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The Production of Flavor Microcapsules from Shrimp Waste

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Abstract The objective of this study was to use microencapsulation to produce flavor microcapsules from whiteleg shrimp heads. The flavor extraction from shrimp head waste (protein hydrolysate) was carried out using neutrase and alcalase at ratios of 0: 2, 0.5: 1.5, 1: 1, 1.5: 0.5 and 2: 0 mixed with shrimp head (98%). The optimal ratio of neutrase to alcalase is 1:1 as it had the highest degree of hydrolysis and the lowest bitterness intensity based on sensory evaluation. Maltodextrin concentrations of 10, 20, 30 wt% were used to encapsulate protein hydrolysate using a spray drying technique. As the percentage of maltodextrin in coating material was increased, the moisture content and water activity of flavor microcapsules decreased whereas solubility index increased.

Keywords: Flavor, microcapsule, Shrimp waste

Introduction

Thailand is a leading shrimp manufacturer and importer of the world. The products consist of frozen shrimp and processed shrimp. Whiteleg shrimp (*Litopenaeus vannamei*) is considered as a sea shrimp that has significance to the economy as it has firm texture, best-testing, and also popular. Whiteleg shrimp is easy to feed with a fine level of growth ratio and endure the change of salty water. In the processing of whiteleg shrimp, the wastes such as shrimp heads, shells and tails are remained in large amount. It found that the wastes are approximately 40-80% and it is rotten easily as it contains mostly protein and fat which may lead to environmental issues. Generally, the utilization of shrimp wastes is to use as animal feeds and other products such as chitin, chitosan, peptone and other products as well. Whiteleg shrimp wastes contain two main parts; heads and shells while the heads mainly consist of protein and fat, therefore, it can be used to develop as protein hydrolysates.

The extraction of protein hydrolysates from shrimp head can be preceded in various methods. The most popular method is to use chemical method to extract the protein from whiteleg shrimp head in the production of chitin.

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However, the protein derived from such method is difficult to use and the using of enzyme for hydrolysis is preferable than using chemical as the enzyme is able to react peptide bond without destroying amino acid and taste caused by free amino acid or peptide better than using chemical. Alcalase is the highest potential enzyme for hydrolysis and also able to cut the bond on protein chain in various positions (Srithongkerd, 2008). For neutrase enzyme, it can cut peptide bond on protein chain and short chain peptide. The utilization of these two enzymes will lead to the strong smell and taste of shrimp and reduce the bitterness, comparing to other types of enzymes (Yeneng, 2001).

Microencapsulation is the technique by which one material or a mixture of materials is coated with or entrapped within another material. The coated material is usually called core material, and the coating material is usually called wall material (Madene *et al*., 2006). Spray drying is the most commonly used microencapsulation technique in the food industry. Because of the process of spray drying is economical and flexible, uses available equipment, and produces powder particles of good quality (Jafari *et al*., 2007). The wall material is usually composed of relatively low molecular weight carbohydrate such as maltodextrin and corn syrup solid. These carbohydrates is a wall material which is the most popular in spray drying due to its physical properties such as high water solubility and bland in flavor (McNamee, 2001).

In this study, we investigate the effect of neutrase and alcalase on protein hydrolysates as shrimp flavor extract from whiteleg shrimp heads and produce shrimp flavor microcapsules by spray drying technique using maltodextrin as wall material in order to use in the food products.

Materials and methods

Raw material

Whiteleg shrimp heads (*Litopenaeus vannamei*) from a freezing plant in Chanthaburi province were frozen at -30°C and kept at -22°C until used. Shrimp heads were partially thaws and ground in a blender.

Preparation of shrimp flavor extract

Ground shrimp heads were blended with water at a ratio of 1:1 and mixed with neutrase to alcalase in various levels; 0:2, 0.5:1.5, 1:1, 1.5:0.5 and 2:0 wt% of shrimp head’s weight. The mixtures were adjusted to pH 8 and incubated at 60°C for 1 hour. After incubation, the mixture were heated at 85°C for 15 min and filtered through Whatman No. 4 paper. The shrimp flavor extract was kept at -22°C before sensory evaluation and analysed degree of hydrolysis (DH).

Preparation of shrimp flavor microcapsules

Shrimp flavor extract was prepared by using neutrase and alcalase at ratio of 1:1 mixed with shrimp head (98%). The extract was mixed with maltodextrin in various contents of 10, 20, 30 wt% and stir for an hour before dehydrate with spray dryer at an inlet air temperature of 175 °C and outlet temperature of 95°C. The microcapsules were analyzed for moisture content, water activity and solubility index.

Results and discussion

Effect of neutrase and alcalase on shrimp flavor extract from whiteleg shrimp heads

The appropriated content of neutrase to alcalase (percentage of shrimp head's weight) in various levels; 0:2, 0.5:1.5, 1.0:1.0, 1.5:0.5 and 2:0 wt% were studied. According to the extraction, the extract with transparent and brown color has used for sensory evaluation by ranked the samples in order of lowest to highest bitterness. The results are shown in Table 1.

Table 1. Ranking of bitterness of shrimp flavor extract prepared with different neutrase and alcalase content.

Enzyme content (%)		**Rank sum**
Neutrase	Alcalase	
0	2	22
0.5	1.5	21
1	1	17
1.5	0.5	19
2	0	20

According to rank sum test of shrimp flavor extracts, it found that the extract used the content of neutrase to alcalase equivalent to 1:1 wt% has the lowest rank sum of bitterness which is 17 whereas the extract used the content of neutrase to alcalase equivalent to 0:2 wt% has the highest rank sum of bitterness which is 22. Puttongsiri and Chaisongkram (2013) reported on the extraction for flavoring agent from whiteleg shimp heads by using various proteases, including papain, bromelain and alcalase. Alcalase with 2 wt% of concentration has the lowest sensory score of bitterness. Therefore, neutrase is required to use as it can hydrolyse peptide bond to short chain peptide. The using of these two enzymes (alcalase and neutrase) has an effect on strong flavor of shrimp with less bitterness (Yeneng, 2001).

Table 2. Degree of hydrolysis of shrimp flavor extract prepared with different neutrase and alcalase content.

Enzyme content (%)		Degree of hydrolysis (%)
Neutrase	Alcalase	
0	2	$19.75^{a} \pm 1.25$
0.5	1.5	$18.30^{a} \pm 5.17$
1	1	$23.06^{a} \pm 3.61$
1.5	0.5	$19.35^{a} \pm 1.92$
2	0	$24.07^{a} \pm 1.92$

Means within column followed by the same letter superscripts, are not significant different (p>0.05)

Degree of hydrolysis (DH) is defined as the percentage of free amino groups obtained by the cleavage of a protein, which was calculated from the ratio of α-amino nitrogen and total nitrogen (Nilsang *et al.*, 2005). Degree of hydrolysis of extracts from shrimp head that has levels of neutrase to alcalase at 0:2, 0.5:1.5, 1:1, 1.5:0.5 and 2:0 wt% has the value of 19.75%, 18.30%, 23.06%, 19.35% and 24.07% , respectively with no significant difference (p>0.05). The results are shown in Table 2. The types and levels of enzyme concentration have an effect on the degree of hydrolysis. The concentration of alcalase tends to make the degree of hydrolysis increase according to the increasing of concentration by using alcalase at 1.5 wt% which has degree of hydrolysis that close to the study at 17.76 (Puttongsiri and Chaisongkram, 2013). The size of peptide molecule and position of hydrolysed peptide bond has significance to the quality of protein hydrolysate (Jodnak, 2013)

In this regards, the results of sensory evaluation and degree of hydrolysis of shrimp flavor extract from whiteleg shrimp heads, the appropriated level of neutrase to alcalase is at 1:1 wt% as it has the high level of degree of hydrolysis with lowest bitterness.

Effect of maltodextrin content on shrimp flavor microcapsules from whiteleg shrimp heads

The characteristics of microcapsules by using maltodextrin contents of 10, 20 and 30 wt%, analysis of moisture content, water activity (Aw), and solubility index shown in Table 3.

Table3 . Characteristics of shrimp flavor microcapsules prepared with different maltodextrin content.

Maltodextrin Content (%)	Moisture content (%)	Water activity	Solubility index (sec)
10	2.60^{b}±0.00	0.53^{c}±0.00	148^{a}±12.8
20	2.55^{b}±0.02	0.46^{b}±0.00	160^{a}±2.85
30	1.98^{a}±0.02	0.42^{a}±0.00	182^{b}±9.41

Means within column followed by different superscripts, are significantly different at P≤0.05 by Duncan's test.

High moisture content affects the flowability of the powders (Sims, 1989). In this study, the moisture content of microcapsules added maltodextrin in various levels; 10, 20 and 30 wt% has value of 2.60, 2.55 and 1.98 %, respectively. The results of our study show that as maltodextrin content increased, moisture in microcapsules decreased. Khunthawad and Sripui (2013) reported that Thai blueberry powder containing maltodextrin concentration of 30 wt% have low moisture absorption. They found that the moisture content and hygroscopicity decreased with increasing encapsulating concentration.

The water activity of the microcapsule containing maltodextrin in various levels; 10, 20 and 30 wt% has values of 0.53, 0.46 and 0.42, respectively with significantly different (p≤0.05). The results showed that water activity of microcapsule powders decreased when maltodextrin content were increased.

According to the analysis of microcapsule powder in terms of solubility index, microcapsule powder added maltodextrin in various levels; 10, 20 and 30 wt% has value of 148, 160 and 182 sec, respectively. The results showed that the increased content of maltodextrin has an effect on longer solubility of microcapsule powder as a good solubility should not consume a long period which can observe when the powder blended with distilled water. Wongsa-Ngasri *et al*. (2015) reported that the solubility of jellyfish powder using spray drying which consume 66-138 seconds when using concentration of maltodextrin at 2-6%, the highest solubility equivalent to 66 seconds with concentration of maltodextrin at 2%. According to the study, it found that the solubility of the food powder decreased when maltodextrin content were increased. (Milton *et al*., 2005)

Conclusion

The shrimp flavor extract from whiteleg shrimp heads by using the content of neutrase to alcalase in the proportion of 1:1 is the most acceptable as the lowest bitterness intensity and high level of degree of hydrolysis. The production of shrimp flavor microcapsules by spray drying can be use maltodextrin as wall material with 10-30 %wt

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