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Some promising microalgal species for commercial applications: A review

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Abstract

Current biofuel production utilizing microalgal biomas is not cost effective. Hence increasing research interest is to find out new microalgal candidate to make microalgal products and by-products economically viable. Several promising microalgal species have drawn scientific interest as they offer commercial sources of high-value by-products (chemicals) such as β-carotene, astaxanthin, docosahexaenoic acid, eicosapentaenoic acid, bioactive and functional pigments, natural dyes, polysaccharides, antioxidants and algal extracts. These species play a significant role in cosmaceuticals, nutraceuticals, pharmaceuticals, fodder, aquaculture, bioremediation and human foods. For making algal biomass production economically viable, high value by-product extracting is paramount. This article emphasises on some important microalgal species that offer such high value by-products for commercial applications.

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Keywords: Microalgal by-product; cosmaceuticals; nutraceutical; pharmaceuticals; functional foods; commercial application

1. Introduction

Microalgae are typically single-cell photosynthetic autotrophic microscopic organisms naturally found in fresh water and marine environment. They produce complex compounds such as lipids, carbohydrates, and proteins, using simple substances located in their surroundings. Most microalgae are photosynthetic “plant like” microorganisms without the distinct cell and organ types that land plants possess. They use the carbon from air for energy production.

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However, some microalgae produce energy by using organic carbon [1]. Microalgae have over 300,000 species out of which around 30,000 are documented [2]. They live in complex natural habitats and can adapt rapidly in extreme conditions (e.g., variable salinity, temperature, nutrients, UV–irradiation). Therefore, they can produce a great variety of fascinating secondary metabolites (biologically active) with novel structures and biological activities that are generally not found in other organisms [3,4]. Microalgae produce some useful bio-products including carotenoids (especially β-carotene), astaxanthin, docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA), bioactive and functional pigments, natural dyes, polysaccharides, antioxidants and algal extracts. The commercial cultivation of microalgae has begun five decades ago. Its commercial application was first introduced in Japan in 1960s. *Chlorella* was the first targeted organism [5]. The microalgal commercial applications are shown in Figure 1.

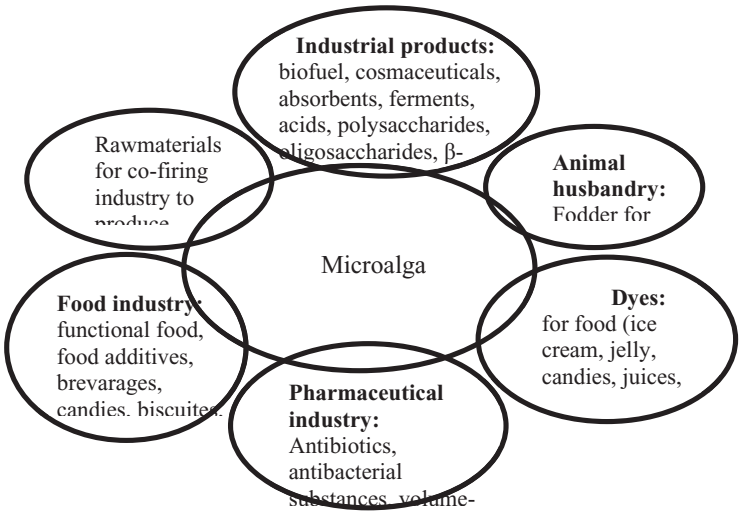

Fig 1. Application of microalgae in various areas, adopted from [6].

The global market value of micro-algae is estimated to be around US$6.5 billion, out of which about US$2.5 billion is generated by the health food sector, US$1.5 billion by the production of DHA and US$700 million by aquaculture. The annual production of microalge is approximately 7.5 million tonnes [5,7]. This article highlights on several promising microalgal species, production process and their high-value products and application.

2. Promising microalgal species and their high value applications

The microalgae are divided into four groups: a) *cynaobacteria* (blue-green algae), b) *rhodophytes* (red algae), c) *chlorophytes* (green algae), and d) *chromophytes* (all other algae). Each group contains hundreds of species and each of these species has thousands of strains [1]. Only a small number of these varieties have been studied for possible beneficial use. The most widely used microalgae include *Cyanophyceae* (blue-green algae), *Chlorophyceae* (green algae), *Bacillariophyceae* (including diatoms), and *Chrysophyceae* (including golden algae). Table 1 highlights some major microalgal species, products and their biotechnological application.

Table 1. Some major microalgal species, products and application, adapted from [7,8,9].

Species/group	Product	Areas of application
Arthrospira (Spirulina) platensis	Phycocyanin, biomass	Health food, cosmetics
Arthrospira (Spirulina)	Protein, Vitamin B_{12}	Antioxidant capsule, immune system
Aphanizomenon flos-aquae	Protein, essential fatty acids, β-carotene	Health food, food supplement,
Chlorella spp.	Biomass, Carbohydrate extract	Animal nutrition, health drinks, food supplement
Chlorella vulgaris	Biomass, Carbohydrate extract	Health food, food supplement, feeds