Nutritional Quality of Non-calcified Macroalgae in Guadeloupe (Lesser Antilles), Evaluated by Their Biochemical Composition

Calidad Nutricional de las Macroalgas No Calcificadas en Guadeloupe (las Pequeñas Antillas), Evaluada por su Composición Bioquímica

Qualité Nutritionnelle des Macroalgues Non-calcifiées en Guadeloupe (Petites Antilles), Évaluée par leur Composition Biochimique

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EXTENDED ABSTRACT

Herbivorous fishes have been widely studied due to their major ecological role in controlling the macroalgae growth on coral reefs (Hughes et al. 2007). The diet of herbivores has been evaluated by different methods as direct observations, transplant experiments, stomach contents or stable isotopes analyses. Food preferences of herbivorous fishes have generally been explained by the morphology of the macroalgae (calcified or soft, filamentous or sheet-like), the presence or the absence of repellent molecules (terpenoids, acetogenins or polyphenolics) or the location of the study (lagoon, reef crest). Few studies have worked on the biochemical content of macroalgae to understand food preferences made by herbivorous fishes (Montgomery and Gerking 1980).

Biochemical composition of macroalgae has already been determined for edible algae. The proportions of macronutrients in macroalgae (proteins, lipids, soluble and insoluble carbohydrates) can be used to evaluate the nutritional quality of macroalgae. High concentrations of proteins, lipids and soluble carbohydrates generally indicate a high nutritional quality because these compounds are readily metabolically available for consumers and provide a large proportion of energy. On the contrary, insoluble carbohydrates are more difficult to digest. Indeed, their high concentration indicates a low nutritional quality. The proportion of ashes has also been measure. Due to the poor content in ash, high proportions of ash in a macroalgae indicate a low nutritional quality.

In the present study, different species and genus of non-calcified macroalgae were analyzed and grouped according to their biochemical composition and by consequence by their nutritional interests. Data from the literature on food preferences of herbivorous fishes (with direct observations or *in situ* experiments) were used to relate the link between food preferences and nutritional quality of macroalgae.

The study was conducted in Guadeloupe (Lesser Antilles), between 5 and 10 m deep in coral reefs and seagrass beds. Samples of macroalgae were hand collected in scuba diving or in free diving. For this study, nine species and seven genus of macroalgae were studied: *Acanthophora spicifera*, *Caulerpa cupressoides*, *C. racemosa*, *C. sertularioides*, *Dictyosphaeria cavernosa*, *Lobophora variegata*, *Sargassum* cf *hystrix*, *S.* cf *polyceratium*; *Turbinaria turbinata*, *Ceramium* sp., *Chondria* sp., *Dictyota* sp., *Hypnea* sp., *Laurencia* sp., *Padina* sp., *Ulva* sp.

For each sample, concentrations of macronutrients and ashes were measured. Concentrations of proteins were measured with the Folin phenol reagent (Lowry et al. 1951). Soluble and insoluble carbohydrates were determined by a modified version of the method of Dubois et al. (1956). Finally, lipids were extracted and measured following the method of Bligh and Dyer (1959). Ash content was obtained by burning samples at 500°C for five hours in a muffle furnace and reweighing after cooling. All concentrations were expressed in mg/g (and %) of dry matter. Concentrations in macronutrients were used in a hierarchical clustering analysis on principal components to group the different species according to their biochemical contents.

Concentrations of proteins, lipids, soluble and insoluble carbohydrates and ash were different according to the macroalgae species or genus (Kruskal-Wallis, all $p < 0.001$). With the clustering analysis, three groups of macroalgae were identified according to their biochemical characteristics (Figure 1).

The first group clusters *Ceramium* sp., *Ulva* sp. and *Lobophora variegata* due to their high concentrations of proteins and soluble carbohydrates, and low proportion of ashes. These species presented high nutritional qualities and, according to previous studies, are appreciated by herbivorous fishes. In different feeding assays experiments, these three macroalgae were widely consumed by herbivorous (Paul and Hay 1986). Indeed, there is a positive correlation between the nutritional quality of macroalgae and the food preferences of herbivores on coral reef for this first group of macroalgae.

A second group constituted by *Dictyota* sp., *Caulerpa cupressoides*, *C. sertularioides* and *Sargassum* cf *polyceratium* presented intermediate nutritional qualities due to higher concentrations of lipids and insoluble carbohydrates. Dictyotaceae and Caulerpaceae are often described as low preference species due to their amount of secondary metabolites (Lewis 1985, Paul and Hay 1986). The susceptibility of grazing of these species is discussed.

Finally, the others species and genus (*Padina* sp., *Caulerpa racemosa*, *Sargassum* cf *hystrix*, *Dictyosphaeria cavernosa*, *Turbinaria turbinata*, *Laurencia* sp., *Chondria* sp., *Hypnea* sp., *Acanthophora spicifera*) are characterized by a high proportion of ashes and consequently by a low nutritional quality. Some of these species as *Dictyosphaeria cavernosa* are avoided by herbivorous and in this case biochemical composition could be related to food preferences. However, some of these species (*Acanthophora spicifera*, *Padina* sp. or *Laurencia* sp.) are cited as preferred macroalgae for some herbivorous fishes. Indeed, the concentration sin macronutrients could not explain totally the food choices made by herbivorous (Mantyka and Bellwood 2007).

The present study indicates that the biochemical composition in macronutrients explains only partially the food choice made by fishes. The consumption of macroalgae by herbivores depends also on the presence of secondary metabolites and deterrent molecules, the composition in micronutrients (vitamins, trace elements), their morphology and their palatability that often decreased with increasing size.

KEYWORDS: Macroalgae, biochemical composition, nutritional quality, macronutrients

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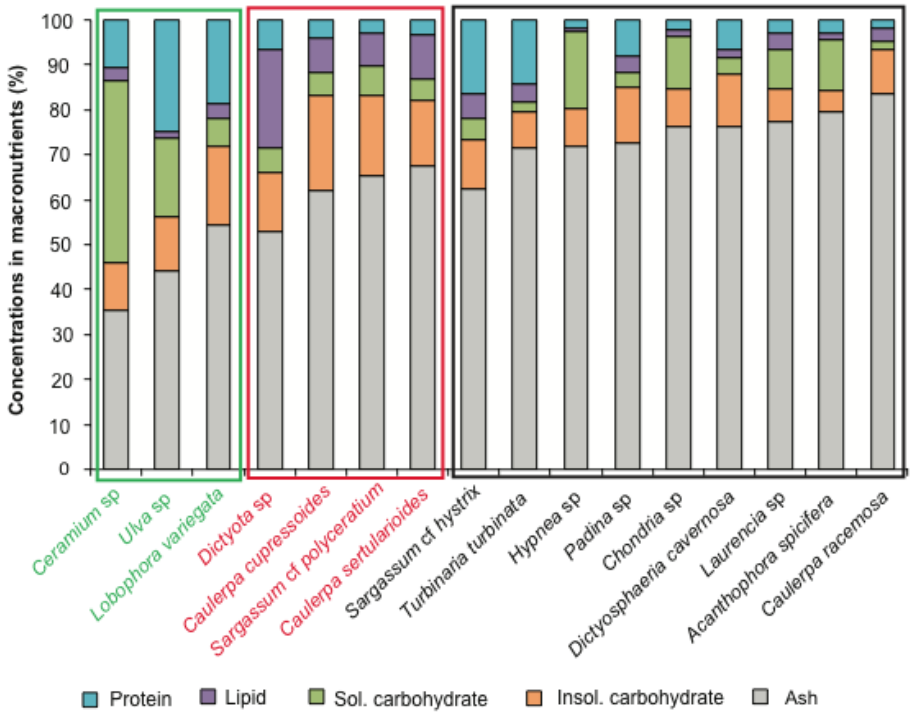

Figure 1. Proportions in macronutrients (% of dry weight) in macroalgae. Sol: soluble, Insol: insoluble. Colored squares indicate the three groups of macroalgae coming from the cluster analysis.