

The protein value in human nutrition of edible marine algae in Japan

Teruko Fujiwara-Arasaki¹, Noriko Mino¹ & Mitsue Kuroda²

¹ *Kobe Yamate Women's College, Chuo-ku, Kobe, Japan*

² *Osaka Seikei Women's College, Higashiyodogawa-ku, Osaka, Japan*

Keywords: seaweed, protein, amino acid, digestibility, human nutrition

Introduction

The food values of marine algae are currently being reconsidered in the hope of coping with future food shortages. From the distant past, a long coastline and a rich and abundant variety of marine algae have allowed the Japanese to take full advantage of this source of food. In Japan more than one hundred species of marine algae have been used traditionally for foods. Even today, Japanese consume as much as 1.6 kg (dry weight) per capita annually of marine algae such as *Laminaria*, *Undaria*, *Eisenia*, *Hizikia*, *Analipus*, *Monostroma*, *Enteromorpha*, *Ulva*, *Porphyra*, *Meristotheca* and *Gelidium*. Among these, *Porphyra tenera*, *Laminaria japonica*, *Undaria pinnatifida* and *Monostroma* sp. have been artificially cultivated on an industrial scale in present Japan, and average annual yields are 2 200 t of *Monostroma*, 150 000 t of *Laminaria*, 50 000 t of *Undaria* and 130 000 t of *Porphyra*, plus 13 000 t of *Gelidium* and other agarophytes.

They have been found to be good sources of proteins, carbohydrates, vitamins and minerals in human nutrition. The marine algae contain various carbohydrates different from those in higher land plants, and in addition a fairly high protein content has been reported (Arasaki & Mino 1973). Carbohydrates of marine algae can not be digested by the human intestinal enzymes. For this reason they provide the human system with no calories. Moreover, these algae are low in fats. The edible marine algae, however, have more vitamins A (β -carotene), B₁, B₂, B₆, B₁₂, C and niacin, in addition to the very important minerals, calcium and iron, than vegetables and fruits. The algae may also contribute

to future healthful human life in such areas as weight reduction and in some medical applications (anti-lipemic, anti-blood-cholesterol, anti-tumor, etc.) in addition to their value in human nutrition.

The protein quality and its digestibility, however, have not been elucidated like those of higher plants. In this paper, we discuss the protein quality and digestibility of eight species of edible Japanese marine algae: *Codium fragile*, *Ulva pertusa*, *Eisenia bicyclis*, *Undaria pinnatifida*, *Laminaria japonica*, *Analipus japonicus*, *Grateloupia turuturu*, and *Porphyra tenera*.

Materials and methods

The fresh fronds were collected at the sea side in middle Japan and were washed with water, then frozen and stored at below -20 °C. The preparation of alkali-soluble protein was carried out in accordance with the previous report (Arasaki & Mino 1973) as follows: frozen fronds were pre-treated with acetone and ether-methanol (1:1 v/v) and then were extracted with 5% (w/v) NaOH. Proteins were precipitated by adding acid to pH = 4. After repeating three times, the purified protein was obtained in a faintly greenish white powder.

Amino acid analyses were performed according to the previous reports (Arasaki & Mino 1973; Fujiwara-Arasaki & Mino 1982). The hydrolyses were carried out with 5.7 N HCl at 105 °C-110 °C for 24 h, or with 4 M Ba(OH)₂ at 105 °C-110 °C for 60-70 h in vacuo. Amino acids were determined using an automatic amino acid analyzer.

In vitro digestion of the alkali-soluble proteins