

11º Encontro de Químicos dos Alimentos

Qualidade dos alimentos:
novos desafios

Resumos

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11º Encontro de Química dos Alimentos

Qualidade dos Alimentos: novos desafios

Livro de Resumos

Sociedade Portuguesa de Química

Divisão de Química Alimentar

Instituto Politécnico de Bragança

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Azorean macroalgae as a food supplement: determination
of proteins, fiber, and total of lipids and carbohydrates
contentLisete Paiva^a, Elisabete Lima^{a,*}, José Baptista^a, Rita Patarra^b, Ana Isabel Neto^b^aCentro de Investigação e Tecnologias Agrárias dos Açores (CITA-A), Universidade dos Açores, Ponta Delgada, Portugal, ^bCentro Interdisciplinar de Investigação Marinha e Ambiental (CIIMAR), Porto, Portugal

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It is well known that algae frequently live in extreme environments of light, salinity, and temperature. In order to adapt to these extreme conditions, most algae produce a high variety of secondary metabolites that often have potent biological activities.

The archipelago of the Azores has a long tradition in the use of marine macroalgae, commonly referred to as "seaweeds", as fertilizers in local agriculture and/or horticulture and also as food supplement (*Fucus spiralis*, *Porphyra* sp., *Laurencia* sp. and *Osmundea* sp.) or for chemicals extraction (*Pterocladia capillacea* and *Gelidium* sp.). In addition to their value for human nutrition, seaweeds have multiple therapeutically applications (e.g. weight control, hypocholesterolemic, antioxidant and antitumor activities) and, in general, contribute and promote human health.

The chemical composition of macroalgae varies with species, habitats, maturity, climate and environmental factors. The objective of this study was to evaluate the chemical composition (proteins, fiber, total lipids and total carbohydrates) of the most common macroalgae at the Azorean shore S. Miguel Island: *Codium adhaerens* and *Chaetomorpha linum* (green algae); *Sargassum cymosum*, *Cystoseira humilis* and *Padina pavonica* (brown algae). The protein and the fiber were determined using the Kjeldahl method and the slightly modified Weende method, respectively. The protein content ranged from 2.86% to 18.48% of dry weight (DW) for *Padina pavonica* and *Codium adhaerens*, respectively, and fiber ranged from 31.02% to 69.10% of DW for *Codium adhaerens* and *Cystoseira humilis*, respectively. The total of lipids ranged from 1.55% to 5.20% of DW for *Cystoseira humilis* and *Codium adhaerens*, respectively, and the total of carbohydrates ranged from 7.61% to 16.78% of DW for *Padina pavonica* and *Codium adhaerens*, respectively.

In conclusion: Taking into account that the Archipelago of the Azores coastal water bodies are in excellent environmental conditions, according to the parameters of the Water Frame Directive, the present investigation shows that the selected seaweeds may be potentially profitable from the biotechnology and commercial perspectives, and also bring benefits to Public Health in general as potential ingredients of so-called functional or health-promoting foods.

Azorean macroalgae as a food supplement: determination of proteins, fiber, and total of lipids and carbohydrates content

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Key words: macroalgae; nutritional value; fiber; protein; total lipids and carbohydrates

ABSTRACT

This study evaluates the chemical composition (proteins, fiber, total lipids, total carbohydrates and ash) of selected macroalgae common at the Azorean shores with potential nutritional value for human food supplement. The protein content ranged from 2.86% to 18.48% of dry weight (DW) for *Padina pavonica* and *Codium adhaerens*, respectively and fiber ranged from 31.02% to 69.10% of DW for *Codium adhaerens* and *Cystoseira humilis*, respectively. The total of lipids ranged from 1.55% to 5.20% of DW for *Cystoseira humilis* and *Codium adhaerens*, respectively, and the total of carbohydrates ranged from 7.61% to 16.78% for *Padina pavonica* and *Codium adhaerens*, respectively.

1. INTRODUCTION

The ever increasing human population has kept the human community in constant search for new resources to meet the growing demand for food, medicine and energy. The marine ecosystem with its rich resources, particularly the macroalgae, appears to be a candidate as a natural resource for these needs. They are also one of nature's richest sources of vegetable protein and provide full spectrum of carotenes, chlorophyll, enzymes, amino acids and fiber in large quantities. Traditionally the Azorean population have gathered seaweeds either to eat (e.g., *Fucus spiralis*, *Porphyra* sp., *Laurencia* sp. and *Osmundea* sp.) or for agar extraction (e.g. *Pterocladia capillacea*) [1]. A recent study of the nutritional value of the seaweeds consumed in the Azores [2] revealed these organisms are a good source of protein and fiber. The objective of this study was to evaluate the chemical composition of the most common macroalgae on the Azorean shore of S. Miguel Island (green algae *Codium adhaerens* and *Chaetomorpha linum*; brown algae *Sargassum cymosum*, *Cystoseira humilis* and *Padina pavonica*), taking into account the low pollution level of sea water [3] and, consequently, the great potential of its use for human consumption and/or for the extraction of novel compounds with added value for the food and pharmaceutical industries.

2. MATERIALS AND METHODS

2.1. Macroalgae sampling and preparation

All macroalgae samples used in this study were collected during July and October of 2010 from the littoral zone of São Miguel Island, in the Azores Archipelago. The samples were first washed with salt water and then distilled water and partially dried with a paper towel. Then the samples were dried and stored in an air-tight container in a freezer (-20 °C) until further analysis. Previous to analytical procedures, macroalgae were defrosted and dried during 48 h at 65 °C and then were cut into small pieces and ground into a fine powder using a dry grinder or homogenized with liquid nitrogen, re-dried at 60 °C and stored in a desiccators.

2.2. Determination of total protein

The organic nitrogen content was quantified using a modified KJELDAHL procedure [4] in a VELP Scientifica UDK 132 apparatus. The digestion was performed with sulfuric acid (H₂SO₄) 96% for 75 min at 420 °C, plus 75 min at 370 °C, then distilled with acid boric solution (2%) and titrated with HCl 0.1 M. Estimation of the crude protein content was calculated multiplying the organic nitrogen by a factor of 6.25.

2.3. Determination of crude fiber

The fiber determination was performed using a modified Weende procedure [4] in a VELP Scientifica *Dosi-Fiber* apparatus. Acid hydrolysis was done with sulfuric acid (H₂SO₄) 0.125 M and the basic hydrolysis with potassium hydroxide (KOH) 0.223 M. The cold extraction was performed with acetone; the sample was then dried during 1h at 150 °C, until reach a constant weight, cooled in a desiccator and weighted (W₁), dried back in a muffle furnace at 550 °C for 3h and reweighted (W₂) after cooling in a desiccator. The crude fiber percentage was calculated following the equation: %crude fiber = 100 × (W₁-W₂)/W₀ (initial weight 1-1.5 g).

2.4. Determination of total carbohydrates content

The total carbohydrates content was assayed by the phenol-sulphuric acid colorimetric method described by Dubois et al. (1956) [5], after extraction with 2.5 N HCl. The results were calculated from a glucose standard curve based on the absorbance at 490 nm.

2.5. Determination of total lipids content

Total lipids was analysed gravimetrically after extraction with chloroform-methanol (2:1). The total lipids was determined by Soxhlet method as described by Folch et al. (1957) [6].

3. RESULTS AND DISCUSSION

Table 1 shows that the macroalgae crude protein content varied within the studied species being the highest in *Codium adhaerens* (18.48%) followed by *Sargassum cymosum* (12.29%). The lowest protein values were found in the *Padina pavonica* (2.86%). In general, the crude

protein content recorded for the studied seaweeds was similar to the one reported in other studies (e.g. [7-13].) Table 1 also shows that the macroalgae crude fiber content was high in all species. It was higher in *Cystoseira humilis* (69.06%) followed by *Chaetomorpha linum* (62.34%), *Sargassum cymosum* (58.56%), *Padina pavonica* (41.56%) and *Codium adhaerens* (31.02%). Table 1 also shows the carbohydrate and total lipids content of the referred macroalgae. Norzian et al. (2000) [14] reported lower fiber content, Ortiz et al. (2009) [15] registered higher content of carbohydrates and lower content of total lipids and ash, and Ratana and Chirapart (2006) [16] reported lower content of fiber and lipids as compared to the Azorean macroalgae. These results may reflect the influence of the species, geographical location, season and/or temperature and environmental conditions [17]. It is also known that different sampling methodologies and drying method could affect the nutritional value of seaweeds [18]. If properly dried, seaweed samples can be stored for a number of years without appreciable loss of their gel content. It is also well known that the yield of chemical extraction depends on the type of solvents with varying pH, polarities, extraction time and temperature, as well as on the chemical compositions of the sample [19].

Table 1. Macroalgae total carbohydrates, total lipids, total protein, total fiber and ash content.

Macroalgae	Chemical composition in % of dry weight (mean±SE, n=2)				
	Total Protein	Total Fiber	Ash	Total Carbohydrates	Total Lipids
<i>Codium adhaerens</i>	18.48±0.08	31.02±0.46	21.86±0.33	16.78±0.50	5.20±0.16
<i>Chaetomorpha linum</i>	7.00±0.04	62.34±0.21	16.8±0.24	13.35±0.40	5.06±0.15
<i>Padina pavonica</i>	2.86±0.08	41.56±0.04	45.06±0.67	7.61±0.23	3.38±0.10
<i>Cystoseira humilis</i>	7.04±0.08	69.10±0.23	14.35±0.22	7.73±0.23	1.55±0.05
<i>Sargassum cymosum</i>	12.29±0.24	58.56±0.09	15.39±0.23	15.80±0.47	2.56±0.08

4. CONCLUSION

This was the first study investigating the nutritional composition of the most common macroalgae on the Azorean shore of S. Miguel Island. It revealed important results for those and other species in what concerns protein, fiber, lipids and carbohydrates content. The level of digestibility of proteins seems to be related to the amount of soluble fiber in the algae, preventing bioavailability of the proteins [20]. Further work involving biotechnological treatment of the studied macroalgae by enzymatic degradation of algal fibers could improve protein digestibility and, therefore, will increase their nutritional value. The present investigation shows that, taking into account the low pollution level of the Azorean sea water, the selected macroalgae may be potentially profitable from the biotechnology and commercial perspectives with some impact on the economy of the Azores Islands.

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