antioxidants

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Review

Carotenoids from Marine Organisms: Biological Functions and Industrial Applications

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Abstract: As is the case for terrestrial organisms, carotenoids represent the most common group of pigments in marine environments. They are generally biosynthesized by all autotrophic marine organisms, such as bacteria and archaea, algae and fungi. Some heterotrophic organisms also contain carotenoids probably accumulated from food or partly modified through metabolic reactions. These natural pigments are divided into two chemical classes: carotenes (such as lycopene and α- and β-carotene) that are composed of hydrogen and carbon; xanthophylls (such as astaxanthin, fucoxanthin and lutein), which are constituted by hydrogen, carbon and oxygen. Carotenoids, as antioxidant compounds, assume a key role in the protection of cells. In fact, quenching of singlet oxygen, light capture and photosynthesis protection are the most relevant biological functions of carotenoids. The present review aims at describing (i) the biological functions of carotenoids and their benefits for human health, (ii) the most common carotenoids from marine organisms and (iii) carotenoids having large success in pharmaceutical, nutraceutical and cosmeceutical industries, highlighting the scientific progress in marine species cultivation for natural pigments production.

Keywords: marine carotenoids; biological functions; antioxidants; industrial applications; antioxidant

1. Introduction

Since the first structural elucidation of β-carotene by the two scientists Kuhn and Karrer in 1930, about 750 naturally occurring carotenoids have been reported. Among these bioactive compounds, more than 250 are of marine origin and show an interesting structural diversity, such as in the case of allenic carotenoids (e.g., fucoxanthin) and all acetylenic carotenoids (e.g., tedaniaxanthin and alloxanthin) originated from marine algae and animals [1,2]. Marine carotenoids exert strong antioxidant, repairing, antiproliferative and antiinflammatory effects and can be used either as skin photo-protection to inhibit adverse effects of solar UV radiation or as nutraceutical/cosmeceutical ingredients to prevent oxidative stress-related diseases [3–5]. Except for autotrophic marine organisms, non-photosynthetic marine organisms are not able to synthesize carotenoids de novo. Therefore, marine animals can either directly accumulate carotenoids from food or partly modify them through metabolic mechanisms. The main metabolic conversions of carotenoids found in animals are translation and oxidative cleavage of double bonds, oxidation, reduction and cleavage of epoxy bonds [6–10]. Among heterotrophic organisms, bacteria, archaea, marine fungi (especially pigmented yeasts) and thraustochytrids (generally defined as fungi-like protists) are a relevant source of carotenoids [11]. Currently, the most common carotenoids that are commercially available are industrially produced by chemical synthesis which increases production costs and waste materials production with potential negative effects on the environment [12]. In the last decade, the