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Short Communication

Study on proximate composition of four seaweeds from Kilinochchi and Kalpitiya area of Sri Lanka

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Abstract
Some of the representatives from edible seaweeds (*Gracilaria verrucosa*, *Gracilaria corticata*, *Turbinaria ornate*, *Sargassum polycystum*) from Kilinochchi and Kalpitiya in Sri Lanka were investigated for proximate composition (moisture, protein, lipid and ash content). The proximate composition was significantly ($p < 0.001$) different across seaweed species. In this regard, moisture content (mean ± SD) varied from 76.33 ± 0.0% in *T. ornata* to 89.78 ± 0.6% in *G. corticata*. The *S. polycystum* presented the highest fat content (1.94 ± 0.5%); whereas, *G. corticata* showed the highest protein level (21.66 ± 1.1%). Fat content was low in *T. ornata* (0.37 ± 0.2%) and *S. polycystum* (1.94 ± 0.5%) while protein content was low in other three species. Also *G. verrucosa* and *G. corticata* had higher ash content (44.34 ± 3.8% and 44.34 ± 3.8% respectively) than other seaweed species. The variation in proximate composition was high among species and would be a healthy addition to normal diets.

Keywords: ash; lipid; moisture; protein; seaweeds

1 | INTRODUCTION

The Sri Lankan seaweed flora is relatively rich, with about 440 taxa, belonging to 148 genera currently recorded along a coastline of 1585 km (Barton 1903; Boergesen 1936; Durairatnam 1961; Baldwin 1991). They are plant like organisms that generally live attached to the rock or hard substrata in the coastal areas. There is ample evidence of the importance of seaweeds in the context of human food needs and ecological benefits of farming (Craigie 2011; Cornish *et al.* 2017). Economic uses of seaweeds particularly for food, feed, phycocolloids and agro-based products, are well known for centuries and are now being extensively investigated for their application in biofuel, nutraceutical, medicinal, personal-care and food additive industries (Hafting *et al.* 2015; Kim *et al.* 2017).

There are three major classes of seaweed namely, Chlorophyceae (green), Rhodophyceae (Red) and Phaeophyceae (Brown) (Trono Jr and Ganzon Ganzon-Fortes 1988). The red, brown and green seaweeds are phylogenetically very different and this is reflected in their differences in growth, structure, and biochemical composition (Lange *et al.* 2020). The most common seaweeds found in Sri Lanka are the brown seaweeds belonging to the genus *Sargassum* (Jayasuriya *et al.* 1990). In this study, *Gracilaria verrucosa* and *Gracilaria corticata* of Rhodophyta and *Turbinaria ornata* and *Sargassum polycystum* of Phaeophyceae were studied for proximate composition.

Seaweeds are not used as much for edible use although many kinds of seaweeds are collected in Sri Lanka

(Komatsuzaki *et al.* 2019). Since 1800s, naturally collected seaweed species have been exported from Sri Lanka (Duraitarnam 1963) and a growing export market was identified thereafter. Furthermore, a small percentage of dried seaweeds is being sold locally, while a good demand for packed *Gracilaria* spp. can be identified in Islamic festive season in Sri Lanka (Jayasuriya 1987). *Gracilaria* spp. are popular food item among fishermen, especially in producing areas and was domestically consumed as porridge and a jelly drink (Ginigaddara *et al.* 2018).

Different species of seaweeds especially protein rich seaweeds are used as human food in many countries all over the world. Therefore, studies on the proximate composition of seaweeds are important to determine their nutritive value (Dawes 1981).

2 | METHODOLOGY

The four seaweed species namely, *G. verrucosa*, *G. corticata*, *T. ornate* and *S. polycystum* were collected from Kalpitiya and Kilinochchi coastal regions of Sri Lanka. Seaweed samples were picked with hand from natural beds and immediately washed with seawater to remove the foreign particles, sand particles and epiphytes. Then they were kept in air tight bags in an ice box containing ice flakes and immediately transported to the laboratory in the department of Aquaculture and Aquatic Resources Management, University College of Anuradhapura. The samples were washed thoroughly using running water to remove the salt on the surface of the sample. The samples were dried in oven at 40°C to constant weight. Then dried samples were grounded in an electric mixer (Trio – MG 158, India) and powdered samples were stored in Chest freezer (HCF775, China) until further analysis. Protein, moisture and ash content of the seaweeds were determined using the AOAC standard methods with triplicate samples.

The moisture content was determined by using the moisture meter at 105°C to constant weight (AOAC 1989). The crude protein content was analysed by the semiautomated Kjeldahl system (Nitrogen distiller; Raypa DNP-2000MP, Spain), which was following the AOAC official method of analysis 984.13 (AOAC 2005). Ash content was analysed by incinerating the seaweeds in the muffle furnace (LabTech LEF-P, Korea) at 550°C for 4 hours by following the AOAC official method of analysis (AOAC 1989). The total lipid content was evaluated using Bligh and Dyer (1959) method.

Data were analysed with SPSS 16.0 software using parametric tests. One-way ANOVA was used to compare the means of chemical composition data determined for the four seaweed species. When significant differences were found, Duncan multiple comparison test was used, and differences were considered significant at $p < 0.05$.

3 | RESULTS AND DISCUSSION

Chemical compositions were significantly ($p < 0.05$) different among the four seaweed species. The moisture content of fresh seaweed samples were ranged from 76.33% to 89.78% (Table 1). Among the four seaweed studied, *G. corticata* (89.78 ± 0.6%) was found to have the highest moisture content followed by *S. polycystum* (mean ± SD: 80.25 ± 0.4%), *G. verrucosa* (79.78 ± 0.7%) and *T. ornate* (76.33 ± 0.0%). The moisture content of four seaweeds was close to the value (79 – 86%) previously reported by Jayasinghe *et al.* (2018).

The ash content in most seaweed varieties is much higher than terrestrial plants (Jayasinghe *et al.* 2018). The ash content of studied seaweeds was between 26.11 ± 0.9% and 46.72 ± 0.5%. The amount of ash content obtained in the present study was in agreement with previous studies which stated that seaweeds contained high proportions of ash (21.1 – 39.3%) (Rupérez 2002; Mohammadi *et al.* 2013.). During this research, it was observed that, the red algae (*G. verrucosa* and *G. corticata*) had significantly higher ash (46.72 – 44.34%) than the brown algae (*T. ornate*, 26.11%; *S. polycystum*, 29.45%). The deference of the ash content depends on the seaweed species, a method of mineralisation, types of processing, marine environmental factors and physiological feature of the seaweed (Rameshkumar *et al.* 2013).

TABLE 1 Proximate composition (moisture, ash, lipid and protein) of selected seaweeds in % dry weight.

Seaweed species	Moisture (%)	Ash (%)	Lipid (%)	Protein (%)
Gracilaria verrucosa	79.78 ± 0.7^{b}	46.72 ± 0.5^{a}	0.20 ± 0.0^{b}	16.51 ± 1.7^{b}
Gracilaria corticata	89.78 ± 0.6^{a}	44.34 ± 3.8^{a}	0.24±0.1 ^{b}	21.66±1.1 ^{a}
Turbinaria ornata	76.33 ± 0.0^{c}	26.11 ± 0.9^{b}	0.37±0.2 ^{b}	16.79±0.2 ^{b}
Sargassum polycystum	80.25 ± 0.4^{b}	29.45 ± 0.7^{b}	1.94±0.5 ^{a}	17.80±0.1 ^{b}

Values are means of triplicate groups ± SD, n = 3.

Seaweeds are relatively low in lipid (1 – 5% of dry weight) (Burtin 2003; Polat and Ozogul 2008). In the present study, the highest crude lipid content was observed in *S. polycystum* (1.94 %) followed by *T. ornata* (0.37 %), *G. corticata* (0.24%) and *G. verrucosa* (0.20%). These results are comparably lower than those reported by Cirik *et al.* (2010); Rohani-Ghadikolaei *et al.* (2012); Remya *et al.* (2019) and Balboa *et al.* (2016). But this research is in accordance with Jayasinghe *et al.* (2018) who reported that the total lipid content was generally low in all seaweeds samples (0.30% to 1.97% in dry weight) and form a minor portion of the proximate component than other components. These differences in results between studies could be due to the different environmental conditions, the season of harvesting and the habitat of the seaweeds.

The protein content is one of the important constituents and suggested as supplemental food for humans and animals (Jayasinghe *et al.* 2018). In this study, the highest protein level was found in *G. corticata* (21.66%) followed by *S. polycystum* (17.8%), *T. ornata* (16.79%) and *G. verrucosa* (16.51%) (Table 1). These levels of the protein content of the seaweeds depend on the environmental factors, maturity stage, seasonality and the physical feature of the seaweeds plants (Banerjee *et al.* 2009)

4 | CONCLUSIONS

From the present study, it is obvious that marine macro algae are rich in nutritive properties. The present findings could be useful to collect the selected seaweeds from Northern and North Western coast of Sri Lanka and use them in the food and pharmaceutical industries for various purposes. The results of the study concluded that these seaweeds can provide dietary alternatives to improve the nutritive value of the human diet. Further study needs to be done on the utilisation and sensory insights of these seaweeds.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTION

VSP Data collection and sample analysis; **DMAE** data analysis, manuscript preparation and research supervision.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

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