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# Astaxanthin in microalgae: pathways, funct logical implications

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## ABSTRACT

Major progress has been made in the past decade towards understanding of the biosynthesis of red carotenoid astaxanthin and its roles in stress response while exploiting microalgae-based astaxanthin as a potent antioxidant for human health and as a coloring agent for aquaculture applications. In this review, astaxanthin-producing green microalgae are briefly summarized with Haematococcus pluvialis and Chlorella zofingiensis recognized to be the most popular astaxanthin-producers. Two distinct pathways for astaxanthin synthesis along with associated cellular, physiological, and biochemical changes are elucidated using H. pluvialis and C. zofingiensis as the model systems. Interactions between astaxanthin biosynthesis and photosynthesis, fatty acid biosynthesis and enzymatic defense systems are described in the context of multiple lines of defense mechanisms working in concert against photooxidative stress. Major pros and cons of mass cultivation of H. pluvialis and C. zofingiensis in phototrophic, heterotrophic, and mixotrophic culture modes are analyzed. Recent progress in genetic engineering of plants and microalgae for astaxanthin production is presented. Future advancement in microalgal astaxanthin research will depend largely on genome sequencing of H. pluvialis and C. zofingiensis and genetic toolbox development. Continuous effort along the heterotrophic-phototrophic culture mode could lead to major expansion of the microalgal astaxanthin industry.

**Key words:** astaxanthin biosynthesis; Chlorella zofingiensis; genetic engineering; Haematococcus pluvialis; mass culture; photooxidative stress