Using Pineapple to Produce Fish Sauce from Surimi Waste

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ABSTRACT

Condiment products such as fish sauce, soy sauce and seasoning sauce are popular among people who live in Southeast Asia. Normally, fish sauce is made from marine fish such as *Stolephorus* spp.. Nowadays, raw materials for fish sauce processing are scarce and costs have increased, so the objective of this study was to see if surimi waste could be used to reduce the production costs for fish sauce. The quality of the fish sauce made from surimi waste passed the standard of the Ministry of Public Health Notification Number 203 (Fish Sauce) which sets the minimum protein and NaCl level at 9 and 200 g/l, respectively. The fish sauce produced had average protein content in the range 11.14-15.33 g/l, with sodium chloride content in the range 241-345 g/l.

Key words: condiment product, fish sauce, surimi waste

INTRODUCTION

Surimi waste, such as the heads, bones, scales and skin of fish from surimi processing plants can be an alternative source for producing fish sauce. Most fish used in surimi processing are *Nemipterus* sp., *Saurida elongata, Johnius* spp. and *Priacanthus tayenus*. About 40% of the waste from a surimi processing plant each day is usually used as animal feed (Pacific Marine Food Products Co., Ltd).

Proteinase enzyme is necessary for fermenting fish sauce and other fermented foods. Bromelain, papain and ficin are proteolytic enzymes used in several kinds of foods. In this research, bromelain from pineapple waste was chosen for the acceleration of the fermentation phase in the condiment products. Bromelain is an enzyme found only in pineapple plants (Laura *et al*., 2005; Gupta *et al*., 2007). The largest amount of this enzyme (36.1%) was found in the stem. The amount of enzyme is greater in older pineapple plants, with at least 53% in a five-year-old plant compared to 11% in a one-year-old plant (Pukrushphan, 1990).

Bromelain is used in many food industries. The Japanese have used bromelain to improve tofu by increasing the taste and flavor compared with using fungi (Pukrushphan, 1990). Bromelain has been used in fermented fish products, such as fish sauce, fish paste and Pla-ra to accelerate the process by reducing the fermentation time. There has been some research on using bromelain from pineapple plants to accelerate the fermentation process. Chuapoehuk *et al*. (1981) reported that bromelain can be used to produce fish sauce from freshwater fish like *Crossocheilus reticularis* Fowler. The activity of bromelain is related to temperature. High temperature can inhibit its reaction, with activity

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of the enzyme decreasing within the first 40 minutes (Reed, 1966) and stopping if the temperature increases from 61°C to 81°C (Balls *et al*., 1941). Temperature and salt have some effect on the fermentation process, so if the process occurs at low temperature, then high salt concentration is needed, while only low salt concentration is necessary for high temperatures. Halophilic bacteria are important in fermented food, especially fermented fish products such as fish sauce, Pla-ra and Pla-som. *Pediococcus halophilus* is one of the lactic acid bacteria that gives the fish sauce its good flavor (Saisithi, 1967). Thus, in this study, bromelain from pineapple waste was used to produce fish sauce from surimi waste.

MATERIALS AND METHODS

Three parts of surimi waste were mixed with one part of granular normal salt and the mixture was divided into two groups with four treatments in each. Pineapple core (10% - 40% w/w) was added to one group (T1-T4), while the same amount of pineapple peel was added to the other group (T5-T8). The samples were placed in baked clay jars each of which had a capacity of about 100 l. The jars were covered by a thick plastic sheet and left in the open air under sunshine for at least six hours per day. Sensory evaluation of fish sauce and chemical and microbiological analyses were made after fermenting for 6 and 12 months.

Chemical analysis

Samples of the fish sauce were analyzed for nitrogen and sodium chloride content according to AOAC (1995) and FAO (1981).

Microbiological examination

Each fish sauce sample was analyzed to group the species of bacteria using biochemical tests following the methods of Cowan (1985) and Buchanan and Gibbons (1974).

Organoleptic test

Sensory evaluation of the fish sauce samples involved 18 panelists who were students of the Department of Fishery Products, Kasetsart University, with two replications. A nine-point hedonic scale (9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 – neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, 1 = dislike extremely) was used to score the appearance, color, flavor and overall liking of each fish sauce sample.

Statistics

The data were analyzed for analysis of variance (ANOVA) using the SAS program. Duncan's new multiple range test was used to compare the means with a significance level of $P<0.05$.

RESULTS AND DISCUSSION

Nitrogen levels in the fish sauce samples are shown in Table 1, sodium chloride content is shown in Table 2 and the sensory evaluation is shown in Table 3. Seven species of bacteria were found in the fish sauce fermented for 12 months: *Micrococcus luteus*, *Streptococcus mutans*, Group E streptococci from swine, *Staphylococcus aureus*, *Micrococcus varians, Streptococcus faecalis* and *Acinetobacter iwolfii*. Group E streptococci from swine were the most common, followed by *Streptococcus mutans* and then *Staphylococcus aureus*. *Staphylococcus aureus*, a pathogenic bacteria associated with streptococci hygiene, is an indicative bacteria that might have originated from the surimi waste. Total nitrogen levels in the fish sauce were higher after longer fermentation time because of autolysis and bacterial activity from the surimi waste. Total nitrogen levels were higher with increasing amounts of pineapple waste, with the exception of T3, T4, and T5. Most fish sauce with pineapple peel added had higher nitrogen content than that with pineapple core added, except for the fish sauce with 10% pineapple core added which had a slightly higher nitrogen level than that with 10% pineapple peel added (Table 1). Total sodium chloride content of fish sauce increased slightly according to the fermentation time (Table 2). Fish sauce with 30% pineapple core added (T3) had the highest increase in sodium chloride after fermenting for 12 months compared to after six months, followed by 30% (T7) and 40% pineapple peel added (T8), respectively. The results of the sensory evaluation of the fish sauce are shown in Table 3. The color of the fish sauce was acceptable with the longer fermentation time of 12 months, as was the odor of fish sauce. This may have resulted from the activity of some bacteria (Saisithi, 1967). The flavor of the fish sauce was more acceptable after long fermentation. Fish sauce with 40% pineapple core added (T4) and fish sauce with 10% pineapple peel added (T5) were about the most acceptable for appearance. After fermentation for 12 months, the sample with 40% added pineapple core (T4) and the sample with 40% added pineapple peel (T8) had the most acceptable fish sauce color. The odor of some fish sauce samples was not acceptable. Fish sauces samples T7, T5 and T3 were the most acceptable for odor.

Table 1 Total nitrogen as an indicator of the protein content in fish sauce fermented for 6 months and 12 months.

Treatment	Protein (g/l)	
	6 months	12 months
T1	6.24^{cA}(0.01)	13.82^{dB}(0.83)
T2	6.84^{cA}(0.08)	14.16^{dB}(0.03)
T3	8.19^{fA}(0.09)	15.33^{cB}(0.07)
T4	6.49^{dA}(0.04)	12.98^{cB}(0.14)
T5	5.88^{bA}(0.13)	12.12^{dB}(0.17)
T6	8.27^{f}(0.02)	NT
T7	9.79^{gA}(0.11)	14.78^{dB}(0.10)
T8	10.42^{bA}(0.01)	14.34^{cB}(0.07)

Means followed by the different lowercase letters in the same column are significantly different (a = 0.05).
Means followed by the different capital letters in the same row are significantly different (a = 0.05).
NT = No test because the treatment was contaminated by rain.
The numbers in parentheses are the standard deviations from 36 replications.

Table 2 Total NaCl content in fish sauce fermented for 6 months and 12 months.

Treatment	NaCl (g/l)	
	6 months	12 months
T1	311.62^{fB}(1.63)	305.45^{cA}(1.46)
T2	268.3^{d}(1.93)	263.74^{b}(4.66)
T3	241.03^{bA}(1.39)	294.37^{cB}(1.45)
T4	243.3^{b}(1.47)	247.34^{a}(3.18)
T5	300^{eB}(1.55)	292.72^{cA}(1.42)
T6	262.2^{c}(1.61)	NT
T7	241.43^{bA}(1.61)	275.77^{bB}(6.46)
T8	218.94^{aA}(3.00)	241.06^{aB}(2.57)

NT = No test because the treatment was contaminated by rain.
The numbers in parentheses are the standard deviations from 36 replications.

Table 3 Sensory evaluation of fish sauce fermented for 6 months and 12 months.

Treatment	T1		T2		T3		T4		T5		T6		T7		T8		Fish sauce from market
Evaluated characters	6 months	12 months	6 months	12 months	6 months	12 months	6 months	12 months	6 months	12 months	6 months	12 months	6 months	12 months	6 months	12 months	
Appearance	5.63^{d}	5.64^{ab}	3.13^{aA}	5.92^{abcdB}	4.00^{abcA}	6.24^{bcdeB}	4.38^{bcdA}	6.56^{deB}	5.38^{d}	6.44^{cde}	5.25^{d}	NT	5.00^{cd}	5.92^{abcd}	5.13^{cd}	5.32^{a}	6.92^{a}
	(0.83)	(1.68)	(0.92)	(1.50)	(1.20)	(1.92)	(0.99)	(1.30)	(0.99)	(1.85)	(1.83)		(1.85)	(1.41)	(1.60)	(1.99)	(1.73)
Color	5.13^{d}	5.64^{ab}	2.63^{aA}	5.76^{abB}	3.50^{abcA}	5.84^{abB}	3.88^{bcdA}	6.32^{bcB}	4.88dA	6.72^{cB}	4.75^{d}	NT	4.50^{cd}	5.80^{ab}	4.63^{cd}	6.24^{a}	7.12^{c}
	(0.83)	(1.91)	(0.92)	(1.51)	(1.20)	(1.93)	(0.99)	(1.60)	(0.99)	(1.54)	(1.83)		(1.85)	(1.91)	(1.60)	(2.22)	(1.30)
Odor	1.31^{a}	3.72^{a}	3.75^{ab}	4.16^{a}	3.88^{ab}	4.36^{a}	4.50^{b}	3.84^{a}	3.88^{ab}	4.04^{a}	3.63^{ab}	NT	3.13^{a}	4.48^{a}	2.88^{a}	3.88^{a}	7.40^{b}
	(1.46)	(1.72)	(1.67)	(1.57)	(1.46)	(1.89)	(1.20)	(2.15)	(1.96)	(2.01)	(1.30)		(0.99)	(1.94)	(2.03)	(2.13)	(1.41)
Flavor	5.13^{de}	4.16^{a}	4.00^{abcd}	4.76^{abc}	5.38^{d}	4.88^{abc}	4.63^{bcde}	4.56^{ab}	3.75^{abc}	5.04^{bc}	4.25^{abcde}	NT	3.00^{aA}	5.24^{bcB}	3.38^{abA}	5.24^{bcB}	7.40^{b}
	(1.13)	(1.84)	(2.00)	(1.56)	(1.41)	(1.83)	(1.60)	(2.04)	(2.05)	(1.70)	(1.98)		(1.85)	(1.42)	(2.56)	(1.81)	(1.41)
Overall acceptance	4.88^{b}	4.88^{a}	3.50^{abA}	4.88^{aB}	4.75^{b}	5.12^{a}	4.50^{ab}	4.96^{a}	3.88^{ab}	5.24^{a}	4.13^{ab}	NT	3.25^{aA}	5.34^{aB}	3.50^{ab}	4.96^{a}	7.52^{b}
	(0.99)	(1.59)	(1.20)	(1.45)	(1.28)	(1.59)	(1.07)	(1.62)	(1.89)	(1.61)	(2.03)		(1.83)	(1.81)	(2.73)	(1.84)	(1.05)

Means with the different capital letters in a row are significantly different for each treatment (a = 0.05).
Means with the different lowercase letters in a row are significantly different only the same fermented period (a = 0.05).
NT = no test because the treatment was contaminated by rain.
The numbers in parentheses are the standard deviations from 36 replications.

CONCLUSION

From this study, it can be concluded that surimi fish waste can be used instead of marine fish (*Stolephorus* spp.) to produce fish sauce, because the total nitrogen content (15.33 g/l) of the fish sauce in this study ranked as second level according to the Traditional Fish Sauce standards of the Ministry of Industry. In addition, this product was also acceptable when compared with the standard of the Ministry of Public Health Notification Number 203 (Fish Sauce) which fixes the minimum protein in fish sauce at 9 g/l and the minimum NaCl level at 200 g/l.

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