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Seasonal variation in the chemical composition of tropical Australian marine macroalgae

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Abstract

The proximate chemical composition (ash, soluble carbohydrate, lipid and protein) was determined in 30 common species of tropical Australian marine macroalgae from Darwin Harbour (12°26′S, 130°51′E), in summer (hot and wet) and winter (cool and dry). There was a wide diversity of species in both seasons (19 species in summer and 20 species in winter). In most species, the major component was soluble carbohydrate (chlorophytes range 2.5–25.8% dry weight (dw), phaeophytes range 8.4–22.2% dw, rhodophytes range 18.7–39.2% dw) with significantly higher ($p < 0.05$) percentages only in winter season rhodophytes. Highest percentages of protein were found in rhodophytes collected in the summer (range 4.8–12.8% dw), with significantly lower percentages ($p < 0.05$) during winter. All species had lipid contents within the range 1.3–7.8% dw, with highest percentages in summer phaeophytes, but no significant differences between species or season. Most species had moderate to high ash contents (24.2–89.7% dw), with the highest percentages during summer. Compared with summer samples, macroalgae collected in winter had higher energy value and slightly lower percentages of inorganic matter. The variation of algal groups and chemical composition may influence the availability of the food source for the majority of herbivores, which in turn is likely to effect their ecology and community structure.

Introduction

Knowledge of the chemical composition of marine macroalgae is both important for the assessment of nutritional value to marine invertebrate or vertebrate herbivores (Hawkins & Hartnoll, 1983), and for the evaluation of potential sources of protein, carbohydrate and lipid for commercial use (Chapman & Chapman, 1980) or for possible human consumption (Abbott, 1988). Seasonal variations in the chemical composition and nutritive value have been reported in common marine macroalgae from Hong Kong (Kaehler & Kennish, 1996), coastal India (Kumar, 1993) and Ireland (Mercer et al., 1993), but little is known of temporal variations in chemical composition of tropical Australian macroalgae.

Wynne and Luong-Van Thinh (1997) identified 76 species of chlorophytes, phaeophytes and rhodophytes collected from Darwin Harbour on the north coast of Australia, and 10 species were subsequently analysed for the proximate chemical composition (carbohydrate, lipid and protein (Renaud et al., 1997).

The aim of the present study was to compare the chemical composition, including ash, soluble carbohydrate, lipid and protein, of common inter-tidal tropical Australian marine macroalgae, in the dry winter season and wet summer season.

Materials and methods

Macroalgal collection

Triplicate samples of each of thirty species of marine macroalgae, including 7 chlorophytes, 8 phaeophytes and 15 rhodophytes were collected from the surface

Table 1. Chemical composition (ash content, soluble carbohydrate, total lipid, total protein) and calculated energy value, of tropical chlorophytes, collected from Darwin Harbour, Northern Territory, Australia (mean, $n = 3$). Coefficients of variation: ash ±2%; carbohydrate ±4%; lipid ±5%; protein ±4%.

		(% dry weight)				
	Code	Ash	Soluble CHO[1]	Lipid	Protein	Energy (kJ g^{-1})
Summer						
Anadyomene brownii (J.E. Gray) J. Agardh	CC9	24.4	25.8	6.2	9.0	8.8
Caulerpa racemosa (Forsskal) J. Agardh	CC8	42.2	16.6[S]	3.8	6.8	5.9
Halimeda macroloba Decaisne[2]	CC6	74.4[S]	4.7	2.3	6.6	3.2
H. opuntia (Linn.) Lamouroux[2]	CC5	86.0	2.7	2.3	3.2	2.1
Neomeris van-bosseae Howe[3]	CC18	55.4	15.2[S]	2.7	1.4	3.9[S]
Mean		*56.5*	*13.0*	*3.5*	*5.4*	*4.8*
Without calcified species:		33.3	21.2	5.0	7.9	7.4
Winter						
Caulerpa lentillifera J. Agardh	CC36	48.9	12.8	2.7	6.6	4.8
C. racemosa (Forsskal) J. Agardh	CC49	47.7[W]	14.7	4.4	6.9	5.8
Enteromorpha intestinales (Linn.) Link	CC42	49.5	18.7	1.8	3.2	4.6
*Halimeda macroloba*Decaisne[2]	CC51	64.4	2.7	2.5	4.6	2.5
H. opunta (Linn.) Lamouroux[2]	CC50	89.7[W]	2.5	2.9[W]	3.2	2.2[W]
Neomeris van -bosseae Howe[3]	CC28	57.8[W]	8.3	2.6	1.5	2.7
Mean		*55.7*	*10.0*	*2.8*	*4.3*	*3.8*
Without calcified species:		48.7	15.4	3.0	5.6	5.1
Overall mean:		58.2	11.3	3.1	4.8	4.2
Without calcified species:		42.5	17.7	3.8	6.5	6.0

[1]CHO = carbohydrate.
[2]Highly calcified species.
[3]Moderately calcified species.
W signifies significantly higher in winter season (ANOVA, $p < 0.05$).
S signifies significantly higher in summer season (ANOVA, $p < 0.05$).

rocks and coral reefs of the intertidal zone off Channel Island, East Point, Nightcliff Beach and Rapid Creek, in Darwin Harbour (12°26′S,130°51′E), Northern Territory, Australia. The study area has a monsoonal climate, with 97% of the annual average 1670 mm rain falling in the October–April summer season, when the winds are frequently from northerly directions. Very little rain falls during the May–September winter season, with predominantly south-easterly winds. Temperatures are high year round, with monthly means for Darwin ranging from 29.2 °C in November to 24.9 °C in July (Commonwealth Bureau of Meteorology, 1998).

There was a wide diversity of species in both seasons (summer 19 species, winter 20 species), but with a predominance of rhodophytes during the summer and phaeophytes during the winter tab (Tables 1, 2 and 3). Nine species were collected in both seasons, including the chlorophytes *Caulerpa racemosa*, *Halimeda macroloba*, *H. opunta* and *Neomeris van-bosseae*, phaeophytes *Dictyota ciliolata*, *Padina boryana* and *Rosenvingea nhatrangensis*, and rhodophytes *Acanthophora muscoides* and *Hypnea* sp.

Seaweed samples were collected into plastic bags, stored on ice and transported to the laboratory, where they were washed with distilled water to remove sand and surface debris, and holdfasts and epiphytes removed. Samples were then rinsed with 0.5 M ammonium formate, freeze-dried, ground and stored at −75 °C prior to chemical analysis.

Analytical methods

For each species, duplicate analyses were averaged for each of the triplicate samples for soluble carbohydrate, total protein, total lipid and total ash (inorganic matter). Soluble carbohydrates were determined by the colorimetric method of Dubois et al. (1956), after extraction with 0.5 M H_2SO_4. Total lipid was analysed gravimetrically after extraction with chloroform-methanol (2:1) by the method of Bligh and Dyer (1959). Total ash