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Mini Review

Fatty Acids Polyunsaturated as Bioactive Compounds of Microalgae: Contribution to Human Health

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Introduction

Microalgae (i.e. the prokaryotic cyanobacteria and the eukaryotic microalgae) are a wide diversity of microscopic unicellular organisms with the ability to convert solar energy into chemical energy through photosynthesis [1,2]. Moreover, this evolutionary and phylogenetic diversity means a great diversity from the point of view of the chemical composition of these organisms. Thus, this makes them extremely attractive for potential exploitation and bioprospecting as commercial sources of a wide range of biomolecules (Table 1) [2].

Table 1: Potential application of biocompounds found in microalgae biomass [7].

Biomolecules activity	Application
Nutraceutical, antimicrobial, anti-inflamatory	Nutritional supplement, antiproliferative, ability to combat infections and diseases
Antioxidant (natural pigment)	Supplement and food ingredient for humans, feeding of fish and shellfish
Biofuels	Natural gas production in fermenters via digestion of biomass to obtain biodiesel
Fertilizers	Biomass as a source of nitrogen and phosphorous
High-value molecules	Chlorophyll-α, phycocyanin, β-carotene, linolenic acid, eicosapentaenoic acid and stable biochemical isotopes
Anticancer and antitumor	Antiproliferative. Inducing G1 inhibition in post-gastric carcinoma cells
Chemical industry	Volatile organic compounds

From among the most biotechnologically relevant microalgae it is worth highlighting the green algae (*Chlorophycea*) *Chlorella vulgaris, Haematococcus pluvialis, Dunaliella salina* and the Cyanobacteria Spirulina maxima which are widely used and commercialized, mainly as nutritional supplements for humans and as animal feed additives [1].

Microalgae are fast growing organisms which could produce a variety of compounds with various commercial uses, namely biodiesel and several compounds industrially produced [3-5]. Moreover, they can be used in the production of energy and to obtain a wide range of metabolites such as proteins, lipids, carbohydrates and minerals for health, food and feed additives and cosmetics [1]. Currently, microalgae play an important role in aquaculture, are used in the enhancement of the nutritional value of food and animal feed due to their chemical composition and can be incorporated into cosmetics [1]. Additionally, microalgae are suitable for use in human health as they are a source of bioactive compounds such as long chain polyunsaturated fatty acids (PUFA), sterols, sugars, pigments, carotenoids, phycobilins and vitamins [1,2,6]. Furthermore, polyunsaturated fatty acid oils are used to obtain nutritional supplements whereas proteins and pigments are important as natural dyes and as compounds which exhibit properties well desired by the pharmaceutical industries to treat certain diseases [1,7]. On the other hand, the production of hydrocarbons and saturated and monounsaturated fatty acids by microalgae strains are appropriate for biodiesel production [4,8].

Unlike terrestrial plants, microalgae bring forward several advantages such as a larger biomass production in shorter periods of time which brings out great health benefits, the requirement of less amounts of water and the absence of the application of fungicides,

herbicides or pesticides during their cultivation [3]. Furthermore, from the environmental point of view, microalgae have great impact on the reduction of greenhouse gases and consequent decrease of global warming, since the production of 1Kg of dry algal biomass consumes around 1.83Kg of CO2 [3].

Importance of Fatty Acids in Health

Marine microalgae are considered as a renewable source of bioactive lipids with a high proportion of polyunsaturated fatty acids (PUFAs), which have demonstrated to be effective in the prevention or treatment of several diseases [1]. Microalgae exhibit a high percentage of lipids, in which represent approximately 30-50% of the total weight of biomass [7]. They are suppliers of long-chain PUFAs such as linolenic acid, arachidonic acid, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) [2,9]. EPA and DHA are vital for keeping the bio membranes and cellular functions (e.g. cell signaling), whereas proteins are important for the primary metabolism of microalgae as biological catalysts responsible for crucial reactions that have effect on cell growth [10-12].

PUFAs, namely omega 3 PUFAs such as α-linolenic acid (C18:3n-3), EPA (C20:5n-3), docosapentaenoic acid (DPA, C22:5n-3) and DHA (C22:6n-3), have been shown to be effective in the prevention and treatment of cardiovascular diseases, cancer, type 2 diabetes, inflammatory bowel disorders, asthma, arthritis, kidney and skin disorders, depression and schizophrenia [1]. Additionally, the essential fatty acids and the long chain PUFAs are crucial as essential components of the biological membranes and precursors of a wide variety of signaling molecules (e.g. leukotrienes, eicosanoids and thromboxanes), which are responsible for multiple physiological and pathological responses [13-15].

Notwithstanding the multiple advantages offered, humans do not have the ability to synthesize these compounds, so their dietary intake is crucial for human health. Furthermore, research regarding the relations between diet and diseases correlate the dietary intake of these fatty acids with the prevention of cardiovascular diseases and cancer, reduction of coronary heart disease, decrease of mild hypertension and alleviation of the symptoms of rheumatoid arthritis [6,13,14,16].

The knowledge of the ability of PUFA-rich oil from phototrophic microalgae, which is relatively expensive to grow, to compete in the marketplace with the heterotrophically grown algae and fungi, as well as, other PUFA rich oils such as fish oil, either as high-value nutritional supplements or in the lower value market as a fish oil replacement in animal nutrition is not well known [2]. Under these circumstances, the 'vegetable' nature of algae may be a marketing differentiator [2]. To upgrade the future production of algal oils and the combination of diverse improvements in lipid productivity through isolation of new species, strain selection, genetic manipulation and engineering, and/or optimization of culture conditions with economics of scale is essential [2].

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Conflict of Interest

No conflict of interest.

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