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Research Article

Effects of Blanching and Drying Condition on the Quality of Small Shrimp (*Acetes*)

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The study aimed to evaluate the influence of various parameters of the blanching and drying condition of small shrimp (*Acetes*) on some product quality parameters. Some criteria were assessed, such as salt content, astaxanthin content (ATC), and color of small shrimp. The results showed that the blanching time significantly affected the salt content. When increasing the blanching time, the salt content was found to increase from 17.35 ± 2.48 mg/g DW to 39.51 ± 0.45 mg/g DW. The astaxanthin content achieved the highest value (0.026 ± 0.001 mg/g DW) in a 2% salt solution. The study showed that the blanching and drying processes significantly affected the salt content, astaxanthin, and color of the small shrimp, and the optimized temperatures for blanching and drying were 70°C and 60°C, respectively.

1. Introduction

Acetes, commonly called small shrimp, is a genus of krill living in brackish waters or coastal areas worldwide. The harvest of small shrimp exhibits economic importance in the economies of many Asian and East African countries [1]. Small shrimp are often called "Ruoc" in Vietnam and is also a popular ingredient in preparing traditional fermented and dried dishes of cultures in Southeast Asian countries.

Acetes are rich in protein and minerals (Ca, Fe, P, and Se), with more than 17 essential amino acids, and vitamins and are also a good source of astaxanthin [2]. Vo et al. found that the proteolysate of *Acetes japonicus*, a species of the *Acetes* genus, contains calcium-binding peptides that can be used as a calcium alternative in the manufacture of calcium supplements [3]. In addition, the ethanolic extract from slated and fermented shrimp was found to exert antiatherosclerotic and anticardiovascular activities by lowering serum cholesterol *in vivo*. Specifically, high-cholesterol-induced mice administrated with a low dosage of small shrimp extract were reported to have a reduction in serum levels of low-density lipoprotein (LDL) cholesterol compared to those without treatment. This is possibly due to the presence of the hepatocytes of the group fed with salted and fermented small shrimp, which noticeably reduced the cholesterol content compared to mice without treatment [4]. In a previous study, chitin and chitosan were recovered from the posthydrolysis sediment of *Acetes chinensis* hydrolysate, suggesting high potentials of small shrimp in developing high value-added products such as dietary supplements or lipid-metabolizing enzyme inhibitor peptides [5]. Traditionally, harvested small shrimps have been subjected to sun-drying for solar irradiation. However, this approach has been considered slow and time-consuming compared to the

conventional dryer using fuel energy. Besides, small shrimps are also susceptible to environmental conditions and microbial contamination during the drying process, thus reducing the quality of the final product and lowering the economic values of small shrimps.

The traditional drying method using solar energy drastically affects the quality of small shrimps. In this study, the effects of blanching and drying conditions were considered in order to select the appropriate technology to minimize nutrient loss and limit negative product quality.

2. Materials and Methods

2.1. Materials. Small shrimp (*Acetes japonicus*) were harvested from the coastal area of Thanh Phu district, Ben Tre province, Vietnam (coordinates 9°56′53'N 106°30'51''E) by Green Seafood Co., Ltd. 100 g of samples were randomly selected from 1 ton/batch. Small shrimps had milky white color, not less than 2 cm in length, with a small red spot under the telson. Samples were washed to remove impurities and stored at 4°C until being used for experiments.

Astaxanthin was purchased from Sigma–Aldrich Ltd., Germany. Other analytical chemicals such as $AgNO_3$, phenolphthalein, methanol, acetone, and $NaHCO_3$ were sourced from Xilong Scientific Co., Ltd., China.

2.2. Evaluation Process. Dried small shrimp products were subjected to two main processes, blanching, and drying. Blanching was carried out under different salt concentration conditions, temperatures, and times. The salt concentration (NaCl) was varied from 0.5% to 2% for the evaluation process. The blanching temperature and time were investigated at 60°C–90°C from 2 to 8 min. Subsequently, the drying process was carried out at various temperatures of 50–80°C. The quality indicators were evaluated, including color parameters, astaxanthin content, and salt content in the sample. The experiment was designed in a single-factor model.

2.3. Determination of Salt Content in the Sample. The salt content was determined using 0.1 N $AgNO_3$ standard solution to titrate Cl- ions present in food samples in neutral or weakly alkaline medium with K_2CrO_4 indicator according to Vietnamese Standard TCVN 3701–90 [1]. First, 2.00 mL of sample (V_m) was accurately added to a 100 mL volumetric flask, and then distilled water was added to fill 2/3 of the volume of the flask. Then, five drops of 1% PP were mixed with the sample. If the sample is colorless, 0.1 N $NaHCO_3$ was added to the mixture until the appearance of a faint pink color. If the sample solution is pale pink, the mixture is adjusted with 0.01 N acetic acid until the color disappears. The sample was then top up to 100 mL with distilled water, and then titrated with 0.1 N $AgNO_3$ solutions with five drops of 10% K_2CrO_4 as an indicator until the presence of brick-red precipitate.

2.4. Determination of Astaxanthin Content (ATC). The astaxanthin present in the sample was determined using a spectrophotometer (UV/VIS-1800 Shimadzu, Japan). First, the sample (7.5 g) was ground into a fine powder and mixed with 100 mL of acetone to entrain the sample's astaxanthin. Then, the mixture solution was filtrated by filter paper (Whatman No 1). Next, the filtrate (1 mL) was mixed with 1 mL of acetone, and then cooled at 4°C for 20 min. Finally, the sample was measured at the wavelength of 455 nm [1]. ATC is calculated based on the calibration curve equation $y = 0.28245x$ with a confidence coefficient $R^2 = 0.99982$.

2.5. Color Measurement. The CIE Lab* color space was used as a reference based on three values of L^*, a^*, and b^*. Brightness was measured through a Chroma Scanner colorimeter (model NR60CP, Shenzhen 3nh Technology Co., Ltd., China). Results were displayed following three color index: L^* (brightness ranges from 0–100), a^* (green to red) and b^* (blue to yellow). Total color difference (TCD) was determined in the following equation:

$$TCD = \sqrt[2]{(L - L_0)^2 + (a - a_0)^2 + (b - b)^2}, \quad (1)$$

where is L, a, and b is trials; L_0, a_0, and b_0 is standard.

With device specifications: Aperture: aperture Φ 8 mm or aperture Φ 4 mm; Light source: LED; lighting/monitoring system: d/8; Display data: Colorimetric Value, Color Difference Value/Graph, PASS/FAIL Result, Color Offs.

2.6. Determination of Recovery Efficiency/Weight Loss. Recovery efficiency is calculated according to the following equation:

$$H = m_2.100\%/m_1, \quad (2)$$

with H: Recovery efficiency, m_1: mass of sample, m_2: mass obtained in reality.

2.7. Data Analysis. In this study, each experiment was repeated three times. The results were presented as mean ± standard deviation. In addition, the significant difference between the experimental samples was evaluated by one-way ANOVA analysis at the significant level of 5% (Duncan test) using Statgraphic software (Statgraphics Technologies, Inc., VA, USA).

3. Results and Discussion

3.1. Effect of Salt Concentration on Quality of Small Shrimp during Hot Water Blanching. The blanching process was carried out to inactivate microbial growth and the browning enzyme reaction. During the blanching process, the salt concentration is considered one of the important factors affecting the blanching process.

Figure 1 shows the significant increase in salt content in small shrimps when changing the salt concentration in the blanching solution. The salt content of small shrimps was the lowest at the salt concentration of 0.5% (17.35 ± 2.48 mg/g DW), and the highest value was obtained at the salt concentration of 2% (39.51 ± 0.45 mg/g DW). The increased salt concentration of the blanching solution positively

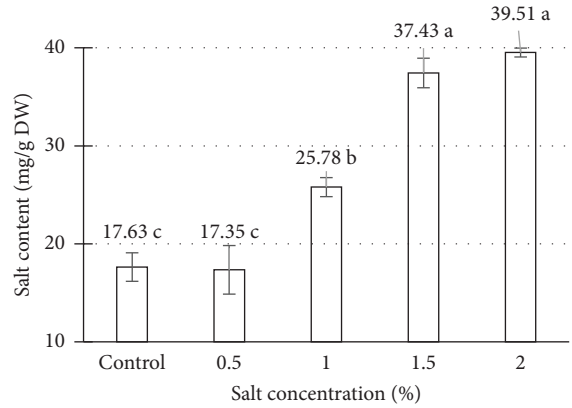

Figure 1: Effect of salt concentration during blanching on the salt content in small shrimps.

accelerated the penetration of NaCl molecules into small shrimp's samples, leading to an increase in the salt content of the sample. Besides, the heating temperature was found to induce the denaturation of protein molecules which facilitated the penetration of NaCl molecules into the sample [6]. This result was consistent with Cyprian et al. in which the addition of 5% salt concentration for 2 min for the blanching process shortened the drying time and impaired the lipid oxidation [7].

Various salt concentrations in the blanching solution from 0.5 to 2% significantly affected the color of the small shrimps (Table 1), as indicated by a decline in L^* value (from 70.74 ± 0.46 to 68.43 ± 0.31) and a^* value (from 3.15 ± 0.07 to 2.96 ± 0.13), followed by, an increase in b^* value (from 7.91 ± 0.03 to 8.10 ± 0.018). When increasing the salt concentration in the blanching solution, some biological compounds of the small shrimps were decomposed, thus reducing the color intensity of the small shrimp. Furthermore, the salt concentration was found to improve the hardness of small shrimps, yet it affected the visual appearance of small shrimps, as indicated by decreased L^* and a^* values [8]. In addition, the color of the small shrimps was also affected by the blanching temperature with different salt concentrations.

As shown in Figure 2, the ATC increased from 0.017 ± 0.003 mg/g DW to 0.026 ± 0.001 mg/g DW as the salt concentration increased from 0.5% to 2%. The diffusion of salt molecules into the structure of small shrimps was observed to induce protein loss [9]. Astaxanthin is a carotenoid compound characterized by a pink or red color [10]. The hot blanching medium can cause the degradation of protein molecules, possibly facilitating the release of astaxanthin [11]. Therefore, the high salt concentration obtained would promote the release of ATC.

A previous study investigated the influence of steam blanching and blanching heated by electrolysis of 1% salt concentration. Results have shown that the high salt concentration and temperature have increased the conductivity of the blanching solution. The elevation of temperature from 5°C to 85°C has increased the electrical conductivity of shrimps by ~30% (from 16.9 to 22.1 mS/cm). For the salt concentration (<1%), the diffusion of salt molecules into the shrimps was undetectable, as the salt content remained the same after blanching [8].

The salt concentration results showed no difference between 1.5% and 2% salt concentration. However, while the preliminary sensory assessment after drying at a salt concentration of 0.5–1% gives a slight sense of taste, the salinity was lower than the allowable threshold. In contrast, for 1.5–2% salinity reaches the sensory value and the taste becomes recognizable. On the other hand, the low salt concentration would lower the production cost. Besides, a salt concentration of 1.5% also resulted in a high AT content of 0.021 ± 0.000 mg/g. The color at 1.5% salt concentration is statistically different from the remaining concentrations. Therefore, the salt concentration of 1.5% is suitable for the blanching process in brine to increase the sensory value of taste, color and retain the astaxanthin compound at a relatively high level.

3.2. Effect of Blanching Temperature on the Quality of Small Shrimp. The temperature of the blanching process is considered an important factor affecting the process. Figure 3 shows the effect of blanching temperature on salt content in small shrimps. The increase in temperature from 60°C to 90°C was found to enhance the salt content in the small shrimps. The highest salt content was obtained at the blanching temperature of 90°C (40.04 ± 2.60 mg/g DW) and the lowest at 60°C (33.14 ± 2.25 mg/g DW). This could be explained by the fact that higher temperature promotes protein hydrolysis, leading to the greater diffusion of NaCl molecules into the structure of small shrimps. In addition, the ability to remain the salt molecules of small shrimp is relatively high. As a result, increasing temperature caused protein denaturation, leading to the attenuation of muscle ability to retain water. However, when water penetrates to the muscles, it also carries NaCl molecules when it is transformed. Therefore, mechanical properties tend to retain NaCl molecules, increasing salt concentration [12, 13].

The blanching process's color values significantly differed when the blanching temperature increased from 60°C to 90°C has been shown in Table 2. Specifically, the L^* value decreased from 67.27 ± 0.86 to 65.00 ± 1.16. Meanwhile, the a^* and b^* values were reported to increase. Biological pigments are easily decomposed during heating and almost many color pigments will be completely degraded, especially heat-sensitive compounds. This is observed by a reduction in L^* value [14]. TCD values clearly showed the degradation of astaxanthin when increasing the blanching temperature of small shrimps from 60°C to 90°C. The result suggested that blanching temperature of 70°C is the optimal temperature to better maintain the color of the shrimps under thermal treatment.

Figure 4 shows the change of astaxanthin content when changing the temperature of the blanching process (60°C–90°C). ATC was the highest at 70°C (0.023 ± 0.002 mg/g DW) and showed the lowest value at 90°C (0.012 ± 0.001 mg/g DW). Some biological pigments are easily degraded with increasing processing temperature [15].

Table 1: Effect of salt concentration on color.

Salt concentration (%)	L^*	a^*	b^*	TCD
Control	61.56 ± 0.48d	3.92 ± 0.03a	7.08 ± 0.06e	0
0.5	70.74 ± 0.46a	3.15 ± 0.07b	7.91 ± 0.03c	9.25 ± 0.46a
1	67.97 ± 0.74b	3.73 ± 0.18a	7.97 ± 0.12bc	6.48 ± 0.72b
1.5	66.84 ± 0.07c	3.11 ± 0.12b	7.32 ± 0.04d	5.35 ± 0.07c
2	68.43 ± 0.31b	2.96 ± 0.13b	8.10 ± 0.18a	7.01 ± 0.26b

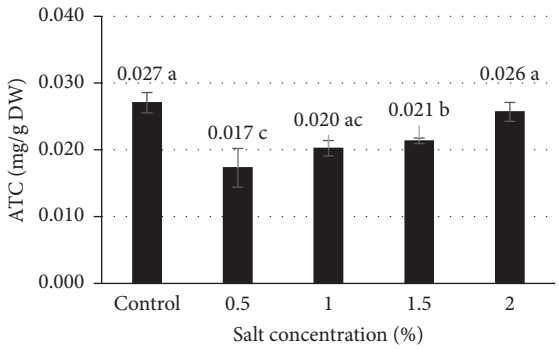

Figure 2: Effect of salt concentration during blanching on astaxanthin content.

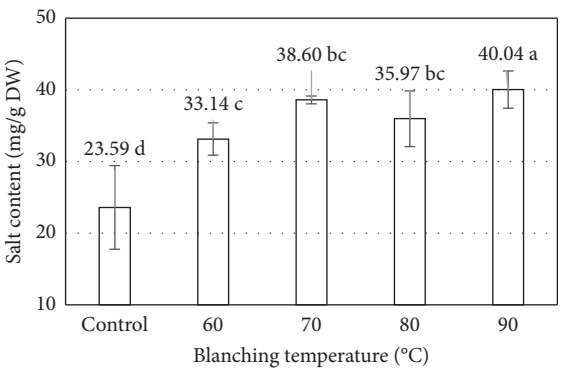

Figure 3: Effect of blanching temperature on salt content in small shrimps.

On the other hand, ATC tends to decrease with increasing temperature and processing time as ATC is a natural pigment found in crabs and shrimps [16]. Luca Giannelli et al. in 2015 studied the effect of temperature on AT on the green algae Haematococcus pluvialis. The study results showed that, when increasing the temperature from 20°C to 27°C in different culture media, the AT significantly decreased in the range of 156 mg/L^{-1} to 115 mg/L^{-1}.

In a previous study, the blanching process was able to strengthen the structure of seafood flesh, promote color to the outer shells of crabs and shrimps, kill bacteria, inhibit enzyme reactions, and remove-free gas in seafood flesh [17]. The salt concentration of 4% and blanching time of 2 min were selected in the subsequent experiment. In addition, this blanching process could remove some perfluorinated compounds (PFCs), a toxic contaminant in seafood. It was reported that salt water used for the blanching process could detach 48.1% of PFCs from the crabs and shrimps [18].

3.3. Effect of Blanching Time on Small Shrimp Quality. The blanching time is considered an indispensable factor in the blanching process, as an appropriate blanching time will attenuate the nutrient losses of the sample, retaining the high nutritional values of raw materials. Figure 5 shows that the salt content increased with the change of a blanching time from 2 to 8 min. The highest salt content was observed at blanching time of 8 min (37.35 ± 2.56 mg/g DW), and the lowest content was at 2 min (36.80 ± 2.26 mg/g DW). However, statistical analysis showed that this difference was insignificant when the blanching time increased. During blanching, some of the proteins dissolve in water, leading to the inward diffusion and accumulation of NaCl molecules inside the muscles of the shrimp [19]. However, as the salt content inside the small shrimp is almost saturated, the water molecules are unable to penetrate to reduce the salt content of the small shrimp.

It is possible to reduce some biological pigments during salting under different conditions. In the following experiment, the increase in blanching time from 1 min to 4 min resulted in the degradation of some biological pigments. This was noted in Table 3, where the L^*, a^*, and b^* values increased with prolonged blanching time. The L^* value increased from 63.38 ± 0.84 to 65.00 ± 1.16. The TCD values varied from 2.53 ± 0.89 to 3.81 ± 1.15. According to Soottawat et al. 2008, when changing the heating time, the color values of L^*, a^*, and b^* increased and the TCD depends on the structure of the individual characteristics of different species [20].

Figure 6 shows how the ATC of the small shrimps changes according to different processing conditions. The decrease in ATC of small shrimps was dependent on blanching time. To be specific, an extended blanching time was found to lower the ATC. The ATC was the highest at 2 min of blanching (0.020 ± 0.001 mg/g DW), and the lowest ATC was found at 3 min of blanching (0.015 ± 0.001 mg/g DW). Based on Figure 6, it can be seen that blanching time of 2 min could retain the ATC at the highest level. Therefore, this was the optimal time for blanching to preserve the structure and beneficial nutrients such as astaxanthin [21]. At 60°C, the blanching time of 1 min was no different from that of 2 min.

3.4. Effect of Drying Process on Quality of Small Shrimp. When increasing the drying temperature from 50 to 80°C, the drying time is significantly different and decreases

Table 2: Effect of blanching temperature on color.

Blanching temperature (°C)	L^*	a^*	b^*	TCD
Control	62.24 ± 0.74c	3.82 ± 0.08a	7.16 ± 0.18d	0
60	67.27 ± 0.86a	3.16 ± 0.26d	7.46 ± 0.08b	5.09 ± 0.81a
70	67.78 ± 0.44a	3.43 ± 0.24ad	7.65 ± 0.16bc	6.00 ± 5.58a
80	68.52 ± 0.4a	3.73 ± 0.10bc	7.82 ± 0.05a	6.32 ± 0.46a
90	65.00 ± 1.16b	3.66 ± 0.05bc	7.64 ± 0.05bc	2.81 ± 1.14b

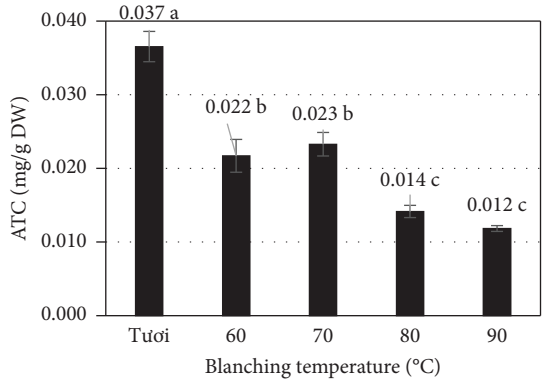

Figure 4: Effect of blanching temperature on astaxanthin content.

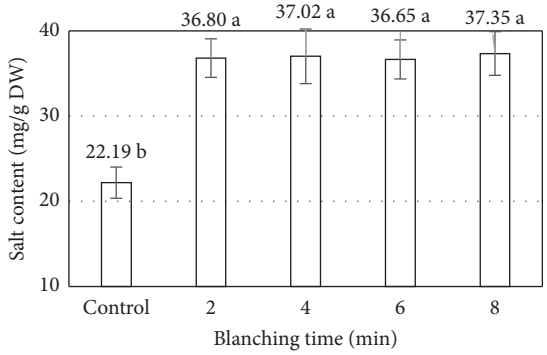

Figure 5: Effect of blanching time on salt content.

Table 3: Effect of blanching time on color.

Blanching time (min)	L^*	a^*	b^*	TCD*
Control	61.23 ± 0.42d	3.89 ± 0.04a	7.19 ± 0.17d	0
2	63.38 ± 0.84c	2.57 ± 0.37e	7.24 ± 0.05d	2.53 ± 0.89
4	63.50 ± 0.70bc	3.33 ± 0.10d	7.44 ± 0.11c	2.37 ± 0.63
6	63.54 ± 1.02bc	3.48 ± 0.07ad	7.54 ± 0.09bc	2.38 ± 0.99
8	65.00 ± 1.16a	3.66 ± 0.05bc	7.64 ± 0.05a	3.81 ± 1.15

sharply from 231 ± 20.07 to 28.33 ± 3.06 min has been recorded in Table 4. The drying process ended after the broiler reached 15–20% moisture to ensure quality and microbiology. The moisture content of shrimps after drying fluctuated from 19.84 ± 1.14 to 16.31 ± 2.86. In 1982, Ramaswamy et al. studied the drying process to reach a water activity of 0.8 at 27°C. This water activity is considered the low limit for the growth of food spoilage microorganisms. Therefore, the shrimp should be dried to a moisture content of about 20% [22]. In addition, the moisture significantly affects the product recovery efficiency, which caused the volume to drop significantly. As the temperature level increased from 50 to 80°C, the recovery efficiency also increased proportionally from 13.85 ± 0.75 to 14.13 ± 0.17 ($p > 0.05$). The changes in protein structure can result from high temperature. When proteins are denatured, their ability to bind water molecules decreases, thereby reducing hydrogen bonding and the hydration of the ionic group in the broth. During the drying process, the protein is strongly denatured and reassembled, leading to a decrease in water-

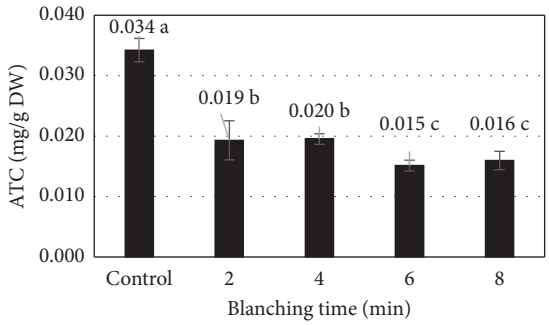

Figure 6: Effect of blanching time on astaxanthin content.

Table 4: Effect of drying temperature on the recovery efficiency of small shrimp.

Evaluation criteria (°C)	Humidity (%)	Drying time (min)	Recovery efficiency (%)*
Control	85.69 ± 0.48a	0	0
50	19.84 ± 1.14b	231 ± 20.07	14.07 ± 0.15
60	17.26 ± 1.83ac	130.76 ± 6.03	13.85 ± 0.75
70	16.31 ± 2.86c	56.67 ± 6.51	13.98 ± 0.33
80	16.93 ± 1.02ac	28.33 ± 3.06	14.133 ± 0.17

holding capacity during the drying process. The protein is strongly denatured and aggregated [23].

Based on Table 4 and Figure 7, the salt content of the sample, at the moisture value of lower than 20%, was in the range from 38.16 ± 4.13 mg/g DW to 44.60 ± 4.07 mg/g DW. The salt content was the lowest at 50°C and obtained the highest value at 80°C, and there was no significant difference according to statistical results. This can be explained by the fact that the salt content in the small shrimps increased during the blanching process, leading to an increased salt content of the small shrimp after drying compared to the original sample [24]. Besides, the denaturation of proteins and the connective tissue conversion from collagen to gelatin released during blanching was found to increase the drying rate [25], as the denatured protein molecules lost their ability to retain water molecules, facilitating the dehydration process [26]. Instead, drying temperature has greatly influence on the oxidation reaction and evaporation of volatile compounds in small shrimps as well as meat and seafood [21, 27]. In the report of Relekar et al., the salt content of fish flesh and seafood was not influenced by the drying process, whereas it was found to be noticeably affected by the pretreatment and the preservation process of the fisherman [28].

Increasing the drying temperature significantly affected the color of the small shrimp presented in Table 5 and Figure 8. The L^* value decreased with increasing temperature from 50°C to 80°C. L^* color value decreased from 68.37 ± 1.25 (at 50°C) to 65.11 ± 0.97 (at 80°C). It can be explained that drying temperature degraded biological pigments. In addition, the temperature induced the protein denaturation, causing the color loss of the small shrimps. When the temperature increased, the shrimp developed some red or pink dots on outer shell as astaxanthin was

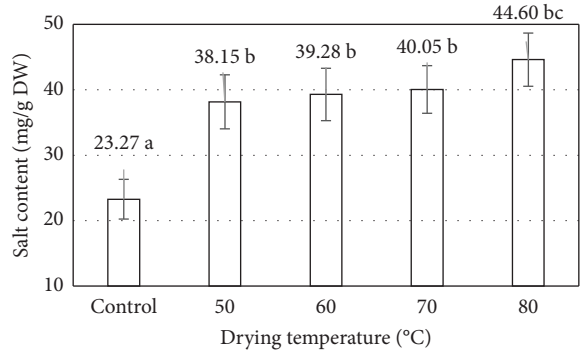

Figure 7: Effect of drying temperature on salt content.

released when carotenoproteins was degraded [29]. Besides, there was a high value of a^* at the temperature of 60°C and 70°C (4.47 ± 0.40 and 4.49 ± 0.16), respectively. This difference was not significant. On the other hand, the highest b^* value was recorded at 60°C (12.38 ± 0.33), and the lowest value was at 80°C (7.13 ± 0.54). Therefore, it can be confirmed that changing the drying temperature negatively affected the color of dried shrimps by the color difference from 50°C to 80°C [30]. Browning reaction can occur during drying or storage. Although reducing sugars can react with amino acids to cause browning, oxidation reactions between lipid and amino acid products can also occur in dried seafood products. In another study, a significant increase in color difference was observed in herring fillets during drying due to the reaction between the carbonyl compounds produced by lipid oxidation and the free amino acids such as lysine [31]. Nonmicrobial browning in krill meal products was also observed during drying [32]. Highly unsaturated α and β aldehydes can react with primary amine groups and contribute to the darkening process. During the darkening

Table 5: Effect of drying temperature on color.

Drying temperature (°C)	L^*	a^*	b^*	TCD
Control	62.24 ± 0.74c	3.82 ± 0.08b	7.16 ± 0.18b	0
50	68.37 ± 1.25a	3.18 ± 0.28c	7.49 ± 0.12b	6.18 ± 1.25b
60	67.35 ± 1.80a	4.47 ± 0.40a	12.38 ± 0.33a	7.43 ± 1.09a
70	65.02 ± 0.46b	4.49 ± 0.16a	11.94 ± 0.69a	5.59 ± 0.58b
80	65.11 ± 0.97b	3.64 ± 0.06b	7.31 ± 0.54b	2.92 ± 0.95c

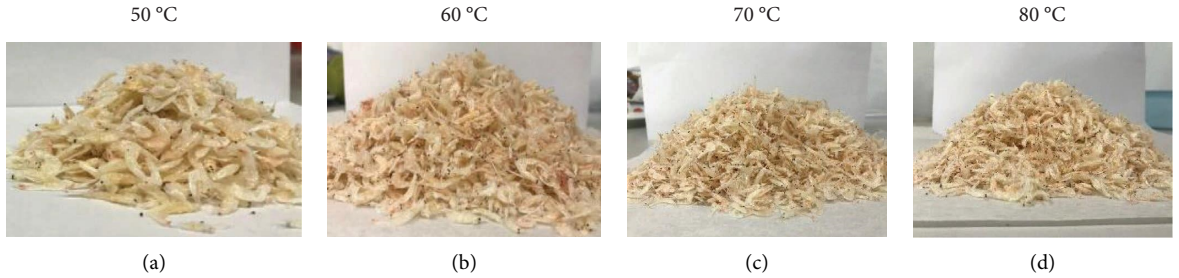

Figure 8: Dried small shrimp. (a) 50°C, (b) 60°C, (c) 70°C, and (d) 80°C.

process, it may adversely affect the quality of the product. Therefore, low-processing temperatures are suggested to prevent the occurrence of nonenzymatic browning reactions. In addition, low storage temperature is also believed to impair the browning reaction rate in semidry processed tomatoes [33].

The astaxanthin content decreased gradually with the temperature levels from 50–80°C as shown in Figure 9. The astaxanthin content was the highest at 50°C (0.033 ± 0.002 mg/g dry matter) and achieved the lowest value at 80°C (0.005 ± 0.001 mg/g dry matter). This can be explained that the temperature induced the decline of astaxanthin content in shrimp. When the temperature is high, the drying speed is faster, and it also promotes the hydrolysis of astaxanthin to produce free astaxanthin, which is easily oxidized. Besides, the decrease in astaxanthin content affected the product's color [34]. The oxidation process also reduced the astaxanthin content of the dried shrimp during drying [35].

Hot air drying is a widely used and highly effective drying method. In this drying process, hot air is used as the heating medium and the steam carrier. Compared with the sun-drying method, this method has several advantages, such as adjustable temperature, velocity, and relative humidity, as well as less pollution to the environment [36]. A kinetic study of ATC degradation in dried shrimp after drying concluded that the correlation coefficient of change between the initial ATC content and C/C_0 after drying was 0.039 [35]. During the drying process, the product was exposed to hot air for a relatively long time, which not only affected the salt content, biologically active compounds, or color but also induced the lipid oxidation process. Ortiz et al. [37] found that the longer drying time was more related to promoting lipid oxidation of dried salmon fillets than drying temperature. Aguiar et al. [38] found that the highest temperature/shortest time combination preserved the best omega-3 fatty acids content. This was consistent with

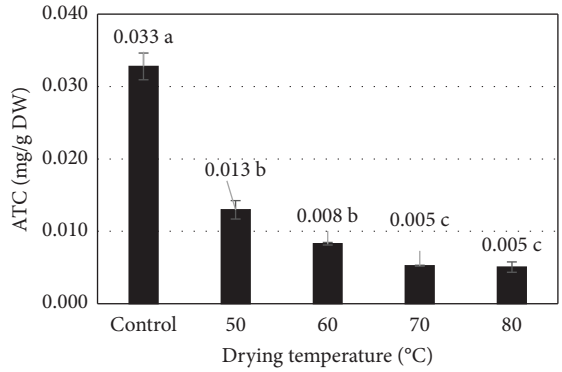

Figure 9: Effect of drying temperature on astaxanthin content.

another study by Slavin et al. [39], which asserted that higher temperatures could quickly remove moisture from the product surface and form an outer layer to protect fat molecules from oxidation. In addition, higher temperatures can also rapidly inactivate enzymes involved in lipid structure and stability, such as lipase and lipoxygenase.

Considering the results of salt and astaxanthin content measurements, the drying process at 60°C was considered as the optimal temperature of the drying process.

4. Conclusions

In this study, we determined the optimal parameters for blanching and drying conditions of small shrimp, which is an aquatic resource with potential nutritional values. The salt and astaxanthin content of small shrimps increased with changing blanching conditions. The blanching process was carried out in hot water at 70°C in the presence of 1.5% NaCl for 2 min while the convection drying process was noted at 60°C until the desired moisture content from 16% to 20% was achieved. In addition, this study provided valuable information on the processing of food products related to

small shrimp and improved the possibility of pharmaceutical applications for using abundant astaxanthin sources from small shrimp.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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