Partial identification and nutritional analysis of Kiribati algae

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ABSTRACT
A chemical analysis of the edible algae from the island of Beru in Kiribati revealed it contained relatively high concentrations of Mg^{2+} and Ca^{2+} ions. A fair amount of protein and other minerals such as Na^{+}, K^{+}, Cu^{2+}, Mn^{2+}, Zn^{2+} and Fe^{2+} ions are also present in it. The scientific identification revealed that the algae are made of a mixture of different species, which are not an entirely new species just discovered. In fact, the two major types of algae that were identified (Lyngbya perelegans and Chroococcus minutus) are known to exist in Hawaii, some areas in Europe and parts of South East Asia.

1 INTRODUCTION

Marine algae, or seaweeds, are the oldest members of the plant kingdom, extending back many hundreds of millions of years. They have little tissue differentiation, no true vascular tissue, no roots, stems, or leaves, and no flowers. Algae range in size from microscopic individual cells to huge plants more than 40m long. Giant Kelp, *Macrocystis pyrifera*, and Bull Kelp, *Nereocystis luetkeana*, are the largest non-vascular plants known. Their blades are harvested for industrially valuable gels, called alginates. The multi-layered canopy of kelp fronds provides a complex aquatic habitat for thousands of fish and invertebrates (Garrison, 2002).

In Hawaii, the *Limu* genus is used for various food additives as condiments and variety. While it gives flavour and variety, it is also a valuable source of vitamins and minerals (Dring, 1992).

1.1 LEGEND ON THE DISCOVERY OF THE KIRIBATI ALGAE

It all began with the clan called *Te Manoku i Taboiaki (n tanrake)*. It was during the time of famine and there was very little food available. A lady by the name of *Nei Tebanikarawa* had a vision that the algae in the neighborhood pond (*te nei*) were edible. Initially she ignored the option that the dream could be real. But the recurrence of the dream made her one day to try it out while her husband was out on a fishing trip.

The procedure involving collection and preparation of the algae as food were outlined in the dream. After preparing and helping herself to this newly-discovered food source, she collected enough for her husband and stored it in huge clam shells. The husband on his return late that night was astonished to see the *'glaring red eyes'* of the red type (*Takarokaron-Mataia-Uea*), inside the clam shells. The local name when literally interpreted means *"The Glaring Eyes of the Gods"*. *Nei Tebanikarawa* related all that happened to her husband who also tasted the stored algae. Eventually, news spread out in the village of the existence of these edible algae. People in that village began collecting and using it as food. Dwellers living close to the pond were requested to move further away in an effort to minimize fouling of the surrounding. The locals named the entire algae in this pond as *"Te Bokaboka"* literally meaning mud. This is probably a name derived from the muddy nature of its habitat.

2 STUDY SITE

The algae studied in this research is from the island of Beru in Kiribati, which is located at Latitude 1.34°S, and Longitude 175.98°E. The population of the island in 1990 was 2200 from a total of 71012 for Kiribati (Anonymous, 1992) while the recent census in 2003 recorded it to be 2600 (Anonymous, 2003). The sampling site where the algae thrived is a saline pond at the southern tip of the island. Several physical parameters of the sampling site were measured during the collection of samples (see Table 1).

Table 1. Physical parameters of the sampling site.

Physical Parameters	*Water Column*	*Within Algae Layer*	*Seawater*
Salinity (psu)	66.4	65.3	36.3
Temperature (°C)	31.9	32.6	29.3
Conductivity (mS)	92.9	92.2	55.0
Dissolved Oxygen (mg/dm^3)	5.85	4.29	NM*
pH	5.82	5.76	8.59

*NM – not measured

3 METHOD

3.1 SAMPLING

The collection of samples was made possible with the use of a netting material (see Plates 1 & 2). Samples were stored in plastic bags in an esky and then frozen. Some specimens were preserved in 10% formalin for identification purposes.

3.2 ANALYSIS

3.2.1 ALGAE IDENTIFICATION

The species identification was done on the two types of algae that were collected. This identification process was carried out at the Institute for Marine Biosciences with the National Research Council of Canada. The formalin-preserved samples were used for this purpose. Morphology rather than ecological features was the basis used during identification.

Single sightings of different looking individuals were not included, especially as some were moribund and exhibited phenotypic variation according to the degree of deterioration.

3.2.1.1 Takarokaron-Mataia-Uea

This appears reddish in colour. It is found some 2-3m below the surface. *Lyngbya perelegans*, was dominant and present mostly as tangled empty sheaths or moribund filaments. Only a few trichomes were healthy enough to permit identification. This species is known to exist in places like Singapore and the atoll of Laysan in Hawaii. *Chroococcus minutus*, was co-dominant but with lesser biomass than *Lyngbya perelegans*. This species is known to exist in Europe but seem to be cosmopolitan, and exists also in some tropical locations.

Figure 1. *Takarokaron-Mataia-Uea*

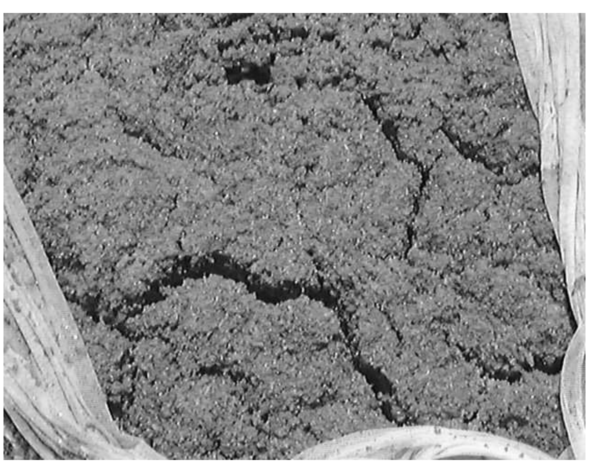

Figure 2. Makano

The less common to occasional found species included, *Chroococcidiopsis thermalis*, *Microcystis orissica*, *Coccochloris peniocystis* and *Tolypothrix limbata*.

3.2.1.2 Makano

This is the most common type of algae seen and is found floating at 1-1.5m below the surface. It has a greenish tincture. The dominant species is *Lyngbya perelegans* (as for *Takarokaron-Mataia-Uea*), but in better condition with many more recognizable trichomes and a considerable incidence of released hormogonia. The less abundant, occasional to locally common species is *Chroococcus minutus*. The species that are less common to occasional include *Chroococcidiopsis thermalis* and *Microcystis orissica* while *Tolypothrix limbata* is rare.

In addition there were a number of other species which were not observed in the former type. These included: *Lyngbya diguetii*, *Spirulina subtilissima*, *Chroococcus turgidus, Anacystis dimidiate*, *Gloeothece* sp. (*Coccochloris stagnina), Synechococcus* species 1 species 2.

3.2.2 CHEMICAL ANALYSIS

The chemical analysis was carried out at the Institute of Applied Sciences analytical laboratory at the University of the South Pacific in Fiji. Since the algae were being used as food by the islanders, only the relevant nutritional components were analyzed as indicated in Table 2. The analytical methods are based on the Association of Official Analytical Chemists method (Anonymous, 1998).

4 RESULTS AND DISCUSSION

4.1 ALGAE IDENTIFICATION

The two types of algae that were collected for identification purposes were distinctly different when considering the color of the fresh samples (see Figures 1 and 2). The two samples had the same basic composition, differing only in the relative amounts and condition of the dominant cyanobacteria and the occurrence of the minor eukaryotic components. Both appeared to be in a transitional stage, with the dominant filamentous cyanobacteria reduced mostly to empty sheaths. It is unknown whether the minor constituent species in better condition are progenitors of successive dominants or will remain rare to occasional. Sampling through time would be needed to determine what sort of annual succession, if any takes place.

4.1.1 PARTIAL IDENTIFICATION

It is evident from the identification process that the two samples consisted of a mixture of different species of algae. The two dominant species which were common in both samples were identified as *Lyngbya perelegans* and *Chroococcus minutus*. These species are known to exist in other parts of the world thus negating the claim by the islanders that the algae is unique to their island (Beru) and is found nowhere else in the world.

This is only a partial identification as many species which were cited once were not included in the listing. It was mainly the poor state in which these algae were in that prevented complete identification. According to the locals, there are six different types of algae present in the pond. Only two (*Takarokaron-mataia-Uea* and *Te Makano*) were studied in this work. The other four types are *Te Ota*, *Te Taribi*, *Te Taninganiba* and *Te Non*.

4.2 CHEMICAL ANALYSIS

Although two species were collected, only one was given for analysis as funding could cater for one set of analysis only. It was the reddish type (*Takarokaron-Mataia-Uea*) which was analyzed. The results of the chemical analyses on this *species* are tabulated in the following table (Table 2). A comparison is made with the data from two edible seaweeds in Fiji, the *Nama* and *Lumi*, which were also analyzed for the same parameters in the same laboratory (English *et al.* 1996).

Table 2. Chemical data from Kiribati algae *(Takarokaron-Mataia-Uea)* and two edible Fiji seaweeds.

Parameters	Unit	Kiribati algae	*Nama* seaweed	*Lumi* seaweed
Moisture	g/100g	91.8 ± 0.2	95.4	92.3
Protein	g/100g	1.5 ± 0.1	0.4	0.8
Fat	g/100g	0.27 ± 0.04	0.4	0.2
Dietary fibre	g/100g	3.7 ± 0.1	0.7	3.1
β-carotene	μg/100g	8.3 ± 0.1	1002	185
Sodium	mg/100g	613.3 ± 49.0	740	880
Potassium	mg/100g	104.2 ± 20.4	68	258
Calcium	mg/100g	424.0 ± 1.2	56	56
Magnesium	mg/100g	97.7 ± 4.7	58	45
Iron	mg/100g	0.9 ± 0.1	8.5	7.5
Zinc	mg/100g	0.7 ± 0.1	T	T
Copper	mg/100g	0.24 ± 0.03	0.4	0.5
Manganese	mg/100g	0.12 ± 0.01	0.4	0.8

T - Trace

It appeared from the above data that the Kiribati algae contained higher levels of Ca^{2+} and Mg^{2+} ions when compared with the two Fiji seaweeds; in fact this algae has almost eight times the concentration of calcium measured in the Fiji seaweeds. One possible explanation for the high content of calcium is the fact that the island is a coralline atoll with calcium carbonate deposits. Calcium plays an important role in the microstructure of bone. In addition to its role in bone growth and maintenance, calcium is also required in muscle contraction, nerve conduction, blood coagulation, cell membrane function and intracellular signaling (Cunningham and Saigo, 1999). To prevent osteoporosis in older people, an intake of calcium of 800 to 1500mg/day is recommended (Shephard, 1997). This would mean a consumption of 200-400g of Kiribati algae daily. Like calcium, magnesium is an integral part of the inorganic structure of bones and teeth. The recommended daily intake for Australian and British women is 270mg/day while for Australian men it is 320mg/day and 300mg/day for their British counterparts (Mann and Truswell, 1998).

The protein content of the Kiribati algae (1.5g/100g) is slightly higher than the average Fiji seaweeds content of 0.6g/100g. The other interesting features noted in this study were the conditions in which these algae thrive in. These were found to be very salty (66psu), acidic (pH 5.8) and somewhat higher temperature (32^{o}C) than normal (29^{o}C).

5 CONCLUSIONS

The Kiribati algae studied in this work showed elevated levels of calcium and magnesium ions; two important elements in the body particularly needed by the bones and for blood physiology. The two major species identified in the algae mixture are known to exist in Hawaii and parts of South East Asia and Europe. Further research is required to completely identify the rest of the species that make up the algae mixture.

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REFERENCES

1. Anonymous, 1992. *The Encyclopedia of the Third World*. 4th edn. New York. Facts on File.
2. Anonymous, 1998. *Official Methods of Analysis of AOAC*. 16th edn. Gaithersburg, Maryland, USA: AOAC International.
3. Anonymous, 2003. *The World Gazetteer*. [Web Page]. Accessed 2003. Available at: <http://www.world-gazetteer.com/d/d_kibe.html>.
4. Cunningham, W.P. and Saigo, B.W. 1999. *Environmental Science.* International edn. McGraw Hill.
5. Dring, M.J. 1992. *The biology of marine plants*. Cambridge University Press.
6. Emsley, J. 1991. *The Elements*. 2nd edn. UK: Oxford

University Press
7. English, R.M., Aalbersberg, W. and Scheelings, P. 1996. *Pacific Island Foods*. Fiji.
8. Garrison, T. 2002. *Oceanography: an invitation to marine science*. 4th edn, USA: Wadsworth/Thomson Learning.
9. Mann, J. and Truswell, A.S. 1998. *Essentials of human nutrition*. USA, Oxford University Press.
10. Shephard, R.J. 1997. *Aging, physical activity and health.* Champaign, ll. Human Kinetics.
11. Sherwood, L. 1997. *Human Physiology - From Cells to Systems*. 3rd edn. Belmont, Calif.: Wadsworth Publishing.