Quality Parameters of Instant Dried Thai Fermented Fish Dip as Affected by Levels of Guar Gum

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ABSTRACT: Thai fermented fish dip (TFFD), an authentic chili dip commonly consumed in Thailand and Loa People's Democratic Republic, can be dried and ground into instant dried TFFD. This product can be rehydrated by adding an appropriate amount of hot water, to return it to the original paste-like form. However, it was found that solid particles in rehydrated TFFD deposited at the bottom of the container and separated from the liquid. Using guar gum as a binding agent may reduce this problem. The objective of this experiment was to investigate the effect of various guar gum levels (0, 0.10, 0.20, 0.30, and 0.40%) on the quality parameters of instant dried TFFD power and rehydrated TFFD. Total plate count, yeast and mold count, a_w, and CIE color values (L*, a*, and b*) of instant dried TFFD powder were then measured. Texture profile analysis (firmness, consistency, cohesiveness and viscosity), CIE color values (L*, a* and b*), and sensory acceptability of the rehydrated TFFD were also evaluated. The study showed the quality parameters were not affected by the level of guar gum, except b* color parameter of instant dried TFFD powder and the cohesiveness of rehydrated TFFD. The b* parameter was increased as the guar gum level increased. The cohesiveness of the product was significantly increased in the samples supplemented with 0.20% guar gum. Thus, 0.20% guar gum is considered the most suitable for TFFD.

Keywords: Guar gum, Thai fermented fish dip, instant dried chili dip, Thai chili paste

Introduction

Thai fermented fish dip (TFFD), known in Thai as Jaew Bong or Pla-Ra Bong, is a type of chili dip, commonly consumed in Thailand and Lao People's Democratic Republic. The dip is popular in the northeast region of Thailand, where it is regarded as one of the symbolic dishes of the region. The TFFD is a mixture of minced fermented fish, dried chili, and herbs. Fermented fish provides the dish with a robust characteristic flavor, described as piquantly sharp and pungent, and, also contributes to protein and saltiness. Chili contributes to the heat and desirable red appearance, reflecting the freshness of the dip. The herbs, including sliced galangal, sliced lemon grass, peeled roasted shallot and peeled roasted garlic, endow aromatic herbal flavors.

The mixture of fermented fish, chili, and herbs can be further seasoned with tamarind juice, fermented fish sauce, sugar, and julienned kaffir lime leaves (Hemwihok and Hongsaeng, 2013). After being mixed, a sticky

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paste is formed, which adheres well to foods upon dipping. The TFFD is mostly eaten with main dishes, including glutinous rice, grilled/fried meat, and steamed/fresh vegetables. The dip offers spiciness and pleasant savory tastes, thereby enhancing the flavors of the foods while simultaneously, the main dishes tone down the heat and spiciness of the dip (Phuangraksa, 2008; Posri, 2008; Teaupun, 2009; Thai Industrial Standards Institute, 2013).

Previously, TFFD was prepared within the home. However, it is now produced for business purposes by small-scale factories. The product is sold to domestic and international markets, due to the increasing demand for the product (Ministry of Finance Region 4, n.d.). However, the TFFD business has encountered several obstacles, mainly, the product's short shelf-life, due to its perishability (Posri, 2008). The perishable nature of TFFD is caused by a low or medium acidity, and intermediate or high moisture contents in the product.

Commercial TFFD is considered a low- or medium-acid food, with a pH of 4.42–5.36 (Posri, 2008). Moisture contents of 48.61–64.40% and water activity (a_w) levels of 0.56–0.69 in TFFD were determined by Ratchatachaiyos (2007) and Stonsaovapak et al. (1995), respectively. The shelf-life of TFFD at room temperature is around 5 days (Teaupun, 2009). Storing the product in a refrigerator can extend its shelf-life to 14 days (Tassanaudom et al., 2009). The high moisture content not only causes a short shelf-life, but it also limits the transportability of the product and may cause liquid leakage and high shipment cost during transportation (Tassanaudom et al., 2009).

Drying is a practical method used around the world to preserve foods, as low water activity (a_w) levels of <0.66 offer microbial stability to foods (Ulloa et al., 2015). The drying process can be used for lowering the moisture content and a_w in TFFD. Dried TFFD can then be ground or pulverized, and used as an instant product. The instant dried TFFD can be rehydrated by adding appropriate amounts of hot water, and the product should return to its original paste-like form. Our previous preliminary experiments on drying TFFD showed that the dip could be suitably dried at 40 or 60 °C (unpublished data). However, after being ground and rehydrated, TFFD powder showed a poor water-absorption characteristic. The product requires at least 30 min to be rehydrated. Insufficient rehydration period (< 30 min) causes solid particles in the product to separate from the liquid portion. The prolonged rehydration period of the product limits the use of instant dried TFFD. To solve this problem, the addition of food binding or thickening agents in the instant dried TFFD should be explored.

To our knowledge, the use of guar gum in TFFD or instant dried TFFD has not yet been reported. Using gums as a binding agent in Thai food has reported by some researchers. Yansupap (2007) and Suwankanit et al. (2007) added xanthan gum and maltodextrin in frozen chicken green curry and instant dry spicy tuna soup, respectively. Guar gum, one of binding agents commonly available in Thailand, has an affordable price (450 Baht/kg) for the small scale TFFD producers. It is a plant-based binding and thickening agent, commonly used by the food industries. The gum is produced from the endosperm of the seeds of *Cyamopsis tetragonolobus* and *C. psoraloides* (Brook et al., 2004). Extraction of guar gum yields a fine, off-white powder containing high amounts of long galactomannan polymers. These polymers produce high viscosity upon dissolving in hot or cold water. Commercial guar gum at 0.10% can generate a high viscosity of up to 7,000 cP (Brook et al., 2004), and 0.20–0.30% guar gum is commonly used

to thicken foods (Natsuwan et al., 2005). The viscosity of food products supplemented with gums can vary, depending on several factors, such as the supplement level and particle size of the gums, and the temperature and pH of the product (Minsakorn, 2012).

Several researchers studied the use of guar gum in Thai food products. Jangchud et al. (2005) found that apricot leather, produced from 70 g pickled apricot, 50 g sucrose, and 2.17 g guar gum or 3 g pectin, had a detectable texture improvement. Sodchit et al. (2003) showed that texture of rice bread could be improved by using 0.50% guar gum in combination with 10% soy protein, and 105% water, based on the weight of the flour. Natsuwan et al. (2005) reported that adding 0.40% guar gum could improve the texture of soft-serve ice cream, produced from a mixture of soy milk, sesame milk, and corn milk. However, to our knowledge, the use of guar gum in TFFD or instant dried TFFD has not yet been reported. The incorporation of the gum may prevent the phase separation in the rehydrated TFFD, thereby enabling its direct use by consumers, immediately after adding hot water to the product. It has been noted that the addition of high levels of gums can cause ropiness in food products (Prapasuwannakul et al., 2012), so the incorporation of a proper amount of guar gum in TFFD should be explored. The current experiment aimed to investigate the effect of various guar gum quantities on the quality parameters of instant dried TFFD powder and rehydrated TFFD.

Materials and Methods

Preparation of TFFD and instant dried TFFD powder

TFFD was composed of fermented fish, dried chili, and herbs. Fermented fish was purchased from Phetdam Foods Co., Ltd. (Kalasin, Thailand). Herbs, chili powder, and the other ingredients were bought from a local supermarket (Tesco Lotus, Khon Kaen, Thailand). The herbal ingredients were trimmed, washed in potable water twice, and decontaminated by submerging in ozonated water for 10 min. TFFD was prepared in accordance with Hemwihok and Hongsaeng (2013), using 1,000 g minced fermented fish, 80 g finely chopped galangal, 60 g sliced lemongrass, 150 g peeled roasted shallots, 150 g peeled roasted garlic, and 34 g dried chili powder. These ingredients were thoroughly blended for 10 min using a food processor (MCM 640660, Bosch, Bratislava, Slovakia). Flavor-enhancing ingredients, including 40 g tamarind juice, 34 g sugar, and 34 g monosodium glutamate (MSG), were added to the mixture. Finally, 6 g julienned kaffir lime leaves were manually combined with the mixture by hand. The level of MSG was used according to Thai Food and Drug Administration (2016). This uncooked TFFD was precooked on a stovetop, until the internal temperature reached 75–85 °C. The internal temperature was then maintained for 15 min, according to Posri (2008). The precooked TFFD was spread on silicone baking sheets at a thickness of about 2 mm, and oven-dried at 60 °C for 18 h. The dried TFFD was removed from the sheets using a sterilized spatula, and ground for 1 min using a Philips HR2115/02 blender (Philips, Eindhoven, Netherlands).

Supplementation of guar gum in instant dried TFFD

The dried TFFD powder was aseptically divided into five equal portions and packed separately in sterilized plastic bags. Five levels (0, 0.10, 0.20, 0.30, and 0.40%) of guar gum (Union Science Trading Co., Ltd., Khon Kaen,

Thailand) were randomly assigned to the five portions of TFFD powder. Each quantity of guar gum was mixed well with the powder. The samples of instant dried TFFD were then analyzed for their quality parameters. The samples were also rehydrated using proper amounts of hot water and further examined for their quality parameters.

Analysis of instant dried TFFD powder

Total bacterial count (TPC; log CFU/g) was measured according to Morton (2001). Twenty-five grams of TFFD powder was aseptically added to 225 ml of sterilized 0.10% peptone water and mixed by using a 3500 Jumbo Stomacher (Seward Laboratory Systems, Inc., Bohemia, NY, USA) for 60 s. The TPC was enumerated in standard plate count agar (BBL, Spark, MD, USA) after incubation at 30 ± 1 °C for 48 h.

Yeast and mold (YM; log CFU/g) were enumerated by spreading a suitable serial dilution on acidified potato dextrose agar (BBL, Spark, MD, USA) and enumerated after incubation at 23 ± 1 °C for 5 days (Mislivec and Stack, 1989).

The a_w was measured using an Aqua Lab Series 4TEV water activity meter (Aqua Lab, Pullman, WA, USA).

CIE color values (L*, a*, and b*) were determined according to Marroquin et al. (2004) by using a Minolta CM-2600d (Konica Minolta, Inc., Tokyo, Japan). CIE L*, a*, and b* represent the lightness, redness–greenness, and yellowness–blueness, respectively.

Analysis of rehydrated TFFD

Powder of instant dried TFFD (Figure 1 a) was rehydrated by adding proper amounts of hot water (>90 ºC). The amount of water added to the product was calculated using Eq. (1). The texture profile analysis, CIE color values, and sensory acceptability of the rehydrated samples (Figure 1b) were evaluated.

$$WT_{reh} = W_{uncook} - W_{dried} \quad (1)$$

where WT_{reh} is the amount of hot water used for rehydrating the sample (g), W_{uncook} is

(a) (b)

Figure 1 powder of instant dried Thai fermented fish dip (a) and paste of the rehydrated powder (b).

the initial weight of uncooked TFFD (g), and W_{dried} is the weight of dried TFFD (g).

Texture profile analysis (TPA) was performed using a TAXT2 texture analyzer (Stable Micro Systems Ltd., Vienna, Austria). Ninety grams of a rehydrated sample was placed in a cylindrical container of 50 mm diameter and 65 mm height. The TPA parameters (firmness, consistency, cohesiveness, and viscosity) were measured using a cylinder probe (P/35) at a speed of 1.0 mm/s, and a distance of 30 mm (Sirilert, 2007; Srigam et al., 2016).

The CIE color values were determined according to Marroquin et al. (2004) as previously described.

Sensory acceptability (color, odor, texture, flavor, and overall acceptability) was evaluated using the nine-point hedonic scale according to Meilgaard et al. (1991) (one = extremely dislike, five = neither like nor dislike, nine = extremely like) by 45 panelists acquainted with TFFD. A score of five was considered the limit of acceptability for all sensory parameters.

Statistical analysis and experimental design

The experiment was carried out using a randomized complete block design. Statistical analysis was conducted using the IBM SPSS statistics 21 program (IBM, Armonk, New York, USA) at a 95% confidence level.

Results and Discussion

Analysis of instant dried TFFD powder

The TPC values (**Table 1**) were not significantly different among treatments ($P>0.05$), indicating that the addition of guar gum did not increase TPC counts in the product. Guar gum, used in the experiment, may contain low TPC counts, explaining its lack of effect on the TPC of TFFD. Levels of TPCs in instant dried TFFD supplemented with guar gum (3.50–3.58 log CFU/g) met that recommended by the Thai Industrial Standards Institute (2004a and 2004b) of <4 log CFU/g.

The YM counts (**Table 1**) ranged from 3.59 to 4.22 log CFU/g and were not significantly different among the treatments ($P>0.05$). Guar gum used in the experiment may contain low YM, which would justify the absence of its effect on the YM counts in instant dried TFFD.

The a_w values of instant dried TFFD (**Table 1**) of 0.36–0.37 were not significantly different

Table 1 Total plate count, yeast and mold, and a_w of instant dried powder of Thai fermented fish dip as affected by guar gum level

Quality parameter	Guar gum level (%)					LSD
	0 (control)	0.10	0.20	0.30	0.40	
Total plate count (log CFU/g)	3.52±0.06a	3.55±0.04a	3.58±0.06a	3.58±0.01a	3.50±0.05a	0.091
Yeast and mold (log CFU/g)	3.92±0.58a	3.70±0.30a	3.89±0.52a	4.22±0.49a	3.59±0.23a	0.709
a_w	0.36±0.03a	0.36±0.02a	0.37±0.03a	0.37±0.03a	0.36±0.02a	0.007

(a) Similar lowercase letters in the same row indicate that the difference is not statistically significant at the 95% confidence level.

among the treatments (P>0.05). The dry powder of commercial guar gum may possess a low a_w, thereby producing no influence on the a_w of the product. As mentioned above, an a_w of < 0.66 presents microbial stability to the product (Ulloa et al., 2015). The results showed that the instant dried TFFD is a microbially stable product.

The color values (L*, a*, and b*) of instant dried TFFD (**Table 2**) revealed that the amount of added guar gum did not affect L* and a* values but significantly changed b* values (P<0.05), which varied over the range 23.34–25.88. The off-white color of guar gum may contribute to the decreasing b* values. Posri (2008) stated that the redness plays an important role in the quality of TFFD because it reflects the freshness and heat of the product. Redness (positive a*) of the product was not affected by the guar gum supplement. Addition of guar gum, even though it changed the b* values of instant dried TFFD, may not produce any adverse effect on the color quality of the product.

Table 2 CIE color values of instant dried powder of Thai fermented fish dip as affected by guar gum level

CIE color values	Guar gum level (%)					LSD
	0 (control)	0.10	0.20	0.30	0.40	
L*	48.93±0.39a	49.83±1.66a	49.16±2.26a	51.30±2.25a	50.31±2.92a	3.493
a*	10.31±0.88a	10.28±0.35a	9.89±0.56a	9.77±0.78a	10.23±0.74a	0.659
b*	25.88±2.19a	25.28±2.19ab	24.48±1.63b	23.34±1.92c	24.82±1.92b	1.021

(abc) Different lowercase letters in the same row indicate that the difference is statistically significant at the 95% confidence level.

Analysis of rehydrated TFFD

The TPA parameters (firmness, consistency, cohesiveness, and viscosity) of rehydrated TFFD, (**Table 3**) indicated that firmness, consistency, and viscosity were not significantly affected by the level of guar gum (P>0.05). However, the levels of 0.20, 0.30, and 0.40% significantly increased the cohesiveness of rehydrated TFFD, compared to 0.00% (control) and 0.10% (P<0.05). Hence, 0.20–0.40% guar gum could increase the cohesiveness of rehydrated TFFD. The cohesiveness parameter is described as a 'long' and elastic texture (Hermansson et al., 2004). The addition of guar gum may promote these texture characteristics in rehydrated TFFD. The gum may prevent the solid particles in the product to separate from the liquid portion and make the portions hold together immediately after waster was added in the product. The consumers, therefore, enable to use the rehydrated product immediately without 30 min waiting for the product to absorb the water.

The CIE color values of rehydrated TFFD (**Table 4**) were not significantly different among the treatments (P>0.05). Thongrong (2006) stated that gums are polysaccharides, which mostly contain no flavor and color, and, after being rehydrated, they offer a transparent viscous liquid or gel. Guar gum, similar to other gums, may produce a transparent colorless

Table 3 Texture profile analysis parameters of rehydrated Thai fermented fish dip as affected by guar gum level

Texture profile analysis	Guar gum level (%)					LSD
	0(control)	0.10	0.20	0.30	0.40	
Firmness(N)	319.85± 124.32a	317.93± 87.07a	337.46± 115.46a	351.8± 196.16a	335.13± 134.18a	131.061
Consistency (kN)	5.92± 2.26a	5.71± 1.46a	6.11± 2.15a	6.44± 4.17a	6.09± 2.04a	2.982
Cohesiveness (cP)	-289.89± 98.27a	-309.53± 126.55a	-419.39± 130.95b	-418.39± 175.05b	-441.25± 125.63b	94.564
Viscosity (cP)	-549.08± 186.42a	-390.71± 340.40a	-686.36± 181.75a	-397.48± 204.40a	-777.20± 116.33a	435.782

(ab) Different lowercase letters in the same row indicate that the difference is statistically significant at the 95% confidence level.

Table 4 CIE color values of rehydrated Thai fermented fish dip as affected by guar gum level

CIE color values	Guar gum level (%)					LSD
	0 (control)	0.10	0.20	0.30	0.40	
L*	42.40±2.43a	41.45±1.59a	41.45±1.18a	41.94±1.24a	42.18±0.48a	1.927
a*	10.97±0.65a	10.95±0.38a	10.69±0.75a	7.20±5.90a	10.74±0.39a	5.379
b*	23.65±2.39a	25.05±1.29a	25.05±1.34a	24.75±1.21a	23.90±0.75a	2.186

(a) Similar lowercase letters in the same row indicate that the difference is not statistically significant at the 95% confidence level.

Table 5 Sensory evaluation scores of rehydrated Thai fermented fish dip as affected by guar gum level

Sensory evaluation	Guar gum level (%)					LSD
	0 (control)	0.10	0.20	0.30	0.40	
Color	7.03±0.25a	6.93±0.35a	7.00±0.20a	7.03±0.15a	7.00±0.10a	0.302
Odor	7.30±0.17a	7.00±0.26a	7.20±0.36a	7.17±0.15a	7.10±0.35a	0.454
Texture	7.33±0.31a	6.93±0.15a	6.87±0.42a	6.63±0.23a	6.63±0.29a	0.730
Flavor	6.87±0.31a	7.10±0.20a	7.01±0.35a	7.21±0.46a	7.03±0.21a	0.463
overall acceptability	7.33±0.21a	7.23±0.15a	6.97±0.31a	7.20±0.30a	6.97±0.21a	0.361

(a) Similar lowercase letters in the same row indicate that the difference is not statistically significant at the 95% confidence level.

gel upon being rehydrated, and in this way, not affect the color of rehydrated TFFD.

The sensory scores of rehydrated TFFD are illustrated in **Table 5**. The results showed the color, odor, texture, flavor, and overall acceptability of TFFD were not impacted by the added guar gum quantities ($P>0.05$). Even though texture profile analysis showed significantly different cohesiveness among treatments (**Table 3**), sensory texture scores showed indifferent results. The results indicated that panelists had a non-significant level of satisfaction. As a result, guar gum at 0.20-0.40% could increase instrumental cohesiveness without any adverse effect on the sensory texture. With a cheaper cost, the level of 0.2% could produce the indifferent sensory effects as 0.30 and 0.40% . This level of 0.2% is therefore suitable for incorporation into instant dried TFFD. The results agreed with Natsuwan et al. (2005), who stated that 0.20–0.30% guar gum is used to thicken foods.

Conclusions

Compared to control and 0.10% guar gum, the level of 0.20-0.40% could improve the cohesiveness of the product. Guar gum at the levels of 0.20-0.40% were not significantly different in term of sensory scores. Moreover, the increase of the levels of guar gum produced no adverse effects on sensory scores. With a cheaper cost, guar gum at the level of 0.20%, which improved cohesiveness of the product and showed no adverse effect on sensory score, is the most suitable level for supplementation of instant dried TFFD.

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