Biochemical Characteristics of small shrimp (Acetes japonicus) of varied sizes collected in Ben Tre Province, Vietnam

T D Ung1, T Y N Tran1,2,3, N L Nguyen2, D A Phan4, L V Tan1,*

1 NTT Hi-Tech Institute, Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam
2 Faculty of Food Engineering and Environment, Nguyen Tat Thanh University, Ho Chi Minh City, Viet Nam
3 Graduate University of Science and Technology, Vietnam Academy of Science and Technology, Vietnam.
4 GREEN SEAFOOD Co., Ltd, Thanh Phu District, Ben Tre Province, Viet Nam

*Corresponding author: lvtan@ntt.edu.vn

Abstract. Small shrimp (Acetes japonicus) is a common ingredient in various dried and fermented dishes on Asian countries. In this study, we explored the nutritional qualities of small shrimps with respect to their body length. The shrimp materials were harvested from near-shore waters of Ben Tre province, Vietnam. Various measures including mineral, lipid, salt and astaxanthin content of small shrimps of three size groups including small, medium, and large were evaluated. Current results indicate high salt content of small, medium, and large shrimp, at 23.74 ± 0.01, 24.09 ± 0.01, and 27.97 ± 1.38 mg/g dry basis, respectively. The mineral content seemed to be irrelevant to body size. Large and medium shrimps showed higher lipid content than the small counterpart. However, small shrimps are advantageous in terms of astaxanthin content. Further studies should contemplate nutritional quality with respect to harvest area and dietary scheme.

1. Introduction

Sergestid shrimp (Acetes japonicus) is a species of small shrimp that is distributed in various waters ranging from India, Thailand, Indonesia, and various regions of South China Sea. The species has the common name of small shrimp and is often called as “Ruoc” in Vietnamese and serves as an important ingredient in crafting traditional fermented and dried dishes in various Asian cultures. Sergestid shrimp is rich in mineral contents and has been proven to be a good source of astaxanthin and protein. It has been shown that the extract of fermented and salted small shrimps could lower cholesterol in rat model, suggesting the potential of small shrimp in manufacture of functional foods. To date, studies involving manufacture of small shrimp-derived food products have been focusing on drying and fermentation. He et al. (2006) reported that the hydrolysate obtained via protease treatment of small shrimp exhibited good antioxidant activity and was able to inhibit Angiotensin-I-converting enzyme. Je et al. (2016) attempted the production of a snack product with rice and dried small shrimp ingredient. The final product showed good sensory, flavour, and nutrient properties and high content of amino acids.

In Vietnam, small shrimp is extensively harvested in near-shore waters of middle, coastal provinces. The products derived from small shrimp are also greatly diversificed with dried and salt fermented...
shrimps being the most common food product. However, the manufacture processes for such products are not standardized and often carried out based on previous experience, thus lacking considerations on critical aspects such as harvesting material selection, drying methods, and product preservation. Therefore, an improved production process might greatly contribute to enhancing the value of this fishery product and play an important role in maintaining nutritional and sensory value of small shrimp-derived foods. In this study, we provided justification for material selection by investigating various nutritional qualities of the small shrimp of varied sizes. Classification of small shrimps by their body length is a common and effortless practice to select appropriate material in the production process. Therefore, adequate data on nutritional characteristics of small shrimps with respect to their body size might justify material selection in food processing.

2. Materials and Methods

2.1. Materials

The sergestid shrimps were harvested in the nature at Thanh Phu District, Ben Tre Province, Vietnam by Green Seafood Co., Ltd. The shrimps were first washed to remove impurities and allowed to dry naturally. Shrimps were distributed into three shrimp groups, including small (1.20-1.43 cm), medium (2.0-2.24 cm) and large (2.0-2.24 cm). Each group consisted of 100 shrimps.

2.2. Methods

2.2.1. Determination of average size of sergestid shrimp. Each shrimp in a group was individually measured by an electronic caliper. The results of shrimp groups are presented as mean with median.

2.2.2. Determination the total mineral content. The whole group of shrimps was stirred vigorously. Then around 2-3g of shrimps was incinerate at a temperature of 550 – 600 °C until white ash was obtained. The ash was then weighed and the total mineral content (%) in food sample was determined according to AOAC 2005.

2.2.3. Determination of the salt content. Shrimps were homogenized before being measured for salt content. Salt content was determined following the Mohr method. To be specific, 2-5g of shrimp paste was then placed into a 100mL volumetric flask and added with double-distilled water to around 2/3 of the flask’s volume. The pH was then adjusted with 5 drops 1% PP. Then, depending on whether the initial color was colorless or pale pink, either 0.1N NaHCO₃ or 0.01 N acetic acid solution was added until the color changed to pale pink or colorless, respectively. Lastly, distilled water was added to the flask to 100mL.

The titration process was carried out as follows. First, 10 mL of the sample was first introduced into a 250 mL conical flask, followed by 10 mL of distilled water and 5 drops of 10% K₂CrO₄ indicator under stirring. The sample was titrated until a red precipitate appeared. The salt content was calculated as follows.

\[
\text{NaCl (g/l)} = \frac{V \times 0.00585 \times V_1}{V_2 \times m_0} \times 1000
\]

Where NaCl is the salt content, m₀ is the weight of the shrimp paste, V₁ is the volume of the volumetric flask (100 mL), V₂ is the volume of the sample for titration (10 mL), V is the volume of the used AgNO₃ solution. NaCl determination was performed in triplicate for each group.

2.2.4. Determination of the total fat content. Shrimps were first dried at 100-105 °C to constant mass. Then about 3-5g of dry shrimps put into a paper thimble filter and then extracted via Soxhlet apparatus for 8 to 12 hours with diethyl ether solvent. The obtained extract was then dried to obtain the resulting fat. Lipid content (%) was calculated by the formula:
\[
\frac{m_1 - m_0}{m} \times 100
\]

Where \( m \) is the sample weight of the dried shrimp, \( m_0 \) is the weight of the thimble filter and \( m_1 \) is the total weight of both filter and the sample contained inside.

2.2.5. **A subsubsection Determination of the Astaxanthin content.** Astaxanthin content was determined following a previous study (Abdolmajid Lababpour and Choul Gyun Lee, 2006). Shrimps were first homogenized to afford the shrimp paste. Then, 7.5g of the paste was put into a 100mL volumetric flask. Acetone was then added to the flask to 100mL, followed by vigorous stirring and filtration. Afterwards, 1 mL of the filtrate was then introduced into 1 mL of acetone into a capped test tube. The tube was then put into the fridge at 4°C for 20min. The sample was then spectrophotometrically measured at a wavelength of 455 nm. The standard curve of astaxanthin was constructed by spectrophotometrically measuring a series of standard astaxanthin solutions with concentrations ranging from 2 to 12 μg/ml at 455 nm.

3. ** Results and Discussion

3.1. **The Small Shrimp Length**

The length of sergestid shrimps is from 1.43 to 2.89 centimeters (Figure 1), size L has the largest size, 2.89 ± 0.2 centimeters, 2.02 times longer than size S (with size 1.43 ± 0.22 centimeters). This difference can be explained by the different growing conditions and due to the current life span of the sergestid shrimps right at the time of capture resulting in different sizes.

![Figure 1](image_url)  
**Figure 1.** The resulting diagram of measuring the length of the baby shrimp  
Different letters (a, b, c) in a sampling period signify a significant difference (p<0.05).

3.2. **The Total Mineral Content**

The mineral content (Figure 2) in the sergestid shrimps ranges from 1.58 to 1.67% (based on the dry content). Mineral content of the size M group is the highest. The mineral content (Fig 3) in the tiny shrimp ranges from 1.58 to 1.67% (dry basis). Mineral content size M is the highest. This could be explained by the fact that a number of medium sized shrimps is often higher than that of the large sized shrimp group in a given mass. Since mineral content of the shrimp species often accumulates on the shell, the shell:flesh ratio of the medium sized shrimps is higher than that of other sizes. However, statistical analysis revealed that the differences are not significant.
Figure 2. The resulting diagram of measuring the mineral content of the baby shrimp. Different letters (a, b, c) in a sampling period signify a significant difference (p<0.05).

3.3. The Salt Content
The large group of shrimps had the highest salt content (27.97 ± 1.38 mg/g dry weight), while small- and medium- sized groups showed approximately similar content of 23.74 ± 0.01 mg/g dry weight and 24.09 ± 0.01 mg/g dry weight respectively (Figure 3). The increased salt content in larger shrimps could be attributable to higher nutrients accumulated in older shrimps compared to younger ones. ANOVA analysis confirmed this difference.

Figure 3. Variations of salt content with respect to size of shrimps. Different letters (a, b, c) in a sampling period signify a significant difference (p<0.05).

3.4. The Lipid Content
The fat content in the sergestid shrimp (Figure 4) peaked at the medium size group, at around 6% and was at the lowest at small sized group, at 4.63%. Normally, in nature, for small shrimp that have not yet developed to adulthood, nutrients such as fat have not been fully synthesized, resulting in the lower nutritional content in comparison with those of other groups.
3.5. The Astaxanthin Content

The calibration curve for astaxanthin (Figure 5) after completion is shown by the equation $y = 0.28245x$ for a concentration of 0 to 12 µg/ml ($R^2 = 0.99982$).

Astaxanthin content (Figure 6) was highest at small sized group (0.040 ± 0.001 mg/g dry weight) and was 2 times higher than that of astaxanthin in medium size group (0.023 ± 0.001 mg/g dry weight). This can be explained by the diet that young shrimps consume before being caught. Due to their swarm and wild behavior, young shrimps often consume a larger amount of food to support their growth. Therefore, the metabolism of canthaxanthin into astaxanthin occurring in their body would be more accelerated, leading to higher astaxanthin content. Astaxanthin content has been shown to vary with developmental stage, organ structure, or tissue. (Scheidt 1990; Howell and Matthews 1991; Okada et al. 1994). According Mantiri et al (1995), astaxanthin accumulation in the hatching stage was located in both tails and tissues of the shrimps while that of older shrimps was mostly identified in the tails only [8].

**Figure 4.** Variations of lipid content with respect to size of shrimps. Different letters (a, b, c) in a sampling period signify a significant difference (p<0.05).

**Figure 5.** Calibration curve diagram for astaxanthin
Figure 6. Variations of astaxanthin content with respect to size of shrimps. Different letters (a, b, c) in a sampling period signify a significant difference (p<0.05).

4. Conclusion
In this study, we aimed to justify the small shrimp material in food processing by examining nutritional qualities of small shrimp of various sizes. Large shrimps are more rich in mineral and salt content while small sized shrimps seemed to contain more astaxanthin than older counterparts. This study also offers useful insights into further attempts in diversifying small shrimp-derived food products and enables development of medicinal applications that utilize this natural and abundant source of astaxanthin.

Acknowledgement
This study was supported by Ben Tre Department of Science and Technology, Ben Tre Province, Vietnam

References
[1] Zafar M, Cho M S K and Amin S M N 2001 Bangladesh F Fish Res 5 205–208
[2] Wenhong C, Chaohua Z, Suhua C and Pengzhi H 2001 J. Fujian Fish. 1
[3] Zhi-feng and C H E N 2012 J Food & Machinery 4.
[4] Liu J, Zhao P, Liu L, Zhang J, Liu S, Zhang Z and Ding Y 2016 Journal of Aquatic Food Product Technology 25 169–76
[5] Lu F, Zhang J-Y, Liu S-L, Wang Y and Ding Y-T 2011 Food Chemistry 127 159–68
[6] Yuan J-P, Peng J, Yin K and Wang J-H 2011 Mol. Nutr. Food Res. 55 150–65
[7] Seok S-H, Park J-H, Cho S-A, Choi S-A and Park J-H 2004 J. Ethnopharmacol. 91 231–5
[8] Pan C-H and Chien Y-H 2003 J World Aquaculture Soc 34 57–65
[9] Schiedt K 1989 New Aspects of Carotenoid Metabolism in Animals Carotenoids ed N I Krinsky, M M Mathews-Roth and R F Taylor (Boston, MA: Springer US) pp 247–68
[10] Howell B K and Matthews A D 1991 Comparative Biochemistry and Physiology Part B: Comparative Biochemistry 98 375–9
[11] Okada S, Shah Amran Nur-E-Borhan and Yamaguchi K 1994 Fisheries science 60 213–5
[12] Mantiri Desy M H, Nègre-Sadargues G, Castillo R and Trilles J-P 1995 Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology 111 553–8