.2 <sup>a</sup>
Color <sup>ns</sup>	7.2±1.0	7.1±1.3	7.1±1.1
Aroma	7.5±1.4 <sup>a</sup>	6.7±1.0 <sup>b</sup>	7.4±1.3 <sup>a</sup>
Sweetness <sup>ns</sup>	7.2±1.3	7.2±1.1	7.2±1.1
Saltiness <sup>ns</sup>	7.2±1.1	7.1±1.2	7.1±1.2
Sourness <sup>ns</sup>	7.1±1.3	7.0±1.4	7.1±1.2
Spiciness <sup>ns</sup>	7.2±1.1	7.1±1.2	7.1±1.3
Viscosity	7.4±1.0 <sup>a</sup>	6.8±1.4 <sup>b</sup>	7.3±1.2 <sup>a</sup>
Overall liking	7.2±1.3 <sup>a</sup>	6.8±1.3 <sup>b</sup>	7.1±1.0 <sup>a</sup>

**Remark:** Means in rows followed by different letters represent significant differences ( $p \leq 0.05$ ).

<sup>ns</sup> = Means in row do not have significant differences ( $p > 0.05$ ).

The results showed no significant difference ( $p > 0.05$ ) in the ratings for color, sweet taste, salty taste, sour taste, and spicy taste, all of which were rated as 'moderately like' ( $7.0 \pm 1.4$ – $7.2 \pm 1.3$ ). Participants rated the instant *Tom Kha Gai* soup from freeze-drying and the control formula for appearance, aroma, viscosity, and overall liking as 'moderately like' ( $7.1 \pm 1.0$  to  $7.4 \pm 1.3$ ), with no significant difference ( $p > 0.05$ ). According to (Jakubczyk & Jaskulska (2021),) this is consistent with findings for instant soups made with raw vegetables. Freeze drying is a useful technique for achieving desirable sensory attributes, as it helps the soup maintain its fresh color and flavor. It preserves the quality of important components and is suitable for producing

instant soups with high-nutrient ingredients, including various mushrooms and their antioxidant levels. As a result of this, freeze-drying soups to retain their nutritional contents has become popular (Mohamed et al., 2020). Based on the liking scores for each characteristic, it was decided that to continue the study by producing the instant *Tom Kha Gai* soup using the freeze-drying method.

Table 6 presents the chemical composition (ash, moisture, fat, protein, crude fiber, and carbohydrate) of the freeze-dried and drum-dried *Tom Kha Gai* soups. When compared to freeze-dried *Tom Kha Gai* soup, the protein level of drum-dried soup was lower. This difference may be due to denaturation or changes in solubility during heating causing the protein to leak into the water (Huang et al., 2024). In terms of moisture, it was found that samples dried by both methods had moisture content lower than 10%, which was safe for loss of nutritional quality. This low moisture content also prevents the growth of microorganisms that cause food to deteriorate (Afolabi, 2014).

**Table 6** Proximate analysis of drum-dried and freeze-dried *Tom Kha Gai* soups

Quality attributes	Drum-dried soup	Freeze-dried soup
Ash (g/100g) <sup>ns</sup>	6.67±0.13	6.83±0.09
Moisture (g/100g)	4.94±0.05 <sup>a</sup>	0.15±0.01 <sup>b</sup>
Fat (g/100g)	27.39±0.45 <sup>a</sup>	19.05±0.33 <sup>b</sup>
Crude fiber (g/100g)	18.13±0.35 <sup>a</sup>	12.25±0.43 <sup>b</sup>
Protein (g/100g)	13.70±0.09 <sup>b</sup>	25.63±0.11 <sup>a</sup>
Carbohydrate (g/100g)	47.30±1.05	48.34±1.07
Calories (g/100g)	490.54±0.99 <sup>a</sup>	470.32±1.11 <sup>b</sup>

**Remark:** Means in rows followed by different letters represent significant differences (p≤0.05).

<sup>ns</sup> = Means in row do not have significant differences (p>0.05).

### 3. Qualities of instant *Tom Kha Gai* soup with nutritional additive

The instant *Tom Kha Gai* soup is produced using a freeze-drying process to preserve the nutritional quality. The optimal formula and process for producing instant *Tom Kha Gai* soup were supplemented with an emulsion powder encapsulated with vitamins B1, B2, B12, and folate. This light yellow, odorless, and fine emulsion powder had an average particle size of 80–100 nm. Each 25 g of emulsion powder contained 5 mg of Vitamin B1, 4 mg of vitamin B2, 700 µg of vitamin B12, and 1 mg of folate. The concentration of each vitamin in emulsion powder was evaluated by the HPLC (Shimadzu Corp., Kyoto, Japan).

The recommended daily intake of vitamins and minerals are as follows: vitamin B1 is 1.1–1.2 mg,

vitamin B2 is 1.1–1.3 mg, vitamin B12 is 2.4 µg, and folate is 300 µg (with a limit of 1000 µg) (Bureau of Nutrition, 2020; WHO & FAO, 2004). As a result, 16 g of emulsion powder containing vitamin B1, vitamin B2, vitamin B12, and folate were added to the container for every 100 g of soup powder. The mixed powder was then packed in aluminum foil bags, each weighing 25g, and sealed. The instant *Tom Kha Gai* soup and the instant *Tom Kha Gai* soup enhanced with emulsion powder containing vitamins B1, B2, B12, and folate (25 g/bag) should be combined with 225 g of boiling water and stirred well. The results for the instant *Tom Kha Gai* soup and instant *Tom Kha Gai* soup supplemented with emulsion powder were compared based on their chemical and physical qualities, as shown in Tables 7 to 9.

Table 7 shows that the two formulations of instant *Tom Kha Gai* soup had considerable protein content (25.57 g and 21.33 g/100 g, respectively). The addition of emulsion powder which increased the carbohydrate content, leading to a decrease in the protein and fat values of the instant *Tom Kha Gai* soup. Mannan-oligosaccharides are a class of carbohydrates used in the emulsion powder, serve as cryoprotectants (Sermsathanaswadi et al., 2023).

**Table 7** Proximate analysis of instant *Tom Kha Gai* soup and instant *Tom Kha Gai* soup supplemented with emulsion powder

Quality attributes	Instant <i>Tom Kha Gai</i> soup	Instant <i>Tom Kha Gai</i> soup supplemented with emulsion powder
Ash (g/100g)	6.78±0.11 <sup>a</sup>	5.68±0.09 <sup>b</sup>
Moisture (g/100g) <sup>ns</sup>	0.13±0.00	0.14±0.00
Fat (g/100g)	19.23±0.53 <sup>a</sup>	16.84±0.44 <sup>b</sup>
Crude fiber (g/100g)	12.31±0.50 <sup>a</sup>	10.52±0.25 <sup>b</sup>
Protein (g/100g)	25.57±0.11 <sup>a</sup>	21.33±0.13 <sup>b</sup>
Carbohydrate (g/100g)	48.29±1.15 <sup>b</sup>	56.01±1.25 <sup>a</sup>
Calories (g/100g) <sup>ns</sup>	468.51±0.93	460.92±1.12

**Remark:** Means in rows followed by different letters represent significant differences (p≤0.05).

<sup>ns</sup> = Means in row do not have significant differences (p>0.05).

According to the nutritional analysis, the instant *Tom Kha Gai* Soup contains dietary fiber, vitamin B2, and vitamin B12. This is due to the inclusion of high-dietary-fiber raw materials such as enoki, king oyster, and straw mushrooms (Mattila et al., 2001). Additionally, the contents of vitamins B1, B2, B12, and folate increased with the addition of the encapsulated emulsion powder, as shown in Table 8. Meanwhile, Table 9 indicates the vitamin and mineral values of each serving (25 g of instant soup) of instant soup fortified with emulsion powder.

**Table 8** Vitamin and mineral contents of instant *Tom Kha Gai* soup and instant *Tom Kha Gai* soup supplemented with emulsion powder

Quality attributes	Instant <i>Tom Kha Gai</i> soup	Instant <i>Tom Kha Gai</i> soup supplemented with emulsion powder
Vitamin A (μg/100 g)	< 35.57±0.00	< 35.57±0.00
Vitamin B1 (mg/100 g)	0.07±0.00	1.35±0.00
Vitamin B2 (mg/100 g)	0.18±0.00	0.82±0.01
Vitamin B12 (μg/100 g)	0.38±0.00	4.98±0.01
Folate (μg/100 g)	-	37.50±0.01
Sodium (mg/100 g)	1,463.00±0.00	1,230.00±0.00
Calcium (mg/100 g)	42.50±0.00	36.30±0.00
Iron (mg/100 g)	2.06±0.01	1.68±0.01

**Table 9** Vitamin and mineral contents of instant soup supplemented with emulsion powder per serving (25 g of instant soup)

Quality attributes	Instant <i>Tom Kha Gai</i> soup supplemented with emulsion powder	% Daily value*
Vitamin A (μg/100 g)	< 8.89±0.00	1
Vitamin B1 (mg/100 g)	0.34±0.00	30
Vitamin B2 (mg/100 g)	0.21±0.01	20
Vitamin B12 (μg/100 g)	1.66±0.01	69
Folate (μg/100 g)	9.38±0.01	4
Sodium (mg/100 g)	307.50±0.00	16
Calcium (mg/100 g)	9.08±0.00	1
Iron (mg/100 g)	0.42±0.01	4

**Remark:** \*The % Daily Value (DV) tells you how much nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

Table 10 presents the comparison between the physical properties of instant *Tom Kha Gai* soup and instant *Tom Kha Gai* soup with emulsion powder. The study results showed no difference in the water activity ( $a_w$ ) of both soups, with the values remaining within the food standard criteria for dry food products, which is set at less than 0.6 (James, 2000).

The color values ( $L^*$ ,  $a^*$ ,  $b^*$ ) of instant *Tom Kha Gai* soup and instant *Tom Kha Gai* soup with emulsion powder showed that adding the light yellow-white emulsion powder increased the brightness value ( $L^*$ ) and the yellow value ( $b^*$ ) of the soup with statistical

**Table 10** Physical properties of instant *Tom Kha Gai* soup and instant *Tom Kha Gai* soup supplemented with emulsion powder

Quality attributes	Instant <i>Tom Kha Gai</i> soup	Instant <i>Tom Kha Gai</i> soup supplemented with emulsion powder
Water activity (at 25°C) <sup>ns</sup>	0.033±0.001	0.036±0.001
Viscosity (cps)	312.00±1.21 <sup>a</sup>	140.00±0.71 <sup>b</sup>
Color		
$L^*$	86.12±0.06 <sup>b</sup>	88.99±0.09 <sup>a</sup>
$a^*$	1.07±0.11 <sup>a</sup>	0.43±0.06 <sup>b</sup>
$b^*$	15.13±0.08 <sup>b</sup>	16.57±0.19 <sup>a</sup>

**Remark:** Means in rows followed by different letters represent significant differences ( $p\leq 0.05$ ).

<sup>ns</sup> = Means in row do not have significant differences ( $p>0.05$ ).

significance ( $p\leq 0.05$ ). However, the color of the emulsion powder reduced the intensity of the red tone, resulting in a decrease in the red value ( $a^*$ ) of the instant *Tom Kha Gai* soup enhanced with the emulsion powder.

Table 11 displays the sensory qualities of instant *Tom Kha Gai* soup and instant *Tom Kha Gai* soup enhanced with emulsion powder. The mean liking scores by the panelists for the sensory evaluation of both soups were not significantly different ( $p>0.05$ ) in every sensory attribute including appearance, color, sweetness, saltiness, sourness, spiciness, viscosity, and overall liking. All attributes were rated moderately (7.0–7.5). Consequently, the sensory characteristics of the instant *Tom Kha Gai* soup were not altered by the addition of emulsion powder containing encapsulated vitamins. The viscosity of instant *Tom Kha Gai* soup was examined and it was found that the proportion of Hom Mali rice in the ingredients decreased with the addition of emulsion powder. Consequently, the viscosity value significantly reduced ( $p\leq 0.05$ ) due to the amylose in Hom Mali rice, which controls the physicochemical properties of rice starch (Colussi et al., 2014). In addition, Hom Mali rice flour exhibited a greater peak and final viscosity than Riceberry rice flour because of its high amylose content (Thiranusornkij et al. (2019).

**Table 11** Mean liking scores of instant *Tom Kha Gai* soup and instant *Tom Kha Gai* soup supplemented with emulsion powder

Sensory attributes	Mean liking score	
	Instant <i>Tom Kha Gai</i> soup	Instant <i>Tom Kha Gai</i> soup supplemented with emulsion powder
Appearance <sup>ns</sup>	7.2±1.3	7.1±1.1
Color <sup>ns</sup>	7.3±1.4	7.2±1.5
Sweetness <sup>ns</sup>	7.4±1.5	7.3±1.2
Saltiness <sup>ns</sup>	7.5±1.3	7.2±1.3
Sourness <sup>ns</sup>	7.3±1.1	7.0±1.2
Spiciness <sup>ns</sup>	7.4±1.2	7.2±1.4
Viscosity <sup>ns</sup>	7.4±1.1	7.3±1.2
Overall liking <sup>ns</sup>	7.5±1.5	7.3±1.1

**Remark:** <sup>ns</sup> = Means in row do not have significant differences ( $p>0.05$ ).

#### 4. Acceptability test

The results of the consumer acceptance of the instant *Tom Kha Gai* soup supplemented with emulsion powder are shown in Tables 12 to 14. This study includes demographic data, consumer liking and acceptability tests of 100 target consumers from the Bangkok Metropolitan Area. All respondents (100%) consumed the soup, with a demographic breakdown of 60% women and 40% men. The majority were over 60 years old (40%), followed by those aged 30–45 years (36%)

and 46–59 years (24%). The highest percentage of consumers had a bachelor's degree (55%). Government officers represented 37% of the respondents, followed by private company employees (32%). The average monthly income for 47% of the respondents was over 30,000 THB, followed by 20,001–30,000 THB. According to Szarka & Dúl (2012), seniors' strong drive to purchase is largely determined by their high income, as they seek to know themselves, consume, and reward themselves.

**Table 12** Demographic data

Demographic attributes	Frequency (percentage)
1. Gender	
- Male	40
- Female	60
2. Age	
- 30–45 years old	36
- 46–59 years old	24
- More than 60 years old	40
3. Education level	
- High school diploma	8
- Bachelor's degree	55
- Higher than bachelor's degree	37
4. Occupation	
- Students	5
- Government officers/employees	37
- Private company employees	18
- Personal business	32
- Housewives	8
5. Average monthly income	
- 10,000–20,000 THB	15
- 20,001–30,000 THB	38
- More than 30,000 THB	47

Consumers' liking of the instant *Tom Kha Gai* soup supplemented with emulsion powder was evaluated on a 9-point hedonic scale for appearance, color, flavor, taste, and overall liking. The results indicate that consumers rated all characteristics at the "like very much" level, with scores ranging from 7.4 to 7.5.

**Table 13** Mean liking scores of the instant *Tom Kha Gai* soup supplemented with emulsion powder

Sensory attributes	Mean liking scores
Appearance	7.4±1.1
Color	7.4±1.4
Flavor	7.4±1.4
Taste	7.5±1.0
Overall liking	7.4±1.1

Consumers' acceptance and purchasing decisions regarding the instant *Tom Kha Gai* soup enhanced with emulsion powder were surveyed. The results showed that 89% of consumers accepted the product and 86% of them

decided to buy the instant soup. Based on these acceptance test results, it is feasible to continue developing the product commercially.

**Table 14** Consumers' acceptance on the instant *Tom Kha Gai* soup supplemented with emulsion powder

Data	Frequency (percentage)
Consumers' acceptance on the instant <i>Tom Kha Gai</i> soup supplemented with emulsion powder	n=100
- Accept	89
- Not accept	11
Decisions on purchasing the instant <i>Tom Kha Gai</i> soup supplemented with emulsion powder	
- Purchase	86
- Not purchase	14

## Conclusion

*Tom Kha Gai* is considered one of the world's best chicken soups due to its mild, sour, oily, spicy flavor, along with the addition of coconut milk and other Thai herbs. Therefore, developing *Tom Kha Gai* soup as a nutritious meal for the elderly is a promising concept, as it is popular with many people, particularly elderly Thai citizens. Moreover, the soup's texture makes it easy to consume, making it ideal for senior citizens who have difficulty chewing and swallowing. In addition, it is beneficial for health as it contains antioxidants from the herbs used in its preparation. Instant *Tom Kha Gai* soup is enhanced with a powder emulsion encapsulated with folate, vitamin B1, vitamin B2, and vitamin B12. Over 89 percent of respondents in the consumer acceptability survey indicated they would accept the product, and more than 86 percent would purchase it if it were made available. The present study demonstrated that adding a powder emulsion containing vitamins with improved nutritional qualities to instant *Tom Kha Gai* soup might potentially produce a functional food. The development of instant soup products with Thai flavors may be extended to other popular food products, providing a variety that can satisfy customer demands. This study can be scaled up to explore its potential in the health food industry.

## Acknowledgments

Appreciation is extended to Thailand Science Research and Innovation (TSRI) and Suan Dusit University for their financial support.

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