SEAWEED & KELP – the recycled resource

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INTRODUCTION

Seaweeds and kelp have been used for thousands of years by mankind to assist with the growing of food, as a direct food source and in housing and industry. Utilising modern technology, access to seaweed has improved together with a greater understanding of the ecology of the seas. The whole basis of the seaweed industry is no different to that of sustainably managing land-based crops - understand the capacity of the resource base and utilise it to the best long-term advantage by ensuring its use is targeted to the most appropriate application as determined by its particular qualities.

In conjunction with taking energy from the sun in the form of photosynthesis, kelps and seaweeds have always relied on and will continue to rely upon nutrient run-off from the landmass for their growth and provision of unique qualities. It is the ongoing return to the land of this complex plant nutrient in the form of seaweeds that makes for investigation into the future sustainability of marine derived materials and the benefits this recycled resource can provide to man and the global ecology.

As the demands on agricultural lands increases and production expectations become higher, so too is the importance of sensible utilisation of all possible nutrient inputs into the human food chain. This paper seeks to present the overall potential nutrient cycle of sea-based materials and then investigates the various benefits with a view to sustainable and practical applications in agriculture.

> *“Call us not weeds; we are flowers of the sea.”* (E.L. Avaline, *The Mother’s Fables*).

HISTORY

Nearly four fifths of the world’s surface is covered with oceans and seas. Over millions of years, various nutrients of the land have been washed into the seas of the world making them increasingly mineral rich. “Thus, it is apparent that the sea is an enormous receptacle of the former richness and balance that once supported life on earth” (Maynard, 2003:29). For eons, since before the first recording of history, man has sought nutrition from the seas – either directly or as a means of enhancing the soils in which crops are grown or to grow the crop itself. The predominant use of health giving kelp, seaweeds and fish were – and in some cases still are – based on cultures such as Japan, whereas many other parts of the world have gone through phases of utilising this remarkable resource. Seaweed’s usage was dependent on the availability of conventional food crops at various times together with the quality and production expectations of crops grown with the assistance of seaweeds and fish. On the islands of Orkney,

> “seaweed had long been gathered by Orcadians, dragged up from the beaches and spread across the fields as a fertiliser. This tradition was capitalised on by the island lairds who quickly saw that there were profits to be made gathering the seaweed and burning it to produce kelp. The ash produced was rich in potash and soda, substances that were eagerly sought after by the glass and soap industries.” Source: http://www.orkneyjar.com/tradition/kelpburning.htm

Historically the application of fish and seaweed was laborious, but with the better machinery and technology of more recent times, the task of application became easier and its function in the growing system much better understood as research progressed.

> *“Seaweed is the last large-scale natural resource unexploited by man”.*
> (W.A. Stephenson, (1974) *Seaweed in Agriculture & Horticulture).*

RESEARCHING & UNDERSTANDING THE NATURAL RESOURCE BASE

Various initiatives around the world are being taken in response to the environmental pressures either already applying to seaweed habitat or that which can be anticipated to occur as a result of population growth on coastal zones. As more is learned about the oceans' resources and the complex relationships contained in marine ecology around the world, local and broader programs, including research, are increasing to conserve and understand what is considered a very valuable asset to the world. As an example, in 1998, Seacare, http://www.seacare.org.au/ a non-profit community group was formed to benefit the marine environment in Tasmania, Australia. Under the National Heritage Trust of Australia Fisheries Action Program, surveys of coastal densities of giant string kelp *Macrocystis pyrifera* and trial plantings of areas where this kelp once grew were conducted. Other similar specific programs and initiatives undertaken include KelpWatch in Australia, Oceana Europe http://europe.oceana.org/ and Marine Bio http://marinebio.org/ across the globe. Governments individually and together are beginning to recognize the value of supporting research by establishing centres of learning. One such example of this is the Australian Institute of Marine Science http://www.aims.gov.au/ on the coast near Townsville in Queensland, Australia. It was "established by the Commonwealth government in 1972 to generate and transfer the knowledge needed for the sustainable use and protection of the marine environment through innovative, world-class scientific and technological research." Source: http://www.aims.gov.au/.

With mission statements such as -

> "We envision a world of healthy, protected oceans with wild and flourishing ecosystems, free of pollution, and filled with diverse and abundant marine wildlife. For centuries people have exploited the oceans with little thought to the future. Clearly, we can't afford to neglect them any longer. They provide much of the food we eat and the oxygen we breathe, and they are home to 97 percent of all living matter. Our very existence depends upon healthy oceans."

from the Ocean Conservancy Website http://www.oceanconservancy.org , humanity can be assured that a global view is taken for future marine management. Just as the air is common to the terrestrial forests and plants of the world, so too are the waters of oceans and seas the common medium for seaweeds and kelp.

Other science based organizations promoting and sharing the understanding of seaweeds include, amongst others, the British Phycological Society and the International Phycological Society which

> " was founded in 1960 and is dedicated to: the development of phycology; the distribution of phycological information; and, international cooperation among phycologists and phycological organisations. The Society publishes the Journal *Phycologia* and organizes the International Phycological Congresses at 4-yearly intervals." Source: http://www.intphycsoc.org/default.lasso

with the 8th International Phycological Congress, held in Durban, South Africa in August, 2005.

GLOBAL PRODUCTION & APPLICATIONS

The top ten producing countries contribute 96% of the world's commercial seaweed volume of over two million tons. About 50% of world production is cultivated. The seven top seaweed farming countries produce 99% of the volume. East Asia and Western Europe predominate.

Total metric tons/yr of seaweed production (cultivated + wild)					Total metric tons/yr of seaweed (cultivated only)			
Rank	Country	Total mt/yr	% total	% cumulated	Country	Total mt/yr	% total	% cumulated
	World	2,165,675	100	n/a	World	1,100,199	100	n/a
1	China	698,529	32	32	China	675,229	61	61
2	France	616,762	28	60	Japan	107,360	10	71
3	U K	205,500	9	70	Philippines	90,912	8	79
4	Japan	123,074	6	76	Korea, N	70,045	6	85
5	Chile	109,308	5	81	Korea, S	65,740	6	91
6	Philippines	95,912	4	85	Indonesia	46,894	4	96
7	Korea, N	71,435	3	88	Chile	34,218	3	99
8	Korea, S	67,050	3	92	Tanzania	5,000	0	100
9	Indonesia	46,894	2	94	Malaysia	4,001	0	100
10	Norway	40,632	2	96	Kiribati	496	0	100
11	USA	15,143	1	96	Thailand	200	0	100
12	Canada	12,702	1	97	Fiji	100	0	100
13	Ireland	10,614	0	97	Canada	n/a	n/a	n/a
14	Mexico	10,405	0	98	India	n/a	n/a	n/a
15	Morocco	6,950	0	98	Madagascar	n/a	n/a	n/a
16	Russia	5,000	0	98				
17	Tanzania	5,000	0	99				
18	Iceland	4,400	0	99				
19	Australia	4,020	0	99				
20	Malaysia	4,001	0	99				
21	India	3,003	0	99				
22	Argentina	2,321	0	99				
23	Portugal	1,302	0	99				
24	S. Africa	1,278	0	100				
25	Spain	1,266	0	100				
26	Namibia	835	0	100				

27	Madagascar	800	0	100
28	Kiribati	496	0	100
29	Vietnam	400	0	100
30	Thailand	200	0	100
31	Peru	194	0	100
32	Denmark	100	0	100
33	Fiji	100	0	100
34	N. Zealand	50	0	100

Reliable statistics concerning commercial seaplant harvests are difficult to obtain since virtually no official entities make accurate data available for public use. Additions and modifications are made to SuriaLink's statistical databases as new information comes from various sources including publications and personal communications from SuriaLink users. We do our best to make sure that we present information that is accurate and correct but we cannot guarantee said accuracy and correctness.

A useful print reference for world seaweed production statistics that was a helpful starting point for us is **Zemke-White, W. L. & M. Ohno, 1999. World seaweed utilisation: an end-of-century summary. Journal of Applied Phycology 11: pp. 369-376.** Please note however that in no way are these authors responsible for any errors or omissions that appear in SuriaLink's statistical summaries." Source: http://www.surialink.com/gis/stats_prod.asp accessed 17th May 2005

Marine algae production covers many levels of processing and numerous applications. Various components are extracted from seaweeds for their unique qualities to enhance cosmetics, pharmaceuticals, foods and industrial processes such as textiles and metal fabrication. The main constituents sought for industry are agar, carrageenans and alginates for their gelling, thickening and emulsifying properties. Globally the need for organic iodine for good health is being addressed by various processes involving kelp, let alone its usefulness as a food in the human diet. In China,

> "there are about 450 million Chinese living in iodine-absent regions. Usually there are two ways to enrich iodine, one is to take iodized salt, and the other is to take iodine oil pills. However, research shown that some 76 percent of iodine in salt was lost during the process of production, transportation and cooking, while taking iodine-oil pills may give rise to iodine- poisoning. By comparison, iodine obtained from kelp will not easily dissipate even after being heated for two hours, and it is more likely to be absorbed than inorganic iodine. "

(Source: http://english.people.com.cn/english/200102/28/eng20010228_63637.html)

When it is understood that kelps are a diverse organism able to grow at rates faster than any terrestrial plants, and draw their complex nutrient requirements from a cocktail of readily available nutrients surrounding its huge surface area, then it comes as no surprise that its makeup is also very complex. By scientific analyses, kelps are shown to be composed of 60 or more elements, numerous vitamins and amino acids and various forms of alginates. Some of the claims made of kelp can be summarised by the following:

> "Kelp is especially high in iodine, which must be present for proper glandular function. By regulating the thyroid, Kelp helps stimulate and balance the metabolism. The large amounts of iodine found in Kelp are important in the treatment of an under-active thyroid. Consequently, Kelp may contribute to weight loss if the weight gain is directly related to thyroid disorders. Containing algin, a fiber that absorbs toxins and nutrients from the digestive system, Kelp helps improve digestion, stimulate kidney function, increase circulation, and purify the blood. Kelp has also been known to treat inflamed joints and tissues caused by arthritis & rheumatism. Furthermore, Kelp enhances the immune system and eliminates the negative effects that stress may have on the body. It can help absorb and remove drugs, chemicals, heavy metals, and radioactive strontium 90 from the body. It can also help to normalize overly low blood pressure. Known topical uses for this herb include its use as a compress or oil for arthritic joints, as a bath herb for cellulite & weight loss and as a lotion for its skin-softening qualities.
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> Kelp is especially high in iodine, which must be present for proper glandular function and metabolism. It also contains iron, sodium, phosphorus and calcium, as well as magnesium and potassium. Kelp is a source of vitamins A, B1, B2, C, D and E, plus amino acids. Kelp also makes a popular salt substitute. Because the plant's nutrients come in a natural form, they are easily assimilated by the body. The electrolytic magnetic action of kelp releases excess body fluids from congested cells and dissolves fatty wastes through the skin, replacing them with depleted minerals, particularly potassium and iodine. As iodine boosts thyroid activity, food fuels are used before they can turn into fatty deposits.
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> Kelp slowly releases nutrients, up to two years Kelp improves soil texture, promotes natural flora and worms. Kelp contains large quantities of the natural growth hormones auxins, gibberellin and cytokinin. Kelp promotes faster growth and germination. Kelp promotes the general health of the plant, including drought and frost resistance. Kelp is non-toxic and is an excellent tonic for plants. Kelp is a natural and safe replacement for chemical fertilizers. Kelp will not harm pets or children.
>
> Kelp will promote stronger stem and leaf growth. Kelp contains Mannitol, which enables plants to better absorb nutrients from the soil. Kelp stimulates beneficial soil bacteria that fix nitrogen and make it available to the plant. Kelp is free of foreign seeds and contamination. Kelp greatly reduces the need for additional fertilizers...up to 90% less. Kelp has algin, which will retain moisture and cut irrigation 20-80%, depending on soil texture. Kelp studies at the Universities of Maryland and Clemson show an increase in plant resistance to fungi, molds, aphids, flea beetles, spider mites, and scabs. Kelp grown fruits and vegetables have a longer shelf life. Kelp adds humus to the soil.
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> Kelp has natural organic antibiotics, bromophenol, tanning, phloroglucinol, and terpenoid, which fend off bacteria and viruses and repel some insects in the garden. Kelp improves soil fertility as nutrients and hormones are directly available to the plant."

Source: http://english.people.com.cn/english/200102/28/eng20010228_63637.html

The message here is that folklore or not, attention should be paid to the qualities exhibited by this natural resource and its application to the human need. It is folly to believe that mankind is able to synthesise products to perform the same task and not pay a penalty by way of environmental contamination or the inextricable introduction of toxins in the food chain. Kelp has the unique ability to supply many benefits without the risk of adulterating the environment or the food chain.

MARICULTURE/AQUACULTURE

As with all food supply through the ages, man has needed to culture it as the reliability of wild harvest supply has declined due to pressures from an increasingly demanding human population. As can be seen from the above table on seaweed production by country, the Asian countries are the main growers of seaweed with about 1 million tonnes grown annually.

> "Mariculture in China has grown dramatically since the later 1970s. In 2000, the total mariculture production of China was 10.6 million MT. Among them, production of both bivalves and macroalgae, mostly cultivated in coastal zone by the suspension culture method, consisted of 82% and 11% respectively. As we know, the growth and reproduction of bivalves rely mainly on the supply of microalgae and detritus, but the growth and reproduction of macroalgae, microalgae and seaweeds depend mostly on the supply of inorganic nutrients coming from their living water body. Any variation in phytoplankton, the basic food chain element in marine ecosystems, will influence not only the growth and reproduction of bivalves directly, but will also cause changes in the whole marine ecosystem in the coastal zone by restraining the secondary production and then influencing the fisheries resources. Similarly, if the supply of inorganic nutrient is limited in the mariculture region, competition for inorganic nutrients will take place between phytoplankton and macroalgae. In addition to that described above, great attention should be paid to the study of the impacts of mariculture on the coastal zone environment. All aquaculture, however, is based on an underlying requirement for a clean environment for two very practical reasons. First, since the final marketed product is for human consumption, the product must meet high quality standards . Second, as in any husbandry operation, production is highest when environmental stresses are minimized. To some extent, then, environmental degradation due to mariculture is directly related both to human health and to the water quality of coastal zone. Therefore, some projects have been launched by the Chinese government to investigate the impact of mariculture on ecosystems and the environment. Summarizing the projects, some research results are showed as following:

1. **effects of intensive macroalgae mariculture on ecosystem and environment**
   Macroalgae such as kelp Laminaria japonica, porphyra spp. etc., are important economic species cultivated in the coastal zone of China. In 2000, the total macroalgae mariculture yield of China was more than 1 million MT. Studies results showed that 1MT Kelp in dry weight would absorb about 10-15kg N from seawater. Such quantities of N can produce 100-150 kg POC. If the mariculture sites are N deficient, the intensive macroalgae culture will certainly reduce the primary production. Therefore, intensive macroalgae mariculture on a large scale will influence the stabilization of coastal ecosystem by depleting the nutrients. In addition, the decay of kelp will occur during the summer season if they cannot be harvested in time. The detritus dropped from the decayed front part of kelp can make the seawater so mucous that it will be harmful to the hatcheries, or may be cause bloom of some species of harmful macroalgae in the mariculture sites. "

FUTURE SEAWEED UTILISATION

Welcome

The International Seaweed Association (ISA) welcomes you to its web site. The ISA is an international organisation dedicated to the encouragement of research and development of seaweed and seaweed products.

One of the main activities of the ISA is the organisation of a 3-yearly International Seaweed Symposium of which 17 have now taken place all over the world, the most recent, the XVIIIth in Bergen, Norway in June 2004. The Proceedings of these Symposia are published on behalf of the ISA by Oxford University Press.

The ISA operates according to a Code which is regularly reviewed by an Executive Council appointed at each Symposium.

http://www.isaseaweed.org/

CONCLUSION

It has been claimed that kelps can cure many ailments from arthritic symptoms in humans and animals through to improved fungal resistance in plants. Some of these claims can be supported in science, but many are considered folklore. Suffice to say, it is not in the purpose of this paper to make or perpetuate any claims. It is to simply raise the notion that our scientifically supported understanding of seaweeds in their contribution to the ecology and how they can assist mankind in reducing chemical inputs into the environment is in its infancy.

The challenge for us is to responsibly exploit the marine resource base to its capacity without affecting the sustainable element of the ecology that has so resiliently survived the ages. The oceans really are the last frontier on earth, and given that it is claimed that more is known about Mars than Earth's marine environment, will we be clever enough and learn from the past by applying the 'precautionary principle' before the seas are plundered and polluted beyond their ability to restore to a surviving equilibrium?

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