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Optimization of carotenoids extraction from *Penaeus semisulcatus* shrimp wastes

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PEER REVIEW

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Comments

Extracting carotenoid from shrimp waste has potential for veterinary and human application. This study is valuable to find appropriate method for carotenoids extraction.
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ABSTRACT

Objective: To find effective method for carotenoids extraction from shrimp waste which is one of the important sources of natural carotenoids and produced in large quantities in Iran.
Methods: Two methods of carotenoids extraction, enzymatic and alkaline (NaOH 1 normal) treatment, were assayed. About 5 g of gritted shrimp wastes were used at each stage. For alkaline treatment, sodium hydroxide were added to shrimp waste. After 48 h, the mixture was filtered and centrifuged.
Results: Alcalase extraction produced (234.00±2.00) mg/L carotenoid and NaOH extraction produced (170.00±1.53) mg/L carotenoid. Based on the samples analyzed, alcalase enzyme showed more efficiency than NaOH extraction to achieve carotenoids from shrimp waste.
Conclusions: It can be concluded that using alcalase enzyme for carotenoids extraction can produce higher carotenoids concentration than NaOH extraction method. So alcalase enzyme method can be used for achieving this kind of antioxidant.

KEYWORDS
Shrimp waste, Carotenoids, Alkaline, Alcalase

1. Introduction

Global production of fish and shrimp has been steadily increasing over the last decade and this trend is expected to continue. Of the estimated 131 million tons of fish produced in 2000 in the world, of which nearly 74% (97 million tons) was used for direct human consumption[1]. Shrimp waste is one of the important sources of natural carotenoids. Carotenoids are responsible for the color of many important fish and shellfish products. Most expensive seafoods, such as shrimp, lobster, crab, crayfish, trout, salmon redfish, red snapper and tuna, have orange-red integument and/or flesh containing carotenoid pigments[2].

Oxidation of lipids and proteins during processing and storage of food products decreases consumer acceptability of foods by causing undesirable changes in flavour, texture, appearance and nutritional quality, as well as by producing toxic compounds[3]. Consumption of these potentially toxic products can give rise to several diseases. Oxidation of foods can be minimised by removing prooxidants, such as free fatty acids, metals and oxidised compounds, by protecting foods from light and air, and by adding antioxidants. In practice, it is very difficult to completely remove all the pro-oxidants and air from foods. Therefore, antioxidants are

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now increasingly added to foods to reduce oxidation in food industry[4].

Shrimp is one of the marine foods that due to high active water (aw) and neutral pH and autolytic enzymes have high decay[5]. Therefore, using of shrimp waste can decrease environmental pollution. These wastes have beneficial byproducts that used in medicine and food industries.

One of the important characteristics of carotenoids is their ability to act as antioxidants. Astaxanthin is a novel carotenoid nutraceutical occurring in many crustaceans and red yeasts[6] and it is a ketocarotenoid oxidized from β-carotene, naturally occurs in a wide variety of marine and aquatic organisms. Owing to its attractive pink colour, its biological functions as a vitamin A precursor, and antioxidative activity, astaxanthin can be used as a colourant in food and medicine[7].

Carotenoids are originally synthesized in plants or bacteria, and additionally can be isolated from animal tissue (salmon, shrimp and egg yolk). The shrimp shell waste is a rich source of astaxanthin. The methods reported to extract astaxanthin from shell matrix employ edible oils, hydrochloric acid or organic solvent[8,9]. Commercial exploitation of prawns first began in 1959 on the Iranian side of the Persian Gulf. In these days, fishing was restricted to the Bushehr area and was based on one species, *Penaeus semisulcatus* (*P. semisulcatus*). Since then, there has been an increase in the number of prawn species fished commercially[10]. Therefore, this study was undertaken to evaluate the efficiency of enzymatic and alkaline method for beneficial use of *P. semisulcatus* wastes in order to extract carotenoids.

2. Materials and methods

2.1. Materials

Shrimp waste (*P. semisulcatus*) was procured from processing plants located at Tehran, Iran. The wastes were then air dried in the shade and powdered.

2.2. Preparation of shrimp waste extract by alkaline method

About 5 g of gritted shrimp wastes were used at each stage. For alkaline treatment, sodium hydroxide (NaOH, 1 N) were added to shrimp waste. After 48 h, the mixture was filtered and centrifuged.

2.3 Preparation of shrimp waste extract by enzymatic method

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

2.4. Determination of total carotenoids of shrimp waste

Total carotenoids was measured by β carotene standard curve at 470 nm using DR 5 000^{TM} UV-Vis Spectrophotometer. The total carotenoids content of samples was calculated on the basis of the standard curve of β carotene[11].

3. Results

Comparison of results achieved in this study showed alcalase extraction has (234.00±2.00) mg/L carotenoid and NaOH has (170.00±1.53) mg/L (Table 1). The results obtained in this study indicate that alcalase extraction has more carotenoids concentration and can be introduced as a applicable method for carotenoid extraction.

Carotenoid extracts from shrimp processing discards were evaluated for antioxidant activity. Crude extract and fractions rich in astaxanthin showed strong antioxidant activity as indicated by radical scavenging, reducing activity and metal chelating activity, comparable to that of the known antioxidants α-tocopherol and TBHQ[8]. Carotenoids occur widely in nature present in other sources, such as the green algae *Chlorococcum humicola*. This kind of algae is a rich source of bioactive compounds especially carotenoids which effectively fight against environmental genotoxic agents. The carotenoids itself is not a genotoxic substance and should be further considered for its beneficial effects[12]. Crustacean exoskeleton is a natural source of carotenoids, particularly astaxanthin. It is noteworthy that main part of carotenoids in crustaceans is astaxanthin that can delay oxidative rancidity in oils[13].

Table 1
Carotenoids concentration in each method.

Treatment	Carotenoids (mg/L)			Mean±SD
Alcalase	236.00	232.00	234.00	234.00±2.00
Alkaline	168.00	170.00	171.00	170.00±1.53

Assays were done for three replicates.

4. Discussion

There is increasing interest in the use and measurment of antioxidant capacity in food and pharmaceutical preparations and in clinical studies. So detecting methods to find sufficient antioxidants has valuable effect on food industry, although it is clear that using natural antioxidants alone or in combination with syntethic ones can reduce the adverse effects of synthetic antioxidants. Carotenoids are natural antioxidants and finding methods to extract these compositions are important. It can be offered that these natural antioxidants may can be

replaced with synthetic ones. In this study, carotenoids were extracted from shrimp waste that is a good source of this pigment. There are two important characteristics of carotenoid pigments. Firstly, they are coloured organic compounds, so they can act as pigments; and secondly, they have antioxidant capacity.Another point that is noteworthy to say is using these kind of wastes to reach antioxidants that can used in industry.Therefore, detecting methods to achieve sufficient antioxidants has valuable effect.

The present study revealed that alcalase enzyme efficiency is more efficiency than NaOH extraction to achieve carotenoids from shrimp waste.

Conflict of interest statement

We declare that we have no conflict of interest.

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Comments

Background

Shrimp waste is a rich source of carotenoids. Introducing methods to extract carotenoids of shrimp wastes is the purpose of this study.

Research frontiers

Using of carotenoids of shrimp waste improves the economy of shrimp producer. This study compares two methods of carotenoids extraction and their efficiency.

Related reports

Alkaline and alcalase enzyme are both economic and can easily be used. But, the more economic using of shrimp waste for carotenoid extraction is the purpose of this paper.

Innovations and breakthroughs

Using of shrimps produce large quantities of wastes. These wastes contain valuable carotenoids. Extracting carotenoid from shrimp waste in Iran is a novel method.

Applications

Increasing biomaterial wastes, developing environmental pollution. Therefore, application of these biomaterial will decrease pollution.

Peer review

Extracting carotenoid from shrimp waste has potential for veterinary and human application. This study is valuable to find appropriate method for carotenoids extraction.

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