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EDITED AND REVIEWED BY
Rosane Freitas Schwan,
Universidade Federal de Lavras, Brazil

*CORRESPONDENCE
Ângelo Paggi Matos,
angelosotam@gmail.com
Giustino Tribuzi,
giustinotribuzi@gmail.com

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Editorial: Algae as food and ingredient: from production to consumer acceptance

Ângelo Paggi Matos[1]*, Enrico Novelli[2] and Giustino Tribuzi[1]*

[1]Department of Food Science and Technology, Federal University of Santa Catarina, Florianópolis, Brazil, [2]Department of Comparative Biomedicine and Food Science, University of Padua, Padua, Italy

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Editorial on the Research Topic
Algae as food and ingredient: from production to consumer acceptance

Microalgae and seaweed are photosynthetic organisms rich in compounds like proteins, carbohydrates and fibres, lipids and fatty acids, pigments, vitamins, and minerals (Matos et al., 2016). Compounds extracted from seaweed notably polysaccharides such as agar, carrageenans, xanthan, and guar gum have been incorporated into many food preparations acting as thickening, gelling, emulsifying, and stabilization agents (Mohamed et al., 2012). Microalgal dried biomass is widely commercialized as dietary supplements for humans, particularly because of its high protein and bioactive compounds. Long-chain polyunsaturated fatty acids and pigments extracted from microalgae have been part of many pharmaceutical and biomedical products due to its therapeutical and nutraceutical properties (Matos, 2017).

Several factors influence the properties of algal biomass as feedstock for food utilization (Mendes et al., 2022). For example, the cultivation techniques and parameters such as the available nutrients, light exposure and intensity can affect the synthesis of intracellular compounds (Coleman et al., 2022), while the appropriate utility of harvesting, dewatering, and drying techniques can preserve the nutritional quality of algal biomass (de Farias Neves et al., 2019; Demarco et al., 2022a). The correct choice of algal extraction techniques, combined with disruption methods can help the extractability of algal compounds, enhancing the bioaccessibility and digestibility of algae-based food (Demarco et al., 2022b).

Factors like traditional food production chain sustainability, climate change, increasing world population and energy costs, motivated the search for innovative food sources. In fact, there is an increasing demand for the development of novel foods and ingredients containing algae by-products with remarkable nutritional, sensorial, and technological properties originated by sustainable food systems. This Research Topic entitled "*Algae as Food and Ingredient: From Production to Consumer Acceptance*," belonging to the Frontiers in Food Science and Technology journal, was released to the scientific community to publish their research contributions and result findings. The Research Topic is composed of three scientific articles (one review and two research articles) and is authored by experts from different countries, including Brazil, Denmark, Italy, and Norway. Research Topic covered are oriented to support the professionals working in the food industry, interested in developing new food products based on algae biomass. The review realized by Matos et al. approaches one of the main challenges of using algae either microalgae or seaweed in food systems, notably the importance of sensorial quality. In fact, algal biomass may contain

several taste and odor-active chemical compounds, which can be undesirable for certain food applications. That review, for instance, provided up-to-date information about studies that investigated the main flavour compounds that directly affect the sensorial properties of algal biomass. Several examples of new and sophisticated foods such as plant-based fish, meat, and dairy analogues enriched with algal biomass are also presented, elevating the credibility of using algal biomass and their by-products for novel food (Matos et al.).

Contrarily to common vegetables, studies about the post-harvest quality changes of seaweed and microalgae are rare in literature, in particular for fresh algae. Wirenfeldt et al. investigated post-harvest quality changes and shelf-life of sugar kelp (*Saccharina latissima*). Sugar kelp is a brown seaweed native in Europe, which grows naturally from the South (Iberian Peninsula/Spain) to the North (Tromso/Norway) of Europe continent. This seaweed species has been sought after to be cultivated along the European coast due to its potential application in human nutrition, food additives, animal feed, and biofuels. Despite its potential in the food industry, few studies have been conducted in terms of storage trials to determine the shelf-life changes in *S. latissima* seaweed. In this paper, the authors investigated the shelf-life of refrigerated sugar kelp following five post-harvest treatments and evaluated the effect of these treatments on changes in quality attributes such as sensory, microbial, chemical and physical. Based on sensorial analysis, the refrigerated (+2.8°C) shelf-life for sugar kelp was established to be 7–9 days, where the end of the sensorial shelf-life was correlated with the development of putative spoilage organisms (˃7 log UFC g^{-1}) from the *Pseudoalteromonadacea* and *Psychromonadacea* families. Favorable organolapetic properties, *i.e.*, sweetness and umami taste, decreased over the time of storage and coincided with a reduction in water-soluble mannitol and free glutamic acid. The seaweed that were blanched for 2 min in sea water or potable water, changed their texture and colour and reduced iodine and vitamin C contents, while retaining components such as fucoxanthin, chlorophyll and β-carotene. In sum, this study provides a valuable documentation of shelf-life determination of *S. latissima*, aiding food manufactures to establish best practices for post-harvest processing and storage of sugar kelp (Wirenfeldt et al.).

Lipid oxidation is a major factor for the quality deterioration of food products, giving rise to unwanted off-odors and–flavors. Hermund et al. proposed to extract compounds from Nordic brown seaweed *Fucus vesiculosus* and evaluated the extract's ability to maintain the physical and oxidative stability of fish oil-enriched mayonnaise (80% fat, 1:4 fish oil: repessed oil) during dark storage conditions for up to 28 days. Supercritical-CO_2 extraction was used to extract the lipid fraction containing high amount of lipid-soluble antioxidants such as carotenoids and tocopherols. Subcritical water extraction was employed to extract polar/hydrophilic compounds, notably polysaccharides, proteins, peptides and phenolic substances. The extracts were previously tested in terms of antioxidant composition and were added (2 g/kg) in different phases of mayonnaise formulations. Results showed that algal extracts delayed the oxidation of lipids, by retarding the formation of hydroperoxides, and subsequent formation of secondary oxidations products. The high level of metal chelating species found in algal extracts also contributed to the retard of lipid oxidation in mayonnaise food products, illustrating that seaweed extracts can be used as natural antioxidants (Hermund et al., 2023).

Taken together, the three articles found within this Research Topic will help readers understand the broadening application of algae, encouraging food biotechnologists to incorporate algal biomass and its extracts in new food formulations.

Author contributions

APM: Bibliographic investigations, writing—original draft, and writing—review and editing. GT: Conceptualization, writing—original draft and writing—review and editing. EN: Writing—review and editing. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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