# Extraction of carotenoids from crustacean waste with vegetable oils

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## ABSTRACT

Crustacean waste is an important source of natural carotenoids. Carotenoids are a group of oil soluble pigments. These solubilization characteristics of carotenoids have led to studies on recovery of these pigments in vegetable oils such as sunflower oil, groundnut oil, Palm oil, rice bran oil, soy oil and etc. Carotenoids are the main compound responsible for the orange-pink coloration in the muscle of salmonids and some Crustaceans. In nature, carotenoids are synthesized only in the vegetal kingdom, while animals obtain them through the food chain.

Keywords: carotenoids, extraction, crustacean waste, vegetable oils

## INTRODUCTION

Carotenoids are a group of fat-soluble pigments occurring widely in nature. Crustacean waste is an example of it that has been explored as a source of carotenoid, protein, and chitin. Carotenoids are highly unstable compounds and need to be protected by suitable storage conditions from excessive heat, exposure to light and oxygen to prevent their breakdown. The recovery of these valuable components from the waste would not only improve the economy for crustacean processors, but also would minimize the pollution potential of the Crustacean waste. Crustacean waste could be the cheapest raw materials for carotenoid recovery, and later could be a better and cheaper alternative to synthetic carotenoid in aquaculture feed formulations and in surimi based products. Salmonids are unable to modify lutein, β-carotene, zeaxanthin or canthaxanthin into astaxanthin; thus these dietary carotenoids are deposited in their tissues without any modification this is contained. There for, can be used this method for carotenoids deficiency in aqua culture feeds, since the oil is a main component of diets. Synthetic astaxanthin is widely used as feed supplement by fish farmers and constitutes 10–20% of the feed cost. However, the high cost of synthetic pigments and the growing demand for natural foods have stimulated the research on extraction of astaxanthin from natural sources. Shrimp processing is one of the most important marine industries that generates considerable quantities of shrimp waste consisting of head, shell and tail of the shrimp. The body parts processed for human consumption comprises approximately 70% of the total shrimp landing, so there is a tremendous tonnage of shrimp waste produced, in which one of the major carotenoids is astaxanthin.

Sachindra and Mahendrakar (2005) extracted carotenoids from shrimp waste (*Penaeus indicus*) with vegetable oils and concluded that sunflower was the best oil for extraction (Table 1).

**Table 1. Carotenoid yield from shrimp waste in different vegetable oils**

| Oil | Carotenoid yield (μg/g waste) |
|---|---|
| Sunflower oil | $26.3 \pm 2.31^{a}$ |
| Groundnut oil | $23.1 \pm 1.56^{b}$ |
| Gingelly oil | $23.9 \pm 1.32^{b}$ |
| Mustard oil | $16.1 \pm 1.85^{c}$ |
| Soya oil | $24.8 \pm 1.51^{ab}$ |
| Coconut oil | $24.7 \pm 2.42^{ab}$ |
| Rice bran oil | $24.3 \pm 1.59^{ab}$ |

Values with different superscripts differ significantly ($p \leqslant 0.05$).

Krichnavaruk *et al*. (2008) used vegetable oils (Soybean oil and olive oil) as co-solvent for supercritical carbon dioxide extraction of astaxanthin from *Haematococcus pluvialis*. They have shown that soybean oil made a 30% increase in extraction efficiency compared with SC-CO2 extraction without soybean oil, whereas the 10% olive oil increased the extraction efficiency.
Handayani *et al*. (2008) used palm oil for extraction of astaxanthin from giant tiger (*Panaeus monodon*) shrimp waste.
Pu *et al*. (2010) extracted astaxanthin from shrimp (*Litopenaeus setiferus*) with flaxseed oil then they compared the flaxseed oil and the flaxseed oil that extracted astaxanthin from shrimp. They found that the flaxseed oil was lighter and more yellow in color than flaxseed oil containing astaxanthin. Flaxseed oil containing astaxanthin and flaxseed oil had similar alpha-linolenic (ALA) content. The oxidation rate of flaxseed oil containing astaxanthin was lower than that of flaxseed oil. When flaxseed oil and flaxseed oil containing astaxanthin were heated to 30$^{o}$C, both oils exhibited minimal lipid oxidation with increasing heating time, whereas flaxseed oil, when heated to 40, 50 and 60$^{o}$C, had a higher lipid oxidation rate than flaxseed oil containing astaxanthin with increasing heating time from 0 to 4 h. Astaxanthin was an effective antioxidant agent in flaxseed oil when it was heated from 40 to 60$^{o}$C. The degradation of astaxanthin in flaxseed oil could be described by first order reaction kinetics. Astaxanthin was stable in flaxseed oil at 30 and 40$^{o}$C, while significant increases in

degradation were observed at 50°C and 60°C. The rate of astaxanthin degradation in flaxseed oil containing astaxanthin was significantly influenced by temperature (Table 2) (figure 1).

**Table 2. Astaxanthin, colour, PV and FFA of FOA and FO. (Pu et al., 2010)**

| | FO | FOA |
|---|---|---|
| Astaxanthin (mg 100 $g^{-1}$ [waste]) | – | $4.83 \pm 0.18$ |
| Astaxanthin (mg 100 $g^{-1}$ [FOA]) | – | $6.23 \pm 0.22$ |
| Pure astaxanthin (mg 100 $g^{-1}$ [FOP]) | – | $6.22 \pm 0.03$ |
| Colour $L^*$ | $47.7 \pm 0.28^a$ | $34.58 \pm 0.50^b$ |
| Colour $a^*$ | $6.0 \pm 0.55^b$ | $36.45 \pm 1.27^a$ |
| Colour $b^*$ | $77.77 \pm 0.35^a$ | $58.93 \pm 1.03^b$ |
| Chroma | $78.00 \pm 0.31^a$ | $69.30 \pm 0.94^b$ |
| Hue angle | $85.59 \pm 0.42^a$ | $58.26 \pm 1.11^b$ |
| PV(m equiv $kg^{-1}$) | $0.87 \pm 0.18^a$ | $1.12 \pm 0.17^a$ |
| FFA(%) | $0.30 \pm 0.00^a$ | $0.30 \pm 0.00^a$ |

Values are means and SD of three determinations. $^{ab}$Means with different letters in each row are significantly different ($p < 0.05$). FO = Flaxseed oil; FOA = Flaxseed oil containing astaxanthin; FOP = Flaxseed oil containing pure astaxanthin; FFA = Free fatty acids; PV = Peroxide value.

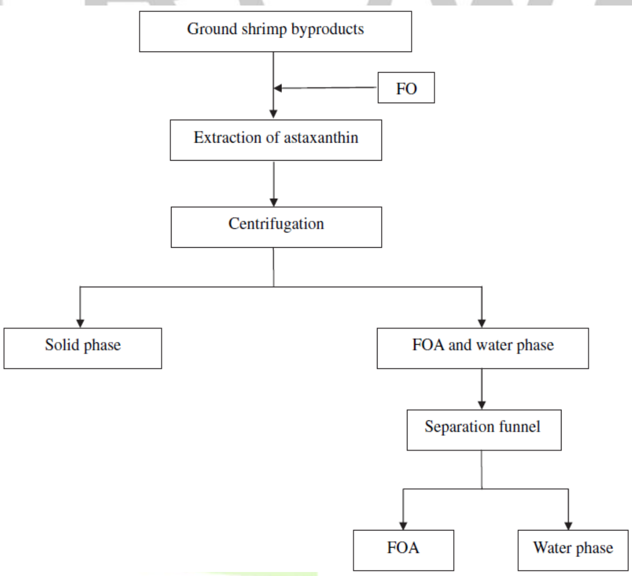


**Figure 1. Extracting astaxanthin from shrimp byproducts using Flaxseed oil. FO (Flaxseed oil); FOA (Flaxseed oil containing astaxanthin) (Pu *et al.*, 2010)**

## CONCLUSIONS

The advantage of oil extraction process is that the pigmented oil finds use as carotenoid source in aquaculture feeds. In aquaculture feed preparations, vegetable oil or fish oil is commonly used as a source of energy. The use of pigmented oil in feeds thus serves the dual purpose of pigment carrier as well a source of lipid energy.

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