Scientific Review Paper:
Seaweed as a source of iodine

Abstract

Iodine is an essential micronutrient required for thyroid function, which impacts on numerous developments in the body.

Globally, Iodine Deficiency Disorder is one of the biggest public health issues. Iodine deficiency is prevalent in the UK, ranking seventh among the ten most iodine-deficient nations in the world[i].

With limited iodine from land plants, the main food contributors of iodine in the UK are seafood, dairy and seaweeds.

This white paper highlights how seaweeds - of the right species, with appropriate sustainability, safety and quality assurances - is a good and natural solution to addressing iodine deficiency disorders.

Seaweeds, in a dried and milled form, are straightforward to include in food, beverage and nutritional supplement products, with multiple benefits beyond iodine alone.

Introduction to Iodine

Iodine is an essential trace mineral and a key component of thyroid hormones – giving it an important role in healthy growth, development and metabolism. It's a particularly important nutrient during pregnancy, due to its critical role in foetal neurological development. It is imperative for women who are hoping to conceive to ensure they're including enough iodine in their diet, due to foetal neurological development commencing in very early pregnancy[ii]. This widely undervalued nutrient remains essential throughout life, having a major role in thyroid health, cognitive function and the nervous system. As the body does not make iodine, it is an essential part of the diet[iii].

There is limited iodine in topsoil, especially where there is regularly leaching from rain and flooding, and where intensive agriculture has not replenished iodine. This leads to few land plants with iodine content, and the iodine availability in land plants being geographically limited[iv].

Iodine Deficiency

Iodine Deficiency Disorder (IDD) issues are one of the biggest worldwide public health problems of today. Their effect is hidden and profoundly affects the quality of human life.

Whilst coastal locations are richer in marine-derived iodine, and seaweeds and seafood can be excellent sources, living on the coast does not guarantee iodine sufficiency. Significant pockets of iodine deficiency have been reported from coastal regions in different parts of the world.

Despite iodine deficiency being the most preventable cause of intellectual disability, around 1.9 billion people worldwide remain deficient in the mineral[v] – this corresponds to 31% of the world's population. Deficiency does not only prevail only in developing countries, but remains a major public health challenge within developed countries too. In fact, the UK ranks seventh among the ten most iodine-deficient nations in the world[vi]. Furthermore, in 2021 the Iodine Global Network reported (from an EU funded study) that Europe is now an iodine deficient continent[vii].

The total number of older adults at risk for development of hypothyroidism, which can be caused through iodine deficiency, steadily increases with age. It has been estimated that there were almost a quarter million individuals with hypothyroidism resulting from treatment of Grave's disease in the United States alone in 1980, with a considerably larger number at risk[viii]. Hypothyroidism is invariably listed as one of the causes of potentially reversible dementia in older adults[ix]. Hypothyroidism may lead to irreversible mental deficiency in the newborn, and early treatment can prevent this outcome[x,xi].

Four groups that may be at risk of low iodine status in the UK include:

1. Teenage girls - Mean iodine intakes of girls aged 11-18 years are not meeting the RNI[xii], meaning that this group may be at risk of low iodine status. It is critical for women of childbearing age to have sufficient iodine intakes, as inadequate iodine intake during pregnancy can impair fetal development.
2. Dairy avoiders - Reducing and removing dairy products from the diet is a growing trend in the UK. Individuals that have lower urinary iodine concentrations are also low dairy consumers[xiii].
3. Veganism and plant-based eating - the exclusion of dairy products and fish from diets, seriously increases the risk of inadequate iodine status[xiv]. A study showed that a group following a plant-based diet had a median UIE of 20.1 µg/L; which, according to WHO criteria, is indicative of severe iodine deficiency[xv].
4. Sufferers of milk allergy, lactose intolerance, fish allergy or ethnic minority groups that do not consume milk and milk products may also be at risk[xvi].

According to WHO, the recommended dietary allowance of iodine is 50µg/day from 0 to 6 months, 90µg/day from 6 months to 6 years, 120µg/day from 7 to 10 years, 150µg/day during adolescence and adulthood, and 200–300µg/day during pregnancy and lactation[xvii].

The UK Reference Nutrient Intake (RNI) for iodine is 140µg per day for adults (including pregnant and lactating women), and between 50µg and 140µg per day for children, depending on their age. The advice from the Committee on the Medical Aspects of Food Policy (COMA) that pregnant and lactating women do not need increased intakes of iodine compared to normal adults was based on the assumption that women entered pregnancy with adequate thyroid status and iodine stores. However, dietary intake data from the National Diet and Nutrition Survey (NDNS) indicate that approximately a fifth of non-pregnant girls aged 11-18 years in the general population are at risk of low iodine intakes[xii].

The best sources of iodine can be found in seaweeds, seafood, and some amounts in milk, eggs and fortified foods - but not all iodine sources are made equal.

Seaweed as a safe, natural and plant-based source

The use of iodised salt in the food industry is compulsory in 18 out of 43 countries in the WHO European Region[xviii]. In the US, iodised salt and seafood are the major dietary sources of iodine. The UK has no current salt iodisation programme.

The iodine used for iodised salt is an artificial source of iodine, which whilst effective to a certain extent, has been shown to be less desirable as compared to natural sources of iodine.

Seaweed is known to be a particularly good natural source of iodine. However, it is important to recognise that with around 10,000 species of seaweed globally, there is much diversity, and different seaweeds have vastly differing levels of iodine. Therefore, the seaweed species should be understood, as well as the source and processing of any seaweed product you may use. This level of knowledge should extend also to general quality and nutrition of all seaweed ingredients and products, and should be properly reported by suppliers and finished products where appropriate.

The differences in naturally occurring iodine and artificial iodine used in some supplements and in iodised salt can be profound. A study published in the British Journal of Nutrition[xix] demonstrated that iodine intake from an artificial source of potassium iodide was highly bioavailable, but quickly excreted, whereas the iodine intake from seaweed was slower to release, with excretion over a longer period. This indicates that iodine from seaweed may be a more effective source of iodine to give a more controlled and consistent release to the body as compared to artificial sources, which may shock the system with high levels of iodine and then be excreted within hours.

Figure 1. Urinary iodine excretion comparison between sources of iodine: potassium iodide (red line) and Hebridean Ascophyllum Seaweed (used for PureSea®) (green line)

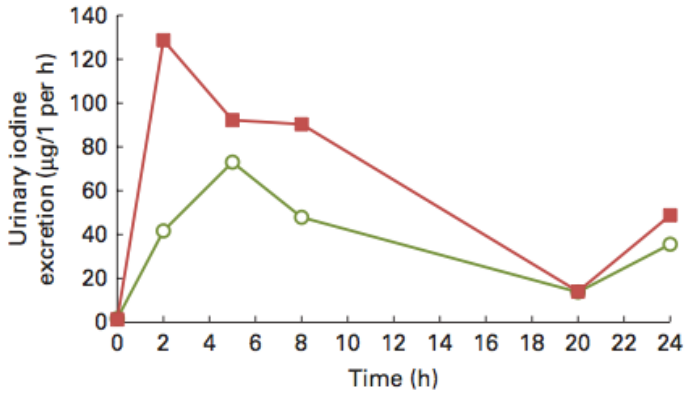


Figure 1 displays the urinary iodine excretion over 24hrs from this study. The women in the study had the same intake of iodine - either as potassium iodide (red line), or the PureSea® seaweed species (green line) and it is clear that the excretion was lower with the seaweed meaning that more was retained in the body over a longer period.

The study concluded:

"We found a difference in the amounts of iodine excreted between those with either sufficient or insufficient iodine intake, as described previously. This is consistent with the generally held view that most of the iodine will be excreted in urine if iodine stores are replete. In vitro digestion confirmed the limited release of iodine from the seaweed matrix in the first gastric and intestinal phases of simulated digestion. We found that colonic fermentation of seaweed is important to free iodine from the seaweed matrix, with the mechanism being reliant on the fermentation of the polysaccharide matrix or metabolism of organic iodine. Therefore, the seaweed matrix may delay iodine absorption (compared with KI), with iodine being released from the food over a longer period."

In cases where seaweed has been linked with thyroid problems, such as 6-12% of Japanese fishermen who have goitre, it has been found that their intakes are 10-20 mg/d (10,000 - 20,000 mcg) of iodine. To put this in further context, a capsule of Ascophyllum seaweed would be typically 0.5g, and thus require 28 to 57 capsules per day to be consumed.

The UK Report's chapter on iodine states the following:

- Normal subjects with intake of 1,000 - 2,000 mcg/d showed an increased iodine concentration in the thyroid gland, but no other changes.

- The Panel recommend that the safe upper limit on intakes of 17 mcg/kg be retained, or not more than 1,000mcg/day.

A subsequent review by the Expert Group on Vitamins and Minerals (EGVM) concluded that iodine intakes of 940 µg/day would not be expected to have any significant adverse effects in adults.

Benefit from seaweed in your products

The right supply of seaweed is critical, and in a form that makes it easy and convenient to use.

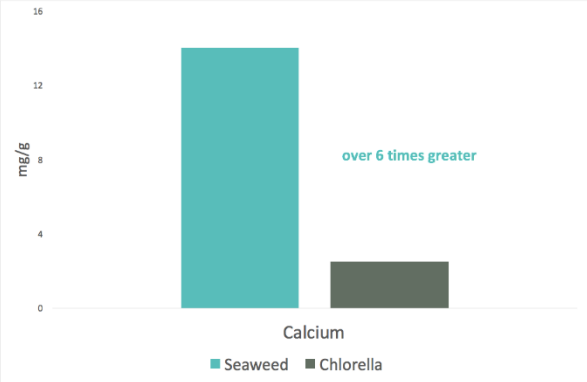
Seaweed & Co.'s PureSea® range of naturally innovative seaweed ingredients are from pristine waters in the Scottish Outer Hebrides, with proprietary processing, full and transparent traceability, and with world-experts on hand to advise.

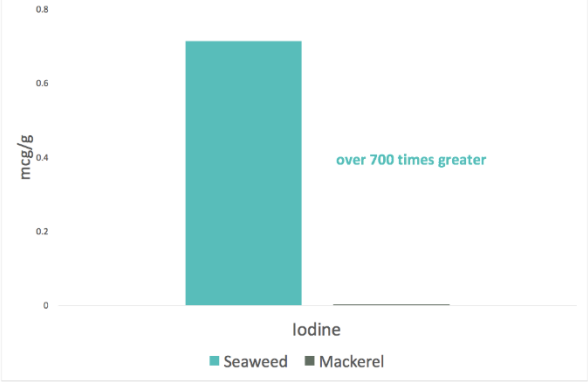
As displayed in Figure 2, the PureSea® ingredients are supplied in a dried and milled format, making them easy and convenient to use in capsules, green/superfood blends, foods, beverages, and a wide range of functional food applications.

Figure 2: Image of the PureSea® range

For more details on the range, please see: www.seaweedandco.com/puresea

Figure 3 demonstrates the gram-for-gram comparison with other known sources of minerals, highlighting how the PureSea® ingredients are ideal to complement green blends, and boost the overall nutrition of finished products and functional foods. In products such as smoothies and green blends, a small addition as little as 100mg can enable EU Approved Health Claims as a good source of iodine.





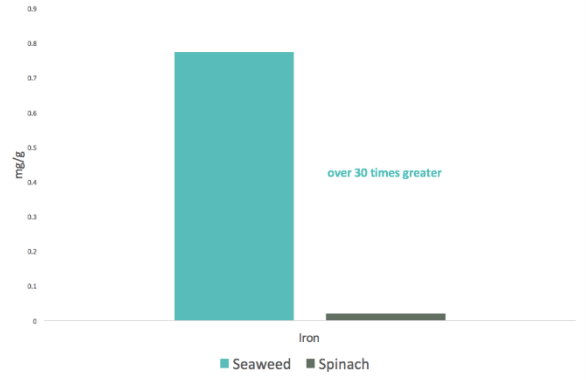
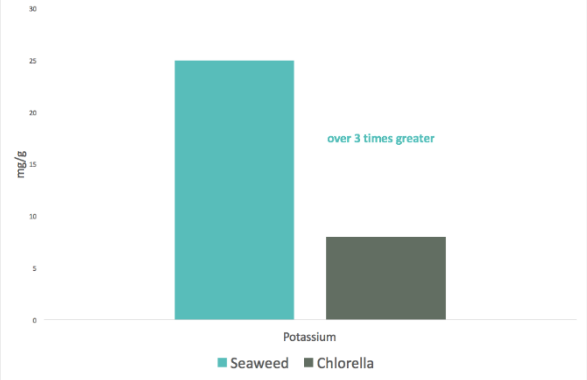
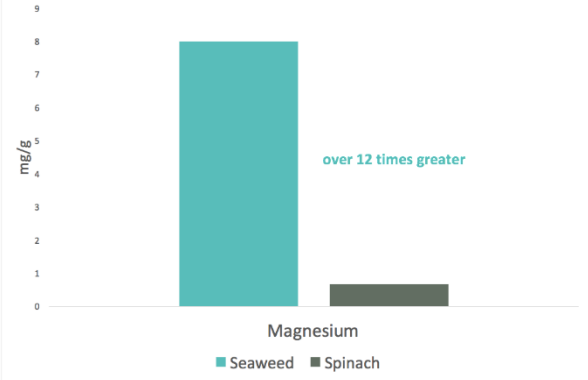


Figure 3: Graphical display of PureSea® Organic Hebridean Ascophyllum Seaweed as a gram-for-gram comparison with other known source of key minerals





Conclusion

The issues of iodine deficiency globally are clear, being labelled as one of the biggest worldwide public health issues of today. Finding solutions, from safe and natural sources must be achieved.

With the proper source, species, and quality assurances, seaweeds offer an extremely viable, sustainable and under-utilised source of iodine in the daily diet through food ingredients and nutritional supplementation.

About the Authors

Craig Rose PhD is Managing Director of Seaweed & Co. He is actively involved in numerous research projects with Universities in the UK, is guest member of staff at Newcastle University, where has supervised a PhD and other seaweed research projects. He sits on the Applied Algae Group of the British Phycological Society, and is on the management group of the Scottish Seaweed Industry Association.

Seaweed & Co. advise on, supply and accredit seaweed, using patent pending technologies and techniques to produce their PureSea® range of seaweed ingredients. Their Organic, Vegan, Allergen Free and Kosher certified PureSea® seaweeds are supplied into the food, health and nutrition markets. Their seaweeds are sustainably wild harvested in pristine waters, naturally rich in iodine, uniquely DNA Authenticated for world-class analytical traceability, extensively batch tested, and accredited for safety and quality.

Sarah-Jane Hall is a Registered Associate Nutritionist, with a degree in Human Nutrition and a master's degree in Public Health Nutrition. Sarah-Jane is the in-house Nutritionist at Seaweed & Co. and has conducted research on various aspects of nutrient deficiency – specifically iodine deficiency.

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