Nutritional Analysis of Kelp – September/October 2003

Aim: To determine the key nutritional composition of kelp (*Macrocystis* sp.) and determine what claims can be made.

Methods:
Sample was ground and analysed as provided. The following analyses were conducted:

- Moisture: Oven method.
- Ash: Muffle furnace method.
- Protein: Total nitrogen was measured by instrumental combustion method. Protein levels were determined by multiplication of total nitrogen levels by the conversion factor (6.25).
- Fat: Folch method
- Available carbohydrate: by difference
- Sugars: HPLC method
- Dietary fibre: Proskey method
- Energy: Calculated using the following conversion factors - carbohydrate (excluding unavailable) 17 kJ/g; unavailable carbohydrate (including dietary fibre) 8 kJ/g; fat 37 kJ/g; protein 17 kJ/g.
- Fatty acids: Gas chromatography as methyl esters
- Elements: Samples digested with acid, followed by analysis with ICP-MS & ICPOES.

Results:
Proximates
The proximate values for the dried kelp are given in Table 1. This data is similar to what has been previously reported for kelp, although because the moisture content is lower the values for protein are slightly higher. However, the dietary fibre value is significantly higher that what has previously been noted (29% compared to 6-15%). This difference could reflect methodological differences or be the nature of the sample. Energy is 677 kJ/100 g (this equals 162 Cal).

Table 1: Proximate composition of dried kelp.

Component	Amount (g/100 g)
Moisture	7
Ash	39.4
Protein	12.7
Fat	1.4
Available carbohydrate	10.1
Sugars	Below detection limits
Dietary fibre (total)	29.4

Elements
Results for the elemental composition of kelp are given in Table 2, note some values are reported in mg and some in µg. Although many elements seem high on a per 100 g basis it is important to consider the amount of the food actually consumed. Apart from iodine no other elements make major contributions to recommended dietary intakes (RDIs) of the elements. It should be noted that the levels of elements may vary a little between different batches of kelp.
The RDI for iodine is 150 µg for males and 120 µg for females. Only 0.05-0.06 g of kelp would be required to achieve this RDI. In humans iodine is needed for production of thyroid hormones, which are important in controlling the body's

metabolism. Iodine impacts on cell respiration, metabolism of energy and nutrients, functioning of nerves and muscles, differentiation of the foetus, growth and repair of tissues, and the condition of skin, hair, teeth and nails. Because the level of iodine in kelp is so high an important consideration is toxicity. Daily intakes of 2 mg should be regarded at excessive or potentially harmful (Wolff 1969) and the general recommendation is not to exceed 1 mg per day (equivalent to 0.4 g of the dried kelp). Such intakes are unlikely to be achieved in a normal diet except where they are very high in fish and seaweed. Data from Great Britain indicated that the average kelp-based supplement contained 1mg of iodine. Supplements contain a variety of levels with many from US appearing to be formulated to the RDI (150 µg). Only a few appear to report the actual level of dry kelp included and is in the range 150-500 mg. Excess iodine intake can cause problems similar to deficiency with enlargement of the thyroid gland. Iodised salt has iodine added in the range 25-65 mg/kg. Thus, a dash (0.4 g) of iodised salt would deliver 10-26 µg iodine. This is less than a 10% kelp/salt combination. Only 2.5% kelp would be required to be added to achieve a similar iodine intake. The bioavailability of pure mineral iodine (as would be used to add to salt) is 80-95% (Aquaron et al. 2002). The bioavailability of iodine from some seaweeds has also been investigated and found to be 61-101% (Aquaron et al. 2002). So taking average values they are very comparable.

Conclusion: The best option is probably to go for an intermediate kelp content for the salt, i.e. 5% kelp.

Arsenic is quite high in kelp, but this is normal for seaweed and other seafoods. The form in which the arsenic is in an organic form, which is non-toxic. It is the inorganic form that is very toxic. A provisional maximum tolerable daily intake of 2 µg/kg body weight for inorganic arsenic has been set by WHO/FAO Joint Committee on Food Additives. The US FDA have assumed 10% of the arsenic in kelp is inorganic. Based on this figure then 11.7 g of kelp would have to be consumed to reach the maximum tolerable daily intake (assuming a 70 kg person). This is much higher than the amount of kelp suggested to consume above, thus it should not be an issue.

Table 2: Elemental composition.

Element	Result (amount/100 g)	Kelp - content per serve[a]	% contribution to RDI[b]	10% Kelp salt - content per serve[c]	% contribution to RDI
Aluminum	21 mg	84 µg	-	8.4 µg	-
Antimony	2.1 µg	T[d]	-	-	-
Arsenic	12 mg	48 µg	-	4.8 µg	-
Barium	620 µg	2.5 µg	-	T	-
Beryllium	<2 µg	-	-	-	-
Bismuth	<10 µg	-	-	-	-
Boron	11 mg	44 µg	-	4.4 µg	-
Cadmium	190 µg	0.8 µg	-	T	-
Caesium	6.3 µg	T	-	-	-
Calcium	1000 mg	4 mg	<1	486 µg	<1
Chromium	88 µg	0.4 µg	-	T	-
Cobalt	24 µg	0.1 µg	-	T	-
Copper	130 µg	0.5 µg	-	T	-
Iodine	260 mg	1 mg	667-833	100 µg	67-83
Iron	17 mg	68 µg	0.4-1.4	8.1 µg	<1
Lead	30 µg	0.1 µg	-	T	-
Lithium	68 µg	0.3 µg	-	T	-
Magnesium	610 mg	2.4 mg	<1	244 µg	<1
Manganese	640 µg	2.5 µg	-	0.3 µg	-

Mercury	2.1 µg	T	-	-	-
Molybdenum	44 µg	0.2 µg	-	T	-
Nickel	70 µg	0.3 µg	-	T	-
Phosphorus	390 mg	1.6 mg	<1	160 µg	
Potassium	13000 mg	52 mg	2.7	5.2 mg	<1
Rubidium	4.2 mg	17 µg	-	1.7 µg	-
Selenium	53 µg	0.2 µg	<1	T	<1
Silver	<5 µg	-	-	-	-
Sodium	3700 mg	15 mg	0.7-1.6	141 mg	6-15
Strontium	56 mg	0.22 mg	-	22 µg	-
Sulphur	1100 mg	4.4 mg	-	440 µg	-
Thallium	<1 µg	-	-	-	-
Tin	4.0 µg	T	-	-	-
Uranium	28 µg	0.1 µg	-	-	-
Vanadium	200 µg	0.8 µg	-	T	-
Zinc	3.1 mg	12.4 µg	<1	1.2 µg	<1

[a] based on serve being a dash (0.4 g), as used for salt in the USDA Nutrient Database

[b] where no % is given no RDI has been set.

[c] based on 10% kelp salt and a serve being a dash (0.4 g total, 0.04g kelp) and salt data from USDA Nutrient Database (only elements reported)

[d] T = trace, <0.1 µg

Nutrient Information Panel (NIP)

An example of a possible NIP for kelp is given below (Table 3). Claim that could be made: Kelp is an excellent source of iodine (one serve exceeds 100% of the RDI of iodine). I have not put dietary fibre on the NIP. Voluntary declaration of Dietary Fibre requires that recommended per serve amounts are meet, and as the serving size is so small for kelp powder I would suggest no claim be made. Basically kelp is not a good dietary source of DF, and could be misleading.

Table 3: Possible NIP for dried kelp.

NUTRIENT INFORMATION Servings per package: ? (insert number of servings) Serving size: 0.4 g		
	Average Quantity per Serving	Average Quantity per 100 g
Energy	Less than 40 kJ	677 kJ (Cal)
Protein	Less than 1 g	13 g
Fat, total	Less than 1 g	1.4 g
- saturated	Less than 1 g	Less than 1 g
Carbohydrate	Less than 1 g	10.1 g
- sugars	Less than 1 g	Less than 1 g
Sodium	16 mg	3700 mg
Iodine	1 mg	260 mg

For 5% kelp salt (where ingredients only sea salt and kelp) a possible NIP may be something like given in Table 4. One serve of 5% kelp salt would meet 35-43% RDI of iodine.

Table 4: Possible NIP for 5% kelp salt.

NUTRIENT INFORMATION Servings per package: ? (insert number of servings) Serving size: 0.4 g (=0.02 g kelp)		
	Average Quantity per Serving	Average Quantity per 100 g
Energy	Less than 40 kJ	Less than 40 kJ
Protein	Less than 1 g	Less than 1 g
Fat, total	Less than 1 g	Less than 1 g
- saturated	Less than 1 g	Less than 1 g
Carbohydrate	Less than 1 g	Less than 1 g
- sugars	Less than 1 g	Less than 1 g
Sodium	148 mg	37005 mg
Iodine	52 µg	13000 µg

May also want to consider some warning notes:

- Excessive consumption of this product is not advisable. Or Do not exceed the recommended daily consumption.
- Warning people with an allergy to iodine should not consume this product.
- People with thyroid disease should check with a doctor before taking supplements that contain kelp.

References:

Aquaron, R.; Delange, F.; Marchal, P.; Lognone, V.; Ninane, L. 2002: Bioavailability of seaweed iodine in human beings. *Cell Mol Biol 48(5)*: 563-569.

Wolff, J. 1969: Iodide goitre and the pharmacological effects of excess iodide. *American Journal of Medicine 47*: 101-124.