Carbohydrate of the Brown Seaweed, *Saccharina latissima*: A Review

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Abstract - *Saccharina latissima* is one of the potential seaweed sources because of its high carbohydrate content. The interest of farming of macroalgae has increased in European countries. Abundant research results have provided data for the biochemical composition of *S. latissima*. This paper collects and summarizes data on carbohydrate content of *S. latissima* from scientific articles published all around the world. The content of polysaccharides in *S. latissima* range from 30 to 50% dw. These polysaccharides include alginate, fucoidan, laminarin and mannitol. Information of the carbohydrate content of *S. latissima* will be needed for further developments, such as in biofuel, food or health industries. It may also increase the interest of cultivation of *S. latissima*. As a result, *S. latissima* may become an important commodity in aquaculture.

Keywords: Carbohydrate, *Saccharina latissima*, seaweed

I. INTRODUCTION

Seaweed farming mostly undertaken in Asian countries. Recently, it also conducted in some African, American and European countries. It is a relatively new industry in North America and Europe[1]. The production has grown by 119% since 1984[2], showing an increased interest of seaweed cultivation. The large increase of seaweed production from 1984 to 1994 includes chlorophytes, rhodophytes and phaeophytes, with increase value of 376%, 167% and 97% respectively[2]. The global production of seaweed in 2016 dominated by *Eucheuma* spp., *Laminaria japonica*, *Gracilaria* spp., *Undaria pinnatifida*, *Kappaphycus alvarezi*, and *Porphyra* spp. [3].

Seaweed are cultivated both as a raw material for seaweed industries and for human food. Seaweed biomass has a potential as a source for producing biofuels [4]; nutraceuticals or functional food [5, 6]; pharmaceutical or medical [7-9] and food [2, 10-12]. The utilization of seaweed has also increased for environmental purpose. Studies on macroalgae farming close to fish farms have revealed that seaweed has the potential for bioremediation services [13, 14].

The high use of seaweed inseparable from its nutritional content, which may up to 50% for the carbohydrate content [15]. Beside direct consumption, seaweed are also extracted for agars, carrageenans and alginates content. *Gracilaria* and *Gelidium* are the principal source of agar[16, 17], *Kappaphycus* and *Eucheuma* are the main sources of carrageenans [18], while brown seaweed (class Phaeophyceae and orders Laminariales and Fucales) have large contents of alginate (up to 55% dw) [19]. *Alaria esculenta* and *Saccharina latissima* are the potential brown seaweed species most suited for cultivation in Europe [13, 20] because they hold valuable nutritional content [21]. The objective of this paper is to provide detailed information on the carbohydrate composition of *S. latissima*. We believe that the information provided here will give the advantages for the industrial uses of this and other macroalgae.

II. CARBOHYDRATE OF *Saccharina latissima*

Total carbohydrate of *S. latissima* range from 30 to 50% dw[22]. The most abundant carbohydrate in sugar kelp (*S. latissima*) is alginate that constitutes up to 40% [23]. Handå et al. found that the alginate content of sugar kelp was in the range between 6 and 27%[13]. Alginate content of *Laminaria saccharina* from Barents Sea were found to be 34.5±1.00% dw[24], and Shiener et al. notified an average alginate content of 28.5±3.9% of the dry weight for *S. latissima* from Scottish waters [25]. Alginic acid distributed universally among the Phaeophyta [26]. Jard et al. suggested that *S. latissima* is the best algae suited for alginate extraction[27]. It is also a key species for the food industries, and *S. latissima* is therefore a main candidate for seaweed aquaculture. Total alginate of *S. latissima* is lower than that of *Himanthalia elongata* (Table 1), but the thickening properties of alginate from *S. latissima* is better than that of other brown algae mentioned [27].
TABLE I
TOTAL ALGINATE OF THE SELECTED BROWN SEAWEED 

| Brown seaweed species | Undaria pinnatifida | Saccorhiza polyschides | Sargassum m. muticum | Saccharina latissima | Himanthalia elongata |
|-----------------------|---------------------|------------------------|--------------------|----------------------|---------------------|
| Total alginate (x1.18 uronic acid) (g/kg TS) | 222 | 192 | 160 | 243 | 350 |

*[27] **total alginate contents were obtained from corresponding references.

The worldwide aquaculture production of aquatic plant dominated by macroalgae showed production yields above 30 million tonnes in 2016 [3]. The average world yield of macroalgae is higher than those of wheat, maize, sugar beet and sugar cane [33]. This makes seaweed available as an industrial raw material for commercial product, and it is suggested that marine sources has the largest biomass potential compare to other sources [34]. In addition to that, huge biomass required for the industrialization of seaweed may reach through aquaculture.

*S. latissima*, as a potential species for seaweed aquaculture, is one of the fastest growing species of kelp in European waters [35, 36], and the species show good growth performance [37]. In Norway, the procedure for seedling production of *S. latissima* has been established through research activities [36], and further farming activities is initiated. Through the MACROSEA project (https://www.sintef.no/projectweb/macrosea/), we will also contribute to provide a knowledge platform for industrial macroalgae cultivation.

IV. CONCLUSION

*S. latissima* has a relatively high content of total carbohydrates. The carbohydrate includes of alginate, fucoidan, laminaran and mannitol, components that can be used for production of biofuel, food and health products. Protocol for the aquaculture of *S. latissima* has also established in Norway.

ACKNOWLEDGMENT

The work was a part of the Research Council of Norway project no.254883/E40 (MACROSEA) and funding from the Department of Biology, Norwegian University of Science and Technology.

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