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Green Alga *Haematococcus Pluvialis* a Potential Source of Pharmaceutical Valuable Astaxanthin

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Mini Review

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Abstract

Haematococcus pluvialis is one of the richest sources of natural astaxanthin which is considered as "super anti-oxidant." Astaxanthin has umpteen applications in the nutraceuticals, cosmetics, food, and aquaculture industries, can significantly decimate free radicals, oxidative stress and help human body maintain a healthy state. With extraordinary potency and increase in demand, astaxanthin is one of the high-value microalgae products of the future. This comprehensive review summarizes different sources of astaxanthin, occurrence, life cycle of *H. pluvialis* and applications of astaxanthin for human and animals.

Keywords: *Haematoccoccus pluvialis*; Astaxanthin; Nutraceuticals; Oxidative stress

Introduction

Astaxanthin is a xanthophyll carotenoid [1]. The main biological sources of astaxanthin are crustacea *crustacean* extracts, the green microalga *Haematococcus pluvialis*, the yeast *Rhodotorula rubra*, and the red yeast *Phaffia rhodozyma*. The aforementioned natural sources cannot compete with the synthetic products available [2]. *Crustacean* meals have low levels of astaxanthin and high levels of moisture, ash and chitin. The algae *Haemotococcus pluvialis* has a relatively high concentration of astaxanthin, the yeast, has been reported to contain astaxanthin [3] but due to the presence of extremely thick cell wall, which hinders the extraction of astaxanthin from *Rhodotorula rubra*. Some bacterial species (Mycobacterium lacticola) produce astaxanthin only in hydrocarbon medium not on nutrient agar [4] have reported astaxanthin in floral parts of *Tagetes erecta* and *Circubita maxima marica*, but the seasonal and geographic variations [5] and the amount of astaxanthin compared to the total mass of the plant is quite small, therefore plants were not considered a suitable source for commercial cultivation [6]. Another source of astaxanthin was found in some yeast genera of *Peniophora* and *Rhodotorula* [7] but the pigment cannot be transformed by salmonids into astaxanthin [8] Astaxanthin production from algae has been studied such as *Dunaliella salina* [9], but the feeding trials using algae added to the salmonid feed showed a low uptake of pigments by the fish [10]. There are various other species of algae which has also been investigated as sources of astaxanthin [11-14]. Among them, the promising algal species investigated

were *Neochloris wimmeri* [15], *Chlamydomonas nivalis* [16] and *Dictyococcus cinnabarinus* [17]. But the most promising algae as an astaxanthin source were considered green alga *Haemotococcus pluvialis* [18].

Natural occurrence of *H. pluvialis*

H. pluvialis occurrence has been reported in different water bodies like artificial pools, natural and manmade ponds [19,20] and has been isolated from different regions of Europe, Africa, North America, and Himachal Pradesh India [21, 22].

Life Cycle H. Pluvialis

The life cycle of *H. pluvialis* consists of four types of cells, microzooids, macrozooids, palmella (Green stage) and hematocysts (Red stage) shown in (Figures 1 & 2) [23,24].

Figure 1: Green and red stage of *H. pluvialis.*

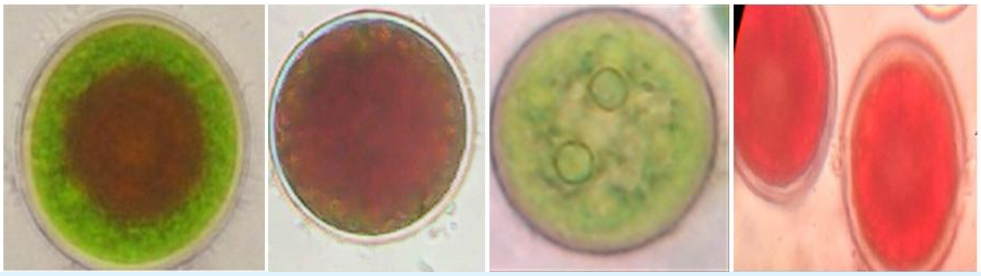

Figure 2: Light microscopic images of *H. pluvialis* cells.

Under favorable culture conditions, *H. pluvialis* cells remain in the green stage, under unfavourable environmental or culture conditions enter into a resting red stage [23]. The red stage of *H. pluvialis* is rich in astaxanthin shown in Figure 2.

Applications of *H. Pluvialis* Astaxanthin

Astaxanthin is a ketocarotenoid or oxygenated derivative of carotenoid, was first chemically identified by Kuhn and Sorenson (1879) as seen in Figure 3 [25].

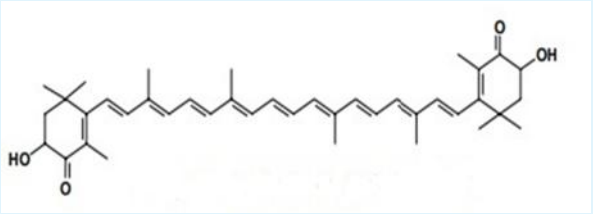

Figure 3: Structure of astaxanthin.

Under normal aerobic metabolism of organisms, produces oxidative molecules, which are known as free radicals or molecules with unpaired electron e.g. hydroxyls, peroxides, reactive oxygen species (singlets) which are innocuous and essential for sustaining of different life processes but excess production of such compounds are harmful to the various biomolecules such as proteins, lipids, carbohydrates and DNA [26] which results in aging, retinopathy, carcinogenesis, arteriosclerosis, and Alzheimer disease. However in order to subsidise these damages, the human body generates its own enzymatic antioxidants such as superoxide dismutase, catalase and peroxidase etc., but it was found that these compounds are not enough to provide suitable protection against oxidative stress, therefore it was reported that consuming proper quantities of antioxidants like vitamin E controls these damages [27]. An antioxidant is a molecule which has the ability to decimate free radicals from a cell, astaxanthin prevents cell membrane from the damage of free radicals as shown in Figure 4 [28].

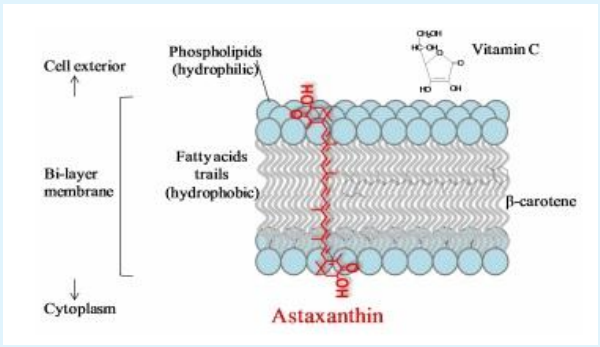

Figure 4: Impact of astaxanthin from *H. pluvialis* on cell membrane.

There are several other studies which showed high antioxidant activity of astaxanthin from *H. pluvialis* in rats supplemented with astaxanthin formulated diet [29-31].

Astaxanthin from *Haematococcus* is safe and effective for flesh pigmentation of fish [32] as seen in Figure 5 [33].

Figure 5: Impact of astaxanthin based feed on fish.

Figure 6: Effect of astaxanthin based cream on fine wrinkles under eyes and outer canth.

Consumption of *H. pluvialis* meal resulted in significant astaxanthin deposition in flesh and skin, which enhanced colour, antioxidant properties of fish, egg quality, better growth and survival of fry of salmonid, sea bream, and rainbow trout[34-38], ornamental fishes [39], and shrimp [34,40]. Astaxanthin from *Haematococcus pluvialis* was evaluated on human skin and was found safe for skin, confirmed by Patch Testing and Skin Repeated Application Test and it was observed that astaxanthin from *H. pluvialis* increased skin moisture retention, smoothness, elasticity of the skin improved the tendency of the fine wrinkles outer canthi and skin grain of cheeks as seen in Figure 6.

Conclusion

In recent years there is an increased interest for natural astaxanthin from green microalga *H. pluvialis*. Various scientific improvements have been achieved since the last decade in terms of production in order to obtain astaxanthin on large scale, however, there is a limited research work on astaxanthin based food Products on large scale. Future research should be focused on commercial production of astaxanthin based food products for human consumption.

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