CHAPTER 5
EXTRACTION FOR BROWN ALGAE

Nur Hidayah Zainan, Nur Nadhirah Waslee, Chee Hui Fen, and Ainul Hayat

5.1 BROWN ALGAE

Algae, commonly known as seaweed, are increasingly being utilized as valuable sources of human food, fertilizers, and pharmaceutical products. Algae have been around for a long time and are considered the oldest type of plants on earth. They are very resilient and abundant. They contain significant amounts of vitamins, minerals, amino acids, and polysaccharides, which are of interest due to their numerous biological functions. Generally, algae can be classified into three main categories, such as red, green, and brown algae, based on their pigmentation and the type of photosynthetic pigments. Each category comprises different species with unique characteristics and applications.

Brown algae are a type of multicellular marine macroalgae, scientifically in the Phaeophyceae or Phaeophytae family. They are exclusively found in coastal habitats, especially on rocky beaches in climatically moderated areas of the world. Brown algae play a significant ecological function by providing a home for a wide variety of marine animals. The size of the approximately 1,500 species of brown algae varies significantly, exhibiting a diversity of shapes. Color distinguishes this species of algae from others. The algae color is determined by the ratio of fucoxanthin to chlorophyll. Their color ranges from brown to olive green,

which inspired their names. However, the coastal communities rarely ingest the brown algae due to its unappealing flavor.

The brown algae contain a holdfast structure that resembles a root to regulate the shape of wave movement, making it suitable for living in coastal areas. Unlike the roots of plants, they do not participate in the intake of nutrients or water. They stop the water movement to prevent algae from being carried away. Brown algae usually feature a flattened structure called the lamina, blade, or frond, which duplicates leaves. The lamina surface of brown algae might be either wrinkled or smooth. Strong wave action helps to loosen and distribute their spores. Brown algae cell walls are composed of two layers: an inner layer of cellulose that provides structural strength and an outside layer that is sticky and made of algin.

Brown algae contain excellent nutrients and bioactive compounds, including carbohydrates, proteins, lipids, polyphenols, vitamins, and minerals. Figure 5.1 shows the nutritional composition of brown algae, indicating carbohydrates as the main component. The carbohydrates in brown algae have a wide range of uses in the pharmaceutical, food, and cosmetic sectors. The bioactive compounds in brown algae have been found to exhibit significant biological properties such as antioxidant activity, antidiabetic, anti-inflammatory, and cytotoxic activity. Moreover, brown algae have been used as a food supplement and functional food. Owing to their excellent moisturizing and calming properties, some varieties of brown algae can be used topically to lighten skin, reduce hyperpigmentation, and protect against age spots.

5.2 CARBOHYDRATES

Carbohydrates are composed of multiple sugar molecules. They serve as an important source of energy and structural component in living organisms. Carbohydrates in brown algae primarily consist of fucoidan (5–40%), alginate (40%) and laminarin (20–50%). The presence of fucoidan, alginate, and laminarin can even account for up to 70% of the total dry weight in some species.

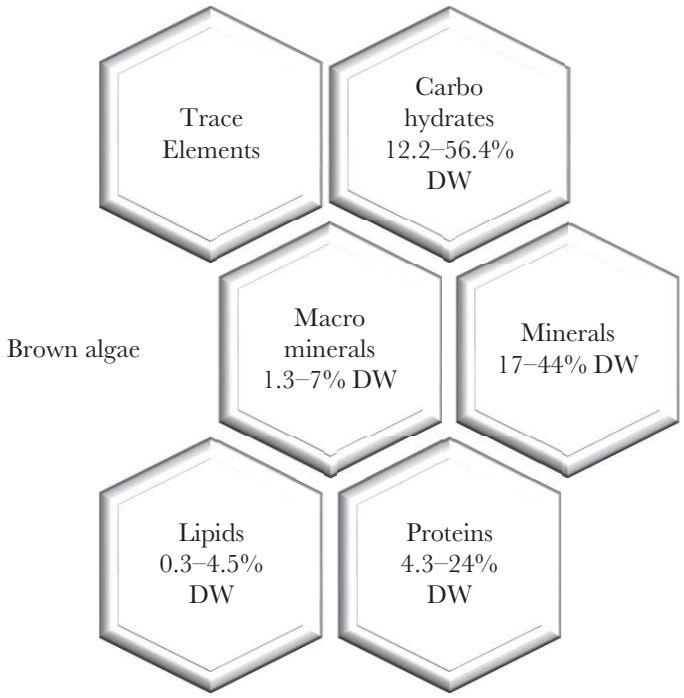

Figure 5.1 Schematic diagram of brown algae composition

Alginates are linear polysaccharides composed of β-D-mannuronic acid and α-L-guluronic acid residues. They are the major component of cell walls and provide structural support for brown algae. Alginates have a wide range of industrial applications, including as thickeners, gelling agents, and emulsifiers in food and pharmaceutical products. They can be obtained through various processing methods such as chemical degradation (acid or alkali hydrolysis), physical degradation (microwave treatment), enzymatic degradation (alginate lyase) or chemical synthesis. Studies have indicated that alginate oligosaccharides (AOSs) possess the ability to regulate numerous biological activities contributing to health benefits. AOSs can be classified according to their degrees of polymerization with distinct biological activities. The yield of alginates determines the value of algae as a valuable source of nutraceuticals, which can be effectively utilized in food industries.