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Chemical and Microbiological Changes during Shrimp Seasoning Fermentation Using Seafood Processing Waste

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Abstract. Shrimp processing industries generate a lot of waste such as head and shell in each year. Objective in this research was to study chemical and microbiological changes during shrimp seasoning fermentation. Shrimp head and shell were fermented at various ratios of materials to salt (1:1, 1:2 and 1:3) at room temperature for 4 months. Shrimp seasoning was sampled every month to determine soluble protein, salt content and pH. The pH of shrimp seasoning was around 7.00 and salt content was 2.0-2.5% for all fermentation period. Soluble protein increased as fermentation time was progressed. The best condition for shrimp seasoning production using shrimp head and shell were at a ratio of materials to salt 1:1 for 3 and 4 months, respectively. Soluble protein content in head shrimp seasoning was higher than shell. Therefore shrimp head might be a good source for shrimp seasoning production.

Keywords: chemical and microbiological changes, shrimp seasoning fermentation, seafood processing waste

1. Introduction

Shrimp processing industries are the most important fishery industry in Thailand. Generally, the head, shell and tail portions of shrimp are remove during processing and these account for approximately50% of the catch. Increasing production of inedible parts of shrimp is causing environmental problems as a result of uncontrolled dumping. Thus, attention must be paid to greater utilization of shrimp processing by-products in order to address such concerns [1]. Studies on shrimp waste have included those on characteristics enzyme, nutrients and value-added products from shrimp processing discard [2], [3] and natural antioxidant extraction from shrimp [4]. Utilization of shrimp shell by-products for the extraction of carotenoprotein [5], [6], chitin [7], chitosan [6], [8]. Even through chitin and chitosan was produced from head and shell, but chitin/ chitosan production spends a lot of chemicals to get rid of protein. Protein in shrimp head and shell that may can be a source for shrimp seasoning fermentation. Objective in this research was to study chemical and microbiological changes during shrimp seasoning fermentation.

2. Materials and Methods

2.1. Raw Materials

White Shrimp head and shell (*Penaeusvannamei*) from Ongkorn Cold Storage Co., Ltd, Samutsakorn, Thailand. They were contained in ice box and transfer to faculty of Fisheries, Kasetsart University in 2 hr.

2.2. Shrimp Seasoning Fermentation

White shrimp head and shell were fermented at various ratios of materials to salt (1:1, 1:2 and 1:3) at room temperature (35 °C) for 4 months. Fermentation liquid was sampled every month by centrifuge at 20,000xg for 30 min.

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2.3. Chemical Analysis

2.3.1. Proximate analysis

Chemical composition of white shrimp head and shell were determined. Crude protein content was calculated by converting the nitrogen content determined by Kjeldahl's method (6.25xN) [9]. Moisture, ash, fat were determined [10].

2.3.2. Chemical quality analysis

Total volatile basic nitrogen (TVB-N) values of raw materials and fermentation liquid were determined using the Conway microdiffusion assay [10].

Soluble protein content of fermentation liquid was determined [11] using Bovine serum albumin as protein standard. Salt content, TVB-N value and pH of fermentation liquid were determined [10].

2.4. Proteolytic Activity

Protease activity was determined [12] using casein as a substrate. One ml of shrimp seasoning was mixed with 1 ml of 1%casein solution pH 7.0 then incubated at room temperature (35 ℃) for 30 min then stop activity by adding 3 ml of 10%TCA. Soluble protein in the filtrate was determined [11].

2.5. Microbiological Analysis

Total bacteria count, proteolytic bacteria and lactic acid bacteria in fermentation liquid were determined [9]. Fermentation liquid was diluted in sterile water in ratio 1:10, 1:100, 1:1,000 and 1:10,000 then transfer 1 ml of each solution in PCA for total plate count bacteria, CCA for proteolytic bacteria and MRS for lactic acid bacteria then incubate in 37 ℃ for 24 , 72 and 48 hr., respectively.

2.6. Color Measurement

Color of fermentation liquid was determined by Minolta CM-3500d Spectrophotometer.

2.7. Sensory Evaluation

Nine point hedonic scales were performed for acceptance evaluation of shrimp head seasoning. Analysis was carried out with untrained 50 panelists who were under graduated and graduated students from the Department of Fishery Products, Kasetsart University, of age ranging from 19 to 22 years. The nine points hedonic scale, in which a score of 1 represented extreme dislike and 9 represented like extremely, was used for evaluation.

2.8. Statistical Analysis

A completely randomized design (CRD) was used throughout the study, and the experiments were done in triplicate. Data were subjected to analysis of variance (ANOVA) and mean comparisons were carried out using Duncan'smultiple range.

3. Results and Discussion

3.1. Chemical Analysis

3.1.1. Proximate analysis

Table I: Chemical composition of white shrimp head and shell

Shrimp portion	Chemical composition content (%)				TVB-N
	protein	moisture	ash	fat	(mg/100g)
head	12.90 ±0.15	78.28 ±0.39	5.25 ±0.11	4.23 ±0.35	9.00 ±1.44
shell	13.18 ±0.09	77.07 ±0.59	4.93 ±0.14	3.39 ±0.58	8.50 ±1.53

Chemical composition of white shrimp head and shell were shown in Table I. Shrimp head contained protein, moisture, ash and fat in similar amount of shrimp shell. The protein content in both head and shell were 12.90 ±0.15 and 13.18 ±0.09 %, respectively.

3.1.2. Chemical quality analysis

The pH of shrimp seasoning was around 7.00 (Figure 1). TVB-N value increased during the fermentation period (Figure 2), but these values were not effect to pH value. TVB-N of shrimp seasoning was lower than fish sauce [13], [14] even through salt content was 2.0-2.5% (Figure 3) for all fermentation period. It may from nitrogen source in shrimp waste lower than fish waste. TVB-N value indicated bacterial spoilage.

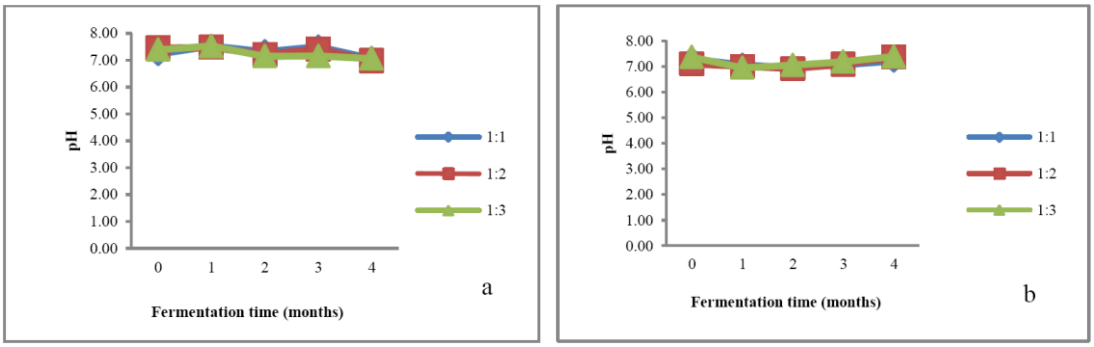

Fig. 1: pH changes in fermentation time of shrimp head (a) and shell (b)

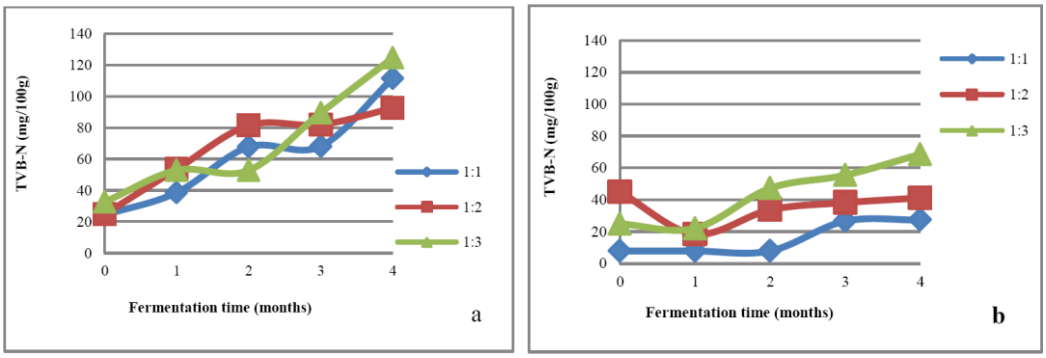

Fig. 2: TVB-N changes in fermentation time of shrimp head (a) and shell (b)

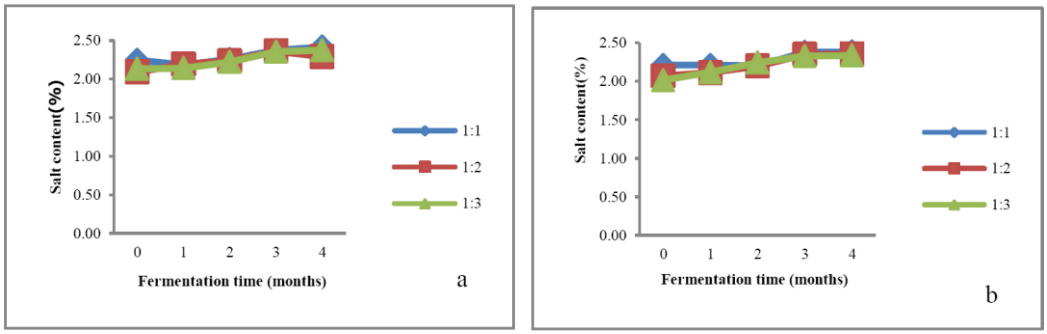

Fig. 3: Salt content changes in fermentation time of shrimp head (a) and shrimp shell (b)

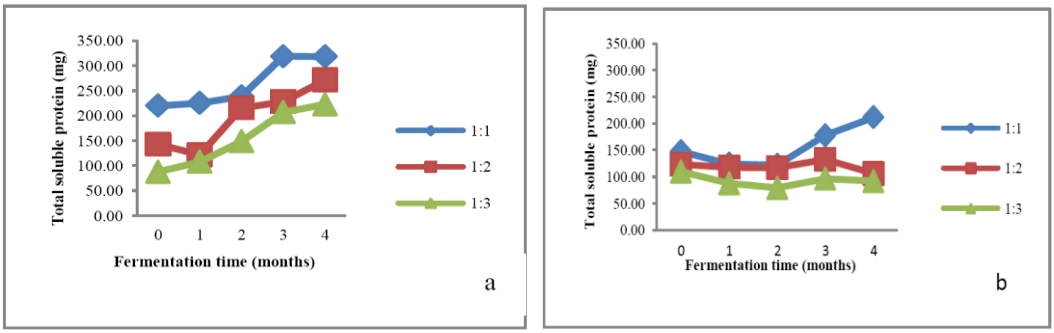

Fig. 4: Total soluble protein changes in fermentation time of shrimp head (a) and shell (b)

Total soluble protein increased as fermentation was progressed (Figure 4). This phenomenon was found in fish sauce production because of degradation of fish muscle by autolysis and bacteria [15]. The best condition for shrimp seasoning production using shrimp head and shell were at a ratio of materials to salt 1:1 for 3 and 4 months, respectively. Soluble protein content in head shrimp seasoning was higher than shell. Therefore shrimp head might be a good source for shrimp seasoning production.

3.2. Proteolytic Activity

Proteolytic activity in fermentation liquid of head shrimp fermentation was decrease when salt concentration was higher (Figure 5). After 2 months, amount of fermentation liquid was higher because of autolysis and bacterial degradation in shrimp head. Shell fermentation liquid was from bacterial degradation because it was respond to protease substrate.

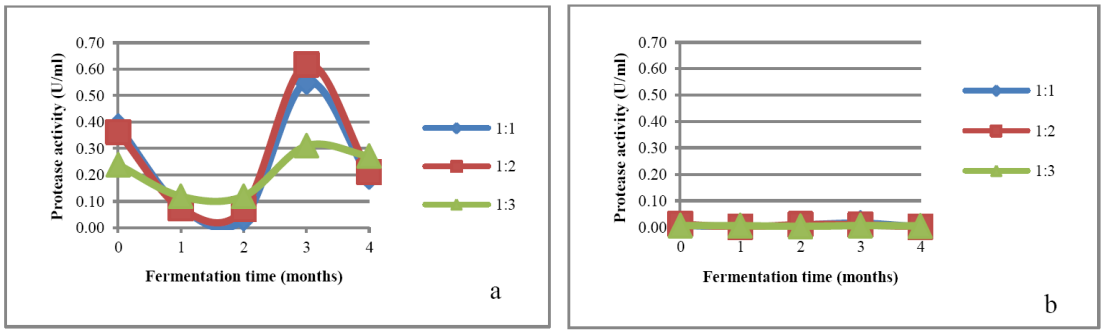

Fig. 5: Protease activity changes in fermentation time of shrimp head (a) and shell (b)

3.3. Microbiological Analysis

Amount of total bacteria was increased as fermentation time progress (Figure 6). This phenomenon related to increasing TVB-N value that indicated initial bacteria amount produced amine product. After 2 months, amount of bacteria was decreased because salt concentration (1:2 and 1:3) was higher to inhibit bacterial growth.

Amount of proteolytic bacteria was decreased as fermentation time progress (Figure 7), it may from salt concentration inhibit proteolytic bacteria growth. Lactic acid bacteria was not found in fermentation liquid. This result may be retained pH in 7.00.

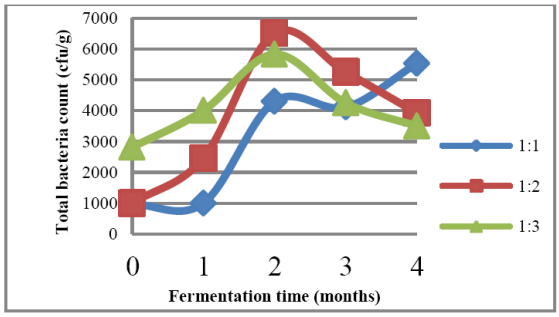

Fig. 6: Amount of total bacteria changes in fermentation time of shrimp head

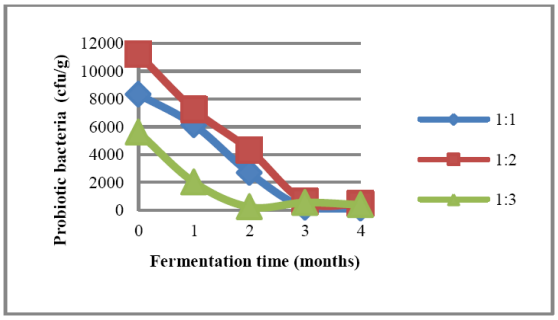

Fig. 7: Amount of probiotic bacteria changes in fermentation time of shrimp head

3.4. Color Measurement

Both of shrimp head and shell seasoning gave light yellow color (L* = 94.76, a* = -1.77, b*= 16.26 and L* = 98.14, a* = -0.19, b*= 7.92, respectively) even through the color was darker as fermentation time progress. The color was lighter than fish seasoning that may from different chemical composition of raw material.

3.5. Sensory Evaluation

Sensory evaluation of shrimp head seasoning was shown in Table II. Overall product liking of shrimp seasoning was lower than fish sauce. It may from quality and quantity of amino acid in shrimp waste lower than whole anchovy, fish sauce raw material.

Table II: Nine point hedonic scales for acceptance evaluation of shrimp head seasoning

	Average score ±SD	
	Control (fish sauce)	Shrimp seasoning
Color liking	6.69 ±1.69[a]	5.09 ±1.57[b]
Flavor liking	6.16 ±1.85[a]	2.44 ±1.56[b]
Saltiness intensity	6.72 ±1.55[a]	4.66 ±1.84[b]
Sweet intensity	5.84 ±1.53[a]	3.88 ±1.83[b]
Bitterness intensity	5.25 ±2.02[a]	3.88 ±1.81[b]
Overall product liking	6.56 ±1.39[a]	3.69 ±1.60[b]

4. Acknowledgements

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