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Seaweeds: A traditional ingredients for new gastronomic sensation

Laurie-Eve Rioux, Lucie Beaulieu, Sylvie L. Turgeon*

Institute of Nutrition and Functional Food, Department of Food Science, 2425, Rue de l'Agriculture, Pavillon Paul-Comtois, Université Laval, Quebec City, QC, G1V 0A6, Canada

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ABSTRACT

Seaweeds have a long tradition in Asian cuisine. In Canada and US, seaweed consumption is mostly limited to sushi and other imported Asian dish. However, seaweeds are well recognized for their richness in several nutrients such as fiber, protein and minerals. But what is limiting seaweed and seaweed derived ingredients utilization in home cooking? Finding fresh seaweeds within inland cities is one limiting step but also the seaweed marketing need to propel the image that seaweed are not only nutritive but can bring flavor and texture in cuisine dish. With the rise of TV cooking shows, blogs and online recipes hosted by several renowned chefs, it is now time to bring seaweed in the spotlight. The aim of this review is to look at seaweeds to support a wider use in culinary applications for their nutritional contribution but also from a sensory perspective.

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1. Introduction

Globally, 96% of the harvested seaweeds are produced by aquaculture which had an economic value of 6.4 billion US dollar in 2013 (FAO, 2016a). The annual macroalgae harvest from wild and cultivated crops was 28.4 million tons in 2014 (FAO, 2016b). This is a

* Corresponding author.
E-mail address: Sylvie.Turgeon@fsaa.ulaval.ca (S.L. Turgeon).

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rise of 43% compared to 2010 where 19.9 million of tons of seaweeds were harvested. Forty percent of the global harvest in 2014 represent seaweeds traditionally eaten in Japanese culture (Fig. 1). 7.7 million of tons of Kombu (*Saccharina japonica*) and 2.4 million tons of Wakame (*Undaria pinnatifida*), two brown seaweeds, were harvested in 2014 (FAO, 2016b). Additionally, 1.8 million tons of Nori (*Porphyra* sp.), particularly used dried in sushi preparation, were harvested (FAO, 2016b). Among the harvested seaweeds, 13% have been used for the production of hydrocolloids (polysaccharides) such as: agar, alginate and carrageenan while 75% are used for food (Hardouin, Bedoux, Burlot, Nyvall-Collén, & Bourgougnon, 2014). The remaining (12%) are used for agriculture.

In Pacific (Indonesia, Philippines, Maori of New Zealand, Hawaii) and Asian cultures (China, Japan, Korea), seaweeds have long been consumed in a variety of dishes such as raw salads, soups, cookies, meals and condiments (McHugh, 2003; Yuan, 2007). In Iceland, Wales, France as well as the Canadian and U.S. Maritimes, there exists a traditional consumption of seaweed-based foods which varies in importance depending between country and regions but which is overall less prominent than in Asia (Chopin, 2015; Yuan, 2007). For example, in the Canadian Arctic, more than 210 species have been identified (Archambault et al., 2010), kelp (Laminariales) and rockweeds (Fucales) being particularly abundant (Sharp, Allard, Lewis, Semple, & Rochefort, 2008; Tamigneaux & Johnson, 2016). These brown seaweeds, together with red seaweeds (Palmariales), have once been a part of the traditional diet of native peoples of the coast of St. Lawrence and Nunavik in Canada (Blanchet & Rochette, 2008; Kuhnlein & Turner, 1991; Wein, Freeman, & Makus, 1996) but this cultural habit has been lost with the modern food offer. The increase of vegetable consumption, including seaweeds, has been promoted in these populations, to exert health benefits during Inuit childhood and life-course (Gagné et al., 2012; Johnson-Down & Egeland, 2010). In the overall Canadian population, the consumption of algae as a food is mostly limited to traditional algal cuisine from Asia (Winberg, 2011).

Seaweeds are well known for their abundance in several nutrients as dietary fibers, minerals (e.g., iodine) and certain vitamins (e.g., B12) and also contain numerous proteins/peptides, polyphenols and polyunsaturated fatty acids (omega-3) (Cardoso, Pereira, Seca, Pinto, & Silva, 2015). A diet rich in seaweed in Asian countries has been consistently associated with a low incidence of cancers (Cian, Drago, de Medina, & Martínez-Augustin, 2015), and other potential health benefits of seaweeds have been reported, including cardioprotective, neuroprotective and anti-inflammatory effects as well as beneficial impacts on gut function and microbiota (Cian et al., 2015; Liu, Banskota, Critchley, Hafting, & Prithiviraj, 2015). These results strongly support the use of seaweeds in functional food development but also to promote new utilization in food products and in the kitchen of consumers. In this paper, we will review the main uses of whole seaweeds and the interest of using some components as ingredients that could play roles on textural or sensory properties of food as well as some nutritional attributes.

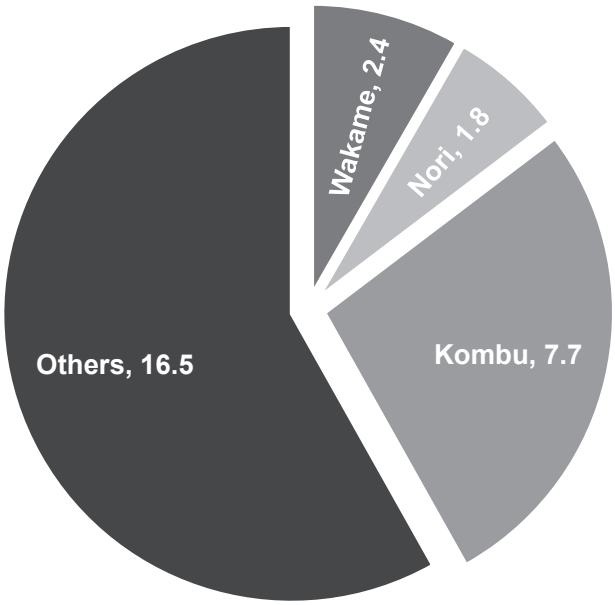

Fig. 1. Global production of wild and cultivated macroalgae in 2014 in million of tons.

2. Seaweed utilization in food formulation

The recent popularity of sushi and Asian cuisine in Western countries has stimulated the seaweed economy. The migration of Asian population across the world has promoted the discovery of new ingredients from seaweeds and has fuelled the creation of new dishes by chefs in restaurants. Among the macroalgae traditionally consumed by Asian population, *Ulva*, *Laminaria* and *Porphyra* (Atlas & Bartha, 1998) are well known. Table 1 displays the seaweed species used in Asian cuisine. These are grouped under three seaweed phylum: *Chlorophyta* (green), *Ochrophyta* (brown) and *Rhodophyta* (red) based on their pigmentation. Species such as Wakame or Kombu requires cooking to overcome their chewy texture while others can be eaten raw (Nori and sea lettuce) (Mouritsen, 2009). The valorization of seaweed as sea vegetables generally involves drying or salting processing treatments. Seaweed drying is one of the primary step to allow transportation. They are either sun dried, air dried or dehydrated by salt addition (Fleurence, 2016; Venugopal, 2011). Seaweed can also be macerated with specific enzymes to improve protein bioaccessibility through hydrolysis of dietary fibers resistant to human digestion but this process hasn't reach any commercial application yet (Fleurence, 1999a, 2016). Fermentation by lactic acid bacteria was also reported but the growth was dependent of the seaweed species (presence of fermentable carbohydrates such as laminaran) and heating treatment applied prior to the inoculation step (Gupta, Abu-Ghannam, & Scannell, 2011). All these processing treatments are likely to affect seaweed's nutrients but to our knowledge, there is a limited number of studies describing their impact. More research may provide useful information to promote their usage in innovative dish and food preparation.

While seaweeds have been consumed traditionally in several countries, there is a current buzz regarding algae derived food product. Food navigator USA has launched an algae special edition newsletter in August 2016 (http://www.foodnavigator-usa.com/feature/news-by-month/08/2016) highlighting several new products from seaweeds and their derivatives (vegan egg, algae oil, etc.). Although most products were derived from microalgae, it shows that consumers are more thrilled to use these products in their kitchen. A recent survey of XTC database, a qualitative worldwide database indexing innovative food products on the market, reported several new food products containing macroalgae launched in 2015–2016 (Table 2, (XTC, 2016)). Seaweed crips, milk-based powder preparation enriched with seaweeds, seaweed biscuits, seaweed instant mashed potatoes, seaweed tagliatelle and *Wakame* salad were among the list. Also, in the literature several studies were conducted regarding the addition of seaweed ingredients/powder in several food formulations (reviewed in (Cardoso et al., 2015; Mahadevan, 2015)). In most studies, the goal was to develop new functional food but none the less, the functional