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Extraction of shrimp waste oil and its fortification with shrimp waste pigments

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ABSTRACT

The oils of marine products such as shrimp have high content of polyunsaturated fatty acid in particular omega-3. In this study, shrimp waste oil was obtained by solvent extraction. The second stage, carotenoids of shrimp waste was separated by trypsin. The equal volumes of solution of extracted carotenoids and shrimp waste oil were centrifuged. The carotenoids from the second stage carried from the solution of extracted carotenoids to shrimp waste oil. Shrimp waste oil containing carotenoids and shrimp waste oil alone was separately exposed to oxidant agent. Inhibition of lipid per-oxidation was evaluated by measuring levels of MDA. This inhibition was significantly more than shrimp waste oil containing carotenoids. The inhibition in this group was 3.02 ± 0.72 nmol/ml (compared with shrimp waste oil alone group, 5.43 ± 0.24 nmol/ml). Carotenoids have an adequate protective effect against oxidation changes.

1. Introduction

The diet may modulate various functions in the body and play beneficial roles in some diseases. Some foods promote better health and help reducing risk of diseases (1). These foods are classified as functional foods. In the last years, there has been growing interest in finding functional food. The wastes of shrimp have complex mixtures of biomaterials. The waste is about 50% of shrimp total body weight which also contaminates the environment. Therefore, utilization of these wastes can prevent environmental contamination. It is a good natural source of raw materials such as protein, chitin, minerals, carotenoids, and shrimp flavor components (2).

It has been reported that the fatty acids in the marine organism have an influence on the health. The oils of marine products have high polyunsaturated fatty acid in particular the omega-3. Omega-3 reduces the risk of atherosclerosis by lowering plasma triglycerides and cholesterol levels. It also helps in stopping blood platelets from clinging to one another. Unsaturated omega-3 also plays an important role in decreasing blood pressure and plasma rigidity (3). Moreover it inhibits the promotion and progression of cancer and suppresses the synthesis of pro-inflammatory mediators.

Carotenoids have also been documented for health promoting function. These components are known to provide a range of biological effects (provitamin, antioxidant, coloring etc.). The role of carotenoids as a source of pigment and in immune defense system has been

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established. Astaxanthin, the main carotenoid found in shrimp, has an antioxidant activity which was reported to be higher than that of α -carotene, β -carotene, and lutein and is also higher than tocopherol against certain reactive oxygen species (4). Astaxanthin also has other important applications in the functional food. This pigment is a potent antioxidant and has a possible role in human health (5). The aim of this study was to use a new technique for producing oil from shrimp wastes which is rich of pigments.

2. Materials and Methods

2.1. The test materials

The shrimp wastes, *Penaeus semisulcatus*, were collected from the processing plants the wastes were then air dried in the shade and powdered.

2.2. Extraction of carotenoids by trypsin

Five g of sample was placed in test tube and dissolved in de-ionized water. Separation of carotenoids was performed by trypsin. 5% of trypsin was added to waste and heated at 37°C for 120 min. The hydrolysate was then centrifuged and the supernatant was used for experiments.

2.3. Extraction of shrimp waste oil

Shrimp waste oil was obtained by the solvent extraction. The sample (5 g) was placed in test tube and dissolved in the solvent. Since hexane is the most popular and also a good solvent for oil extraction, it was used for the experiment. During the extraction, volatile hexane was evaporated.

2.4. Preparation of shrimp waste oil containing carotenoids

The equal volumes of the solution of extracted carotenoids by trypsin and shrimp waste oil were centrifuged. The carotenoids entered from the solution of extracted carotenoids to shrimp waste oil.

2.5. Comparative assay of lipid peroxidation in shrimp waste oil containing carotenoids and without

Shrimp waste oils with (group a) and without (group b) carotenoids were separately exposed to CuSO_4 . CuSO_4 induced lipid per-oxidation. The oxidative stability was assayed by measuring levels of malondialdehyde (MDA) according to the previous method (6). Briefly, the samples mixed with 20% trichloroacetic

acid then they were centrifuged. Thiobarbituric acid was added to the supernatant and heated. The absorbance of the supernatant was measured at 532 nm. Lipid per-oxidation was expressed in nmol/ml. The values were expressed in nmoles MDA/mg protein, using a molar extinction coefficient of $1.56 \times 10^5 \text{ M}^{-1} \text{ cm}^{-1}$.

3. Results

The results of this study are given in Table 1. There was significant difference in values of level of lipid per-oxidation in two groups ($p < 0.05$). The shrimp waste oil containing carotenoids (group a) has significantly been shown to exhibit a high activity against oxidation. The level of lipid peroxides decreased in this group (3.02 ± 0.72).

Table 1. Level of lipid oxidation in shrimp waste oil

Component	Level of lipid per-oxidation (nmol/ml)
shrimp waste oil containing carotenoids (group a)	3.02 ± 0.72
shrimp waste oil (group b)	5.43 ± 0.24

4. Discussion

Carotenoids are soluble in the polar solvents including edible fats and oils. Since they are usually entered into the oil, this method will boost the antioxidant content of oil. Omega-3 in shrimp waste oil is very sensitive to oxidation. Carotenoids inhibit lipid per-oxidation in the shrimp waste oil containing carotenoids (Table 1). This kind of oil was enriched with carotenoids. Carotenoids showed powerful antioxidants. They can delay oxidative rancidity (7). Therefore, carotenoids can keep oils for longer time.

Generally it is accepted that the oils of marine products have high levels of polyunsaturated fatty acids such as the omega-3 with good effects on health, particularly on cardiovascular system. Heart disease is a significant problem that causes annually considerable deaths. The cardiovascular disease is strongly related to dietary. The finding shows that consuming foods that contain these components can be a candidate for preventing the cardiovascular diseases. This product is a good source of carotenoids and omega-3.

5. Conclusion

Shrimp waste oil fortified by its pigments has more effects in association with anti-oxidant potentials, and this matter could be considered by food industries. Our finding offers an opportunity for using shrimp waste oil and its pigments for medical and food purposes. This product can be used as natural component for application in food such as margarine, ice cream, cheese, etc to obtain better health benefit. This product has functional ingredients such as omega-3 and carotenoids. Carotenoids are considered to be critical in protection against oxidative damages. Therefore, carotenoids control lipid peroxidation.

Conflict of Interests

Authors have no conflict of interest.

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