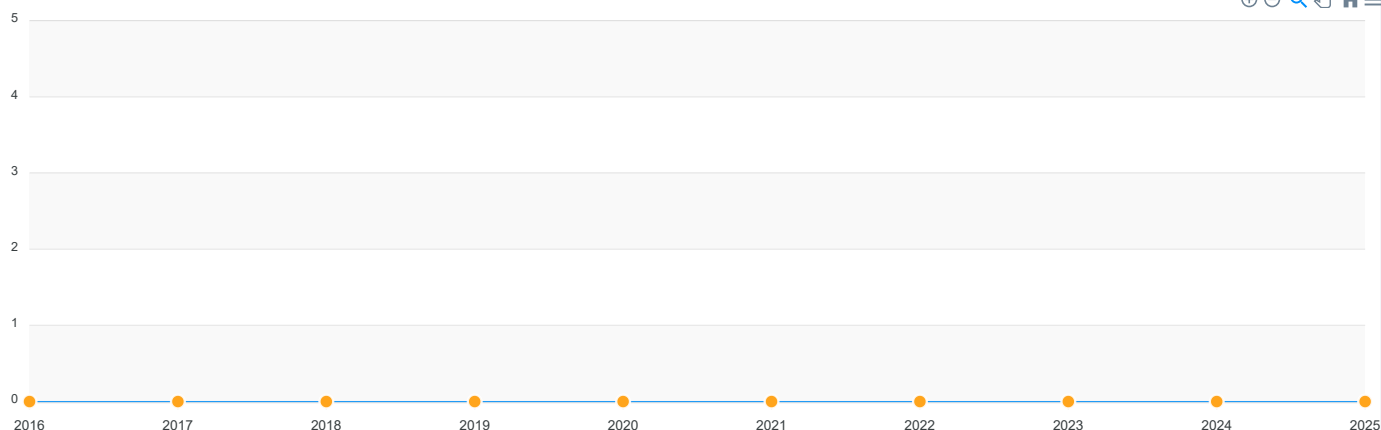




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Research Article

Development of Shredded Catfish as a Health Food Product for the Elderly

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ABSTRACT

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This research aimed to develop shredded catfish products for the elderly by studying physical, chemical, and microbiological qualities, and evaluating sensory attributes. Using 30 people with a 9-point hedonic scale, formula 3 was most accepted, leading to the development of two products: original flavor and seaweed with sesame flavor. Results showed lightness (L^*) values of 53.91 ± 1.36 and 50.20 ± 0 , red (a^*) values of 10.50 ± 0.69 and 11.25 ± 0.51 , and yellow (b^*) values of 30.23 ± 0.26 and 28.65 ± 0.51 , respectively, with significant differences ($P < 0.05$). Water activity values (0.57 and 0.56) were not statistically different ($P > 0.05$). Chemical composition of the original and seaweed with sesame products were, respectively, moisture 4.53% and 4.75% , protein 48.06% and 50.12% , fat 6.54% and 7.35% , carbohydrate 32.64% and 33.52% , and ash 7.47% and 7.54% . Moisture content met standards. Microbiological analysis showed total microbial counts of 2.5×10^3 CFU/g (original) and 3×10^3 CFU/g (seaweed with sesame). Both flossed catfish products contained yeast and mold levels of less than 25 CFU/g, which are within the standard limits.

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1. Introduction

In the present day, with societal changes, people are living in a hurried state, which has affected their eating habits. There is a growing demand for ready-to-eat and save time in preparation or cooking. Consequently, consumers increasingly seek processed food products, leading to the study and development of innovative food products that are nutritionally valuable and convenient to consume. Moreover, utilizing local agricultural raw materials as much as possible can enhance the value of local produce, thereby creating additional income for the farmers who produce them.

Fish is increasingly becoming a popular choice among health-conscious consumers due to its

nutritional benefits. Fish meat is rich in high-quality protein, low in fat, and the fats present in fish help reduce blood cholesterol levels. The protein in fish is of high quality and easily digestible, which benefits the body by nourishing and developing the brain, promoting growth, and repairing tissues (Jiwaphong, 1999). Freshwater fish (100 grams) provides 95 kilocalories, 0.8 grams of fat, trace amounts of carbohydrates, 18.0 grams of protein, 0.05 grams of calcium, and 0.001 grams of iron (Nutrition Division, 1987). Fish meat can be prepared into a variety of savory dishes such as curry, sour soup, sour curry, hot and sour soup, tom yum, steamed, fried, grilled, stir-fried, and salads. Moreover, the role of diverse food processing methods has increased as alternatives for consumers. For

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instance, fresh fish meat can be cooked and processed into fish floss, mimicking the product made from pork floss. This involves cooking the fish, separating the muscle fibers into strands, and drying them to create a fluffy and shredded texture (Industrial Standards Institute, 1987). Fish floss processing involves moisture reduction through drying, which helps preserve the food. The choice of fish should be one with fibrous meat, whether white or red meat, preferably inexpensive and yielding a high meat-to-bone ratio. Marine fish such as tilapia, mackerel, and threadfin can be used for fish floss (Department of Fisheries, n.d.). There has been the development of herbal-enriched fish floss products, studying steaming and grilling methods for three types of fish: stingray, mackerel, and threadfin. Sensory tests indicated that grilled threadfin fish floss was the most favored. Fish floss products are nutritionally high, with studies showing 87.4% protein and 6.3% fat (Panmanee and Sakulkuhasawan, 2003). Additionally, when dried properly, they can be stored for long periods without becoming rancid due to their low-fat content. (Fitri *et al.*, 2022) Fish floss can serve as a substitute for pork floss, reducing production costs since pork is generally more expensive than fish. It also offers a healthier option for consumers. Especially for the Elderly: In contemporary Thai society, the elderly population is growing, with approximately 13,064,929 elderly individuals across 77 provinces in Thailand as of December 31, 2023, accounting for 20.08% of the total population (Department of Provincial Administration, 2023). The elderly is characterized by physical deterioration rather than enhancement, unlike other age groups. This change impacts various aspects of their lives, including important factors like dietary habits. Thus, food or products designed for the elderly are crucial for their well-being. Fish is particularly suitable for the elderly because it is easy to digest. Fish is a nutritionally rich animal and one of the most popular seafood, providing

good-quality protein and beneficial fats. Fish fats are present in smaller quantities compared to fats from other animals, and certain fish contain Omega-3 fatty acids, which promote heart and vascular health. For example, Omega-3 is found in salmon, particularly wild salmon, which is high in vitamins and minerals, as well as in trout, such as rainbow trout, which has a pleasant taste and high Omega-3 content. (Phogat *et al.*, 2022). However, since salmon is not produced in Thailand and is expensive, catfish becomes a viable alternative. Catfish is beneficial to health, with low calories, low mercury content, and rich in fats, including Vitamin B12, Omega-3, and Omega-6. These are unsaturated fatty acids that the body cannot produce on its own and help reduce blood cholesterol. (Mendivil, 2021) Therefore, this research aims to develop a prototype catfish floss recipe, examine its quality, and assess consumer acceptance of the catfish floss product. This provides a dietary alternative and benefits the health of the elderly.

2. Materials and Methods

2.1 Study the prototype shredded catfish recipes by selecting the basic production recipe from three different formulas

The shredded catfish using the following steps: The catfish was decapitated, the belly was cut open, and the guts were removed. It was cleaned thoroughly with a 4% saline solution. The catfish was steamed at 100°C for 30 minutes. The fish meat was then separated. All seasoning ingredients were measured, including minced garlic, finely chopped galangal, light soy sauce, dark soy sauce, granulated sugar, salt, and water. These ingredients were melted in a pan over heat, then the catfish meat was added and stir-fried until dry. Next, it was placed in an oven at 50°C for 1 hour and 30 minutes. After cooling, it was packaged in polyethylene terephthalate (PET) bags. The ingredient proportions vary as shown in Table 1.

Table 1 Ingredients of shredded catfish in various recipes.

Ingredient	Weight of ingredients in each recipe (grams)		
	1 ^a	2 ^b	3 ^c
cooked fish fillet	500	400	600
minced garlic	-	-	40
chopped galangal	-	-	40
soy sauce	60	50	50
Dark soy sauce	15	45	15
sugar	75	90	50
water	250	175	50
salt	-	30	-

Source: a Department of Fisheries, (n.d.)

b Suban (1984)

c Terdkwanchai and Charoenchai (2011)

After obtaining all 3 recipes, they were tested for product acceptance using the 9-point hedonic scale. The most accepted recipe was selected and further developed into two prototype catfish floss products: Original Flavored Catfish Floss and Catfish Floss with Seaweed and Sesame.

2.2 Study on the quality of shredded catfish and consumer acceptance:

The physical quality was evaluated by measuring the color parameters L*, a*, and b* using a spectrophotometer (model CM-3500d) and the water activity (aw) using a water activity meter (model Pawkit). Chemical quality assessment included moisture content, protein, fat, crude fiber, carbohydrates, and ash content (AOAC, 2000). Microbiological quality was determined by total plate count for total microorganisms and yeast and mold count using a yeast and mold enumeration method in culture media. Consumer acceptance was evaluated by sensory quality assessment using a 9-point hedonic scale (Chompreeda, 2006) focusing on

appearance, color, odor, flavor, texture, and overall acceptability (1 represents "dislike extremely" and 9 represents "like extremely"). The sensory evaluation involved 30 untrained panelists aged 60 and above. The results were analyzed using statistical methods, including analysis of variance (ANOVA) based on a completely randomized design (CRD), and differences in means for each test item were compared using Duncan's New Multiple Range Test (DMRT) at a 95% confidence level, utilizing statistical software.

3. Results and Discussion

3.1 Results of the development of prototype shredded catfish

Three prototype shredded catfish recipes were developed. The appropriate production recipes were derived from three different basic sources with varying ingredients (Table 1). Once all three catfish floss recipes were prepared, they were subjected to sensory evaluation. The average sensory quality scores of the basic catfish floss recipes are presented in Table 2.

Table 2 Sensory properties of shredded catfish

Acceptance Sensory Properties	Recipe		
	1	2	3
Appearance	6.70 ^b ±1.39	6.27 ^b ±1.46	7.60 ^a ±1.19
Color	6.83 ^b ±1.21	5.33 ^c ±1.79	7.70 ^a ±1.18
Odor	6.53 ^b ±1.61	5.43 ^c ±1.59	7.47 ^a ±1.22
Flavor	6.40 ^b ±1.81	5.17 ^c ±2.02	7.40 ^a ±1.74
Texture	6.60 ^b ±1.57	5.47 ^c ±1.78	7.33 ^a ±1.35
Overall	7.23 ^a ±1.45	5.93 ^b ±1.66	7.63 ^a ±1.10

Remark: ^{a,b,c} mean± SD values in the same row with different letters are statistically different ($P < 0.05$)

1 represents "dislike extremely" and 9 represents "like extremely"

Table 3 The physical qualities of the shredded catfish products

Product	Prototype of shredded catfish product	
	Original flavor	Seaweed and sesame seeds flavor
Water activity (a_w) ^{ns}	0.57±0.01	0.56±0.01
Hunter		
L*	53.91 ^a ±1.36	50.20 ^b ±0.01
a*	10.50 ^b ±0.69	11.25 ^a ±0.51
b*	30.23 ^a ±0.26	28.65 ^b ±0.51

Remark: ^{a,b} mean± SD values in the same row with different letters are statistically different ($P < 0.05$)

^{ns} mean non-significant difference in the same row ($P > 0.05$)

All three recipes of shredded catfish have a soft, fluffy, and fibrous appearance. Recipes 1 and 3 have a lighter brown color compared to recipe 2 due to a lower amount of dark soy sauce used in recipes 1 and 3, which affects the color of the shredded catfish. Recipes 1 and 2 have a slight fishy odor because the fish was washed with 4% saltwater, which helps reduce the fishy smell. However, recipe 3 does not have any fishy odor due to the presence of herbal aromas from garlic and galangal, which make it more fragrant than recipes 1 and 2, which do not contain herbs. In terms of taste and texture, recipe 3 has a higher average rating than recipes 1 and 2. Whereas recipe 3 has a softer and fluffier texture than recipe 2 and 1. The overall preference scores for the three recipes are 7.23±1.45, 5.93±1.66, and 7.63±1.10, respectively, showing a statistically significant difference ($P < 0.05$). Therefore, recipe 3 received the highest acceptance score. The researcher chose recipe 3 to develop prototype products of shredded catfish with the original flavor and seaweed-sesame flavor, and further studied their physical, chemical, microbial quality, and consumer acceptance

3.2 Results of product quality study and consumer acceptance

Physical quality

From the experimental results on physical quality, including L*, a*, and b* color values of the original flavored shredded catfish product, it was found that the average values were 53.91±1.36, 10.50±0.69, and 30.23±0.26, respectively. For the shredded catfish with seaweed-sesame flavor, the average values were 50.20±0.01, 11.25±0.51, and 28.65±0.51, respectively, which are significantly different ($P < 0.05$). The analysis of the L*, a*, and b* color values of the shredded catfish products indicates differences in color between the original flavor and the seaweed-sesame flavor. The original flavor exhibits higher lightness and yellow intensity compared to the seaweed-sesame flavor, while the seaweed-sesame flavor shows a higher intensity of red. However, the water activity (a_w) values of both products did not differ statistically ($P > 0.05$), as shown in Table 3.

From Table 3, the physical quality of both shredded catfish products shows that the shredded catfish has a medium lightness value L^* , a positive a^* value, indicating a reddish color, and a high positive b^* value, indicating a deep yellow color. This means that the shredded catfish has a slightly reddish-yellow color and is not dark. The water activity (a_w) value is 0.57, indicating a very low free water content. This water activity level meets the standard criteria, as the industrial product standards require an a_w value of less than 0.6. This result is consistent with Siririksh (2018) in the development of calcium-fortified Nile tilapia chili paste made from Nile tilapia bones, which has an a_w value of 0.388, also less than 0.6, in line with the standards. This indicates that microbial growth is minimal, and consumers can consume the product safely.

Chemical quality

The chemical composition of the original flavored shredded catfish and the seaweed-sesame flavored shredded catfish was found to have a moisture content of $4.53 \pm 0.01\%$ and $4.75 \pm 0.03\%$, respectively. The protein content was $48.06 \pm 0.02\%$ and $50.12 \pm 0.02\%$, respectively, consistent with Thammaratwasik (1989) which reported that catfish is an important protein source with low carbohydrate content and 5 % fat, mostly composed of unsaturated fatty acids and no cholesterol. Most of the fat is unsaturated fat, which is beneficial for heart health. Since older adults often face

vascular issues, consuming healthy fats can help control cholesterol levels and improve heart function (Food and Agriculture Organization of the United Nations (FAO), 2020). The fat content was $6.5 \pm 0.014\%$ and $7.35 \pm 0.02\%$, the carbohydrate content was $32.64 \pm 0.03\%$ and $33.52 \pm 0.02\%$, respectively, and the ash content was $7.47 \pm 0.02\%$ and $7.54 \pm 0.02\%$, respectively. Both shredded catfish products have moisture levels within the standard limits due to being roasted and baked with heat to remove water from the food, resulting in moisture levels that prevent microbial growth.

Microbial quality

The results of the microbial quality analysis of the original flavored shredded catfish product showed a total plate count (TPC) of 2.5×10^3 CFU/g, and the seaweed-sesame flavored shredded catfish had a TPC of 3×10^3 CFU/g. Both shredded catfish products had yeast and mold counts of <25 CFU/g. In the processing of shredded catfish products, the methods of washing with saline solution, steaming, roasting, and applying heat while controlling the moisture content of the catfish to not exceed 6 percent resulted in low levels of microorganisms (Mahendra *et al.*, 2016). As shown in Table 5. These microbial counts are within the standard limits (Industrial Standards Institute, 1987) indicating that both shredded catfish products have good microbial quality and are safe for consumers to eat. Examples of the original flavored shredded catfish and the seaweed-sesame flavored shredded catfish are shown in Figure 1.

Table 5 Microbiological quality values of shredded catfish products.

Microbiological quality (CFU/g)	Prototype of shredded catfish product	
	Original flavor	Seaweed and sesame seeds flavor
Total Plate Count, TPC	2.5×10^3	3×10^3
Yeast and mold	< 25	<25



Figure 1 Shredded catfish product prototype (a) shredded catfish original flavor, (b) shredded catfish mixed with seaweed and sesame seed

Table 6 Consumer acceptance of the prototype product of shredded catfish.

Acceptance Sensory Properties	Prototype of shredded catfish product	
	Original flavor	Seaweed and sesame seeds flavor
Appearance ^{ns}	7.45±1.09	7.05±1.61
Color ^{ns}	7.85±1.93	7.60±1.64
Odor	7.85 ^b ±1.76	8.05 ^a ±1.21
Flavor ^{ns}	7.80±1.77	7.60±1.72
Texture ^{ns}	7.70±1.80	7.50±1.69
Overall	8.91 ^a ±1.76	8.60 ^b ±1.68

Sensory quality evaluation and panelists acceptance

The results of the sensory evaluation and panelists acceptance of both shredded catfish products using a 9-point hedonic scale revealed that consumers rated satisfaction in terms of appearance, color, taste, and texture with statistically insignificant differences ($P>0.05$). However, regarding aroma, panelists rated the seaweed-sesame flavored shredded catfish higher than the original flavored shredded catfish, with average scores of 8.05 ± 1.21 and 7.85 ± 1.76 , respectively. This difference was statistically significant ($P<0.05$), likely due to the enhanced aroma of seaweed and sesame. In addition, sesame seeds and seaweed are rich in important nutrients. They contain healthy fats, particularly unsaturated fats, which are beneficial for heart health. They are also sources of protein, vitamins B1, B6, and E, as well as minerals such as calcium, magnesium, and iron. Seaweed, in particular, is rich in dietary fiber, which aids in digestion and promotes intestinal health

(Wei *et al.*, 2022; Zhang *et al.*, 2021). Overall panelists acceptance of the shredded catfish products showed that consumers rated the original flavored shredded catfish highest in satisfaction compared to the seaweed-sesame flavored product, with average scores of 8.91 ± 1.76 and 8.60 ± 1.68 , respectively. This difference was statistically significant ($P<0.05$), indicating that consumers preferred the original flavored product more.

4. Conclusion

The development of prototype products of original flavored shredded catfish and seaweed-sesame flavored shredded catfish shows that they meet industrial standards in terms of physical, chemical, and microbial quality. Additionally, they have been accepted by panelists, indicating that consumers can safely consume these products. This makes them viable food

options for elderly individuals and health-conscious individuals alike

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