Nutraceuticals from the cold: impact of global warming on the polyunsaturated fatty acid biosynthesis in the Antarctic diatom Fragilariopsis cylindrus

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R. Giaccari *[I], D. Giordano *[II], M. Clark[III], M. Davey[IV], N. Thomas[IV], A. Thomson[IV], M. Viglioli[I], F. Vacondio[I], C. Verde[II], **S. Bruno**[I]

[I]Department of Food and Drug, University of Parma, Parma, Italy, [II]Institute of Biosciences and Bioresources, CNR, Naples, Italy, [III]British Antarctic Survey, Cambridge, United Kingdom, [IV]Scottish Association for Marine Science, Oban, United Kingdom

Diatoms, a key component of polar marine ecosystems, represent one of the major groups of photosynthetic algae and account for more than half of the total primary production. They are also primary producers of omega-3 polyunsaturated fatty acids (PUFAs), including eicosapentaenoic and docosahexaenoic acids. Since PUFAs' composition of diatoms can be affected by temperature, light, and nutrient conditions, understanding the influence of environmental changes on the PUFAs' biosynthetic pathway can provide insights not only into their ecological future in the global warming scenario but can also offer opportunities for their biotechnological exploitation. Among cold-adapted species, *Fragilariopsis cylindrus* is the first polar diatom whose genome has been sequenced and annotated. In this work, we have grown *F. cylindrus* at temperatures mimicking a normal and a warm Antarctic summer using Xanthella LTD© photobioreactors. Upon (1) *in silico* identification of the genes encoding for the desaturases and elongases involved in PUFA production from linoleic acid, we have (2) cloned and sequenced their allelic variants, (3) analyzed by RT-qPCR their transcription levels in *F. cylindrus* grown at different temperatures, (4) explored by Liquid Chromatography-High Resolution Mass Spectrometry the resulting differential lipidomic profile and (5) recombinantly expressed the enzymes to evaluate substrate specificity. Exploring the pathway responsible for PUFA production in *F. cylindrus* will offer promising avenues for advancing our understanding of lipid metabolism in polar microorganisms and obtaining a more sustainable production of marine PUFAs for nutraceutical applications.

* The authors marked with an asterisk equally contributed to the work.