Anti-Obesity Effects of Microalgae

Subjects: Nursing

Contributor: Saioa Gómez-Zorita, Jenifer Trepiana, Maitane González-Arceo, Leixuri Aguirre, Iñaki Milton-Laskibar, Marcela González, Itziar Eseberri, Alfredo Fernández-Quintela, María P. Portillo

Microalgae are prokaryotic or eukaryotic microscopic single-cell organisms, producing a great variety of compounds, such as photosynthetic pigments (carotenoids and chlorophylls), sterols, polyunsaturated fatty acids, vitamins, minerals, fiber, polysaccharides, enzymes, peptides, and toxins. In recent years, they have attracted great interest as a major source of bioactive medicinal products and food ingredients with anti-oxidant, anti-inflammatory, anti-cancer and anti-microbial properties.

In most pre-clinical studies performed with *Euglena gracilis, Phaeodactylum tricornutum, Spirulina maxima, Spirulina platensis*, or *Nitzschia laevis* microalgae*,* positive anti-obesity effects have been addressed in animals submitted to an obesogenic feeding pattern. However, more research is warranted to determine which bioactive compound(s) are responsible for their anti-obesity effects, as well as to establish the mechanisms underlying those effects.

Keywords: microalgae ; anti-obesity effects ; pre-clinical studies ; clinical trials

1. Introduction

Microalgae are prokaryotic or eukaryotic microscopic single-cell organisms, found in fresh water and marine systems. They produce approximately half of the atmospheric oxygen and use the greenhouse gas carbon dioxide to grow photo-autotrophically. Together with bacteria, microalgae provide energy for all the trophic levels above them. Although microalgae show a great biodiversity, the ones most studied are *Chlorella, Spirulina, Haematococcus, Dunaniella* y *Scenedesmus.*

Microalgae produce a great variety of compounds, such as photosynthetic pigments (carotenoids and chlorophylls), sterols, polyunsaturated fatty acids, vitamins, minerals, fiber, polysaccharides, enzymes, peptides, and toxins. It is important to emphasize that the chemical composition of microalgae depends on the species and the cultivation conditions, such as temperature, illumination, pH, CO_2 supply, salt, and nutrients [1][2]. They have attracted great interest in recent years due to their potential applications in nutraceutical and pharmaceutical industries, and are a major source of bioactive medicinal products and food ingredients with anti-oxidant, anti-inflammatory, anti-cancer, and anti-microbial properties[2][3].

One of the potential application fields for the microalgae bioactive compounds is obesity, which has become a serious health problem due to its high prevalence, and because it is a major risk factor for a wide range of chronic diseases, including diabetes, cardiovascular diseases, and cancer [4][5][6]. Nowadays, approved new-generation anti-obesity medications offer a safe and tolerable adjunct to lifestyle interventions for the majority of individuals with obesity. Nevertheless, depending on patient tolerability to side effects, poor adherence or discontinuation can be treatment limitations. In fact, this situation reduces treatment benefits[7].

2. Pre-clinical and clinical studies

Data reported in the literature, and gathered in the present review, show that there is scientific evidence supporting the anti-obesity effect of several microalgae: *Euglena gracilis, Phaeodactylum tricornutum, Spirulina maxima, Spirulina platensis*, and *Nitzschia laevis.* With the exception of one study, the published works carried out in animal models have addressed the effects of microalgae in animals submitted to an obesogenic feeding pattern. Consequently, the results have shown the ability of microalgae to total or partially prevent obesity development associated to this dietary pattern.

Preclinical studies have revealed some of the mechanisms of action underlying this effect. Depending on the species and concentration, microalgae can inhibit pre-adipocyte differentiation, thus reducing the number of mature adipocytes ready to accumulate triglycerides (TG). Moreover, they reduce de novo lipogenesis and TG assembly, thus limiting the amount of TG to be stored. An increase in lipolysis and fatty acid oxidation can also be observed. Finally, microalgae can induce

an increase in energy expenditure via thermogenesis activation in brown adipose tissue, as well as by inducing browning in white adipose tissue. It could be thought that a potential toxic effect of some constituent common in microalgae could be responsible, at least in part, for the reduced lipid retention and weight reduction. However, this possibility can be discarded because in vitro studies have shown no cytotoxicity of microalgae extracts in a wide range of doses. In parallel with the reduction in body fat accumulation, other features which are typical of individuals with obesity, such as enhanced plasma lipid levels, insulin resistance or diabetes, and low-grade inflammation, are also improved by microalgae treatment.

The anti-obesity effect of microalgae, as well as the improvement of several comorbidities observed in preclinical studies, has been confirmed in clinical trials. In this case, due to the experimental design characteristics, the role of microalgae in obesity treatment, rather than in obesity prevention, has been evidenced.

3. Limitations and future research

Concerning the limitations of the reported studies, it should be pointed out that more research is needed to determine which bioactive compounds, present in microalgae, are responsible for their anti-obesity effects, as well as to look for potential synergies among them. In addition, although several mechanisms have been proposed to explain the anti-obesity effects of microalgae, further studies are needed in order to gain more insight concerning this issue. For instance, in several studies increased expression of genes related to thermogenesis has been found, suggesting the activation of this process, but additional studies are needed to confirm that in fact thermogenesis, and consequently energy expenditure, are increased.

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