SURVEY OF IODINE LEVELS IN SEAWEED AND SEAWEED CONTAINING PRODUCTS IN AUSTRALIA

SUMMARY

A survey of iodine levels in seaweed and seaweed containing products was undertaken in 2010. This survey work was co-ordinated nationally with Food Standards Australia New Zealand (FSANZ) leading the work and all Australian State and Territory jurisdictions participating.

The survey was undertaken in response to a national food incident, which occurred due to an increased number of reported human thyroid dysfunction cases resulting from high iodine intake. This increase suggested a link to the consumption of a particular brand of soy beverage, Bonsoy, which contained high iodine levels resulting from the addition of seaweed (kombu, *Laminaria* spp) during the manufacturing process.

The analysis of iodine levels in a range of seaweed species and products containing seaweed as an ingredient was conducted. The findings of this survey showed that:

- Iodine levels in seaweed varied between red and brown seaweed but were generally higher in brown seaweed
- Iodine concentrations in wakame and nori seaweed and seaweed containing products were generally low.
- Some other dried seaweed types had high iodine levels, considered to be unsafe for human consumption.

For those seaweed products considered to be unsafe, the relevant jurisdiction was advised for appropriate follow up action. The Australian Quarantine and Inspection Service (AQIS) has now included brown algae/seaweed vegetables on the imported food 'Risk List' and are monitoring at the border to ensure that only products with safe levels of iodine are imported (≤1000 mg iodine/kg dried weight).

1. BACKGROUND

On 24 December 2009, FSANZ issued advice for consumers not to consume Bonsoy soy beverage products. This advice was provided following a cluster of individuals in NSW presenting with thyroid problems. All cases (nine adults aged from 29 to 47 years, and one child) reported having consumed Bonsoy soy beverage. Initial testing of Bonsoy soy beverage showed unusually high levels of iodine which was believed to be from the addition of seaweed (kombu) during the manufacturing process. A voluntary food recall of the product was conducted at this time.

1.1 Seaweed types and usage

Seaweed is a type of algae produced in a variety of water temperatures from cold to tropical. There are a variety of seaweed types, which are generally categorised into three main groups; red, green and brown, based on colour (McHugh, 2003). Species from all three groups are consumed as food in Australia, although seaweed and products containing seaweeds is a relatively new feature of the mainstream Australian diet. Red seaweed (e.g. nori) is used in making sushi, whereas brown seaweed (e.g. kombu, wakame and arame) is used in salads, soups and as vegetables. Iodine levels in seaweed varies between red, brown and green seaweed, however iodine levels in brown seaweed are generally higher (Dawczynski et al., 2007; Teas et al., 2004).

1.2 Iodine function in the body

Iodine is an essential trace element required for normal thyroid performance (NHMRC, 2006). Exposure to excess or inadequate iodine levels can result in thyroid dysfunction, such as hypo- and hyperthyroidism (Topliss & Eastman, 2004).

The prevalence of hypo- and hyperthyroidism in Australia is not well defined due to the lack of current available data. Estimations of the prevalence of naturally-induced hypo- and hyperthyroidism in Australia have been extrapolated and are predicted to occur in 7.5% of women and 1.5% of men (Stevens, 2000). These estimates are derived from the results of the Whickham Survey conducted in England in 1972 over a 20 year period (Stevens, 2000). In addition, the 1998 Health Report produced by the Australian Institute of Health and Welfare (AIHW) states that 4% of women aged 15 years and above have a self-reported thyroid disorder (AIHW, 1998), however the specifics of the types of conditions were not elucidated in the report.

The prevalence of thyroid dysfunction in other countries has been investigated. For example, in New Zealand a retrospective study in 2006-2007 was conducted in Hamilton and concluded that the overall prevalence of thyroid dysfunction in patients engaged in the study was 3.1% (2.5% overt hypothyroidism, 0.2% overt hyperthyroidism and 0.4% for other related conditions such as goitre and thyroiditis) (Gibbons et al., 2008). In the United States, the prevalence rates of hypo- and hyperthyroidism has been reported as 3.7% and 0.5%, respectively for the general population based on the findings from the National Health and Nutrition Survey (NHANES) conducted in 1999-2002. Specifically, for women aged 12-49 years, the prevalence of hypothyroidism for the same period was 3.1% (Aoki et al., 2007).

1.3 Health significance of high iodine intake

Given the potential for thyroid dysfunction due to excess iodine intake, the National Health and Medical Research Council (NHMRC) and the New Zealand Ministry of Health (MoH) have established an Upper level of Intake (UL) for iodine (NHMRC, 2006). For adults, the UL is 1100 µg/day and is lower for children, ranging from 200-900 µg /day for 1-18 years dependent on the age group (please refer to NHMRC, 2006 for specific ULs for each age category). The ULs established are considered to be protective for the general healthy population. However, it should be noted that individuals with pre-existing thyroid conditions or long-term iodine deficiency may have adverse effects at levels below the UL (NHMRC, 2006).

In the Bonsoy product involved in the food incident in Australia, the levels of iodine were such that an adult consuming as little as 30 mL beverage a day (just over a tablespoon) would have an iodine intake exceeding the UL. This exceedance does not take into account any additional sources of iodine (e.g. bread) consumed as part of a typical Australian diet.

1.4 Other information available on iodine levels in foods in Australia

In recent years, FSANZ has monitored iodine levels in a range of food and beverages available for sale in Australia and used this data to estimate dietary intake for various population groups. For example, iodine levels in foods were collected in 2004 as part of the 22nd Australian Total Diet Study (ATDS) (FSANZ, 2008a). In this study, foods such as milk, iodised salt, ice cream and yoghurt were considered as major food contributors to dietary iodine (>5%) for most population groups assessed.

In the 22nd ATDS, six composite samples of nori were analysed for iodine, with the concentrations ranging from 10-34 mg/kg. In the context of the total diet, the study concluded that nori was not considered to be a major contributor (<1%) of iodine in the total diet. Data on the iodine content of a range of Australian foods are also available from the national food composition databases (NUTTAB10 and AUSNUT 07), published by FSANZ on line; (http://www.foodstandards.gov.au/consumerinformation/nuttab2010/; http://www.foodstandards.gov.au/consumerinformation/ausnut2007/).

1.5 The national coordinated surveys in response to this food incident

In response to the high level of iodine in Bonsoy beverage, the National Food Incident Response Protocol (the Protocol) was activated by FSANZ on 5 January 2010. The Protocol provides clear guidance to member agencies of the Food Regulation Standing Committee's Implementation Sub-Committee[1] (ISC) for responding to a range of national food incidents in a timely, appropriate, consistent and coordinated manner. It provides a link between the protocols of Australian Government and State and Territory agencies responsible for food safety.

In response to the Protocol activation, the Food Surveillance Network[2] convened and agreed to conduct an ISC national coordinated food survey to investigate iodine levels in other beverages enriched with seaweed as well as a survey of iodine levels in seaweed and seaweed containing products. FSANZ coordinated both surveys with input from the States and Territories. The first *'Survey of iodine levels in beverages enriched with seaweed'* was completed and published in November 2010. The findings were reassuring, indicating that iodine levels in the beverages analysed were well within the safety margin and pose a negligible risk to the Australian and New Zealand consumer (FSANZ, 2010). The Bonsoy soy beverage product was not available in the market at the time of this survey.

The second survey, *Survey of iodine in seaweed and seaweed containing products* is the current survey, as described in this report. In this survey, the first step was to identify seaweed and seaweed products other than beverages available for sale in Australia, and gather information on the various preparation methods for seaweed. Based on this information, FSANZ developed a sampling plan in consultation with the food regulatory agencies in the Australian States and Territories.

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[1] The Food Regulation Standing Committee's Implementation Sub-Committee (ISC) was established to develop guidelines on food regulations, standards implementation and enforcement activities. ISC comprises representatives from the Department of Health and Ageing, Department of Agriculture, Forestry and Fisheries, Australian Quarantine and Inspection Service, FSANZ, each State and Territory jurisdiction, New Zealand and a representative of Australian local government. ISC members are responsible for food safety and include the government agencies in each jurisdiction with statutory responsibility for food safety.

[2] FSANZ coordinates the Food Surveillance Network (FSN), which facilitates the planning and coordination of the food surveillance and monitoring activities undertaken by government health agencies in Australia and New Zealand. The FSN comprises representatives from Australian State and Territory jurisdictions and the Australian and New Zealand governments. The FSN is a group associated with ISC and is formally recognised as having a role in co-ordinating survey work under the Protocol where relevant.

During the planning phase for the *Survey of iodine levels in seaweed and seaweed containing products*, a voluntary food recall of Heng Fai Dried Seaweed Brand ® (*Sargassum fusiforme*) occurred due to a finding of high levels of naturally occurring iodine. This provided further impetus for investigating the levels of iodine in a variety of seaweed types available in the Australian marketplace.

2. OBJECTIVE

The objectives of this survey were:

- to determine the concentration of iodine in seaweed and seaweed containing products; and
- to assess whether there are any potential health and safety risks for consumers associated with iodine concentrations in seaweed and seaweed containing products.

3. METHODOLOGY

3.1 Sampling

Samples were collected based on the following criteria:

- Seaweed – labelled on the ingredient list as kombu (kelp), nori, wakame, hijiki/hiziki, *Sargassum fusiforme* and arame.
- Products containing: seaweed, seaweed extract, sea vegetable, kombu (kelp), nori, wakame, hijiki/hiziki and arame on the ingredients list.

Samples were collected from a variety of retail outlets in April/May 2010 from all States and Territories in Australia. A total of 110 individual samples of seaweed and seaweed products were purchased for this survey.

3.2 Sample preparation

Samples were dispatched to the laboratory in an unopened state. Samples were prepared according to the manufacturer's instructions. Where preparation instructions were not provided, samples were prepared according to the instructions provided on similar products. For example, 10-20 grams of dried seaweed (excluding nori) was soaked in approximately 250 mls of deionised water for 10 mins prior to analysis, whereas soup bases were reconstituted with deionised boiling water and stirred prior to compositing according to the manufacturer's instructions. Given seaweed can be consumed dried, cooked and used to make soup broth, the iodine concentration for dry and cooked seaweed and broth was determined for all dried seaweed types, excluding nori. Compositing of sample was then undertaken as follows:

From the 110 individual samples purchased:

- thirty four (34) composites[3] consisting of three primary[4] samples (individual purchases) were analysed;
- three composites consisting of two primary samples were analysed; and
- two individual samples were analysed.

[3] A composite sample is generated when an equal portion of the same type of food is mixed together. While the food may be of the same type, it can be of differing brands or varieties. The composite sample can be analysed rather than the individual brands/varieties which make up the composite.
[4] A primary sample is an individual food product, representative of a single purchase. This sample can be analysed individually or used together with other primary samples, to make up a composite sample.

Composites were comprised of the same type of seaweed (e.g. kombu) based on the ingredient list, or the same type of product (e.g. miso pastes) with varying use-by dates/batch codes.

3.3 Analysis

FSANZ engaged the National Measurement Institute (NMI) to analyse the samples for iodine content using a NATA accredited method of alkaline digestion followed by Inductively Coupled Plasma-Mass Spectrometry (ICP/MS). This method was also used in the 22nd ATDS (FSANZ, 2008a) and the recent survey of *Iodine levels in beverages enriched with seaweed* (FSANZ, 2010). The Limit of Detection (LOD) for this analysis was 0.005 mg/kg, with a Limit of Reporting (LOR) and Limit of Quantification (LOQ) of 0.01 mg/kg.

4. RESULTS

A summary of the results from this survey are provided in Tables 1, 2 and 3. All samples analysed had iodine levels detected above the LOQ of 0.01 mg/kg. The iodine concentration in different seaweed species (e.g. nori, kombu, hijiki, wakame) was variable. This variability is consistent with findings in other studies which identified that brown seaweed (e.g. wakame, kombu, hijiki) contained higher iodine levels than red seaweed types (e.g. nori) (Dawczynski *et al*., 2007; Teas *et al*., 2004).

Analysis of the various forms of seaweed that can be consumed (e.g. dried, cooked or ingredient in broth), indicated that dried seaweed contained the highest level of iodine, with concentrations ranging from 9.4 mg/kg to 4300 mg/kg for nori and kombu, respectively. The iodine concentration in nori determined in this study at 9.4-20 mg/kg was similar to previous levels reported in the 22nd ATDS of 10-34 mg/kg (FSANZ, 2008a). Information on the concentration of iodine in other seaweed species in Australia was previously not available.

The concentration of iodine in cooked seaweed and the broth made from seaweed was at least 5-fold lower than the concentration in dried seaweed, which may reflect the uptake of water into the seaweed or loss of iodine into the surrounding water. The iodine concentrations in other seaweed containing products were generally much lower, with concentrations ranging from approximately 0.01 mg/kg in desserts containing seaweed to 110 mg/kg in dashi powder.

Table 1: Iodine concentration (mg/kg) in dried and prepared seaweed

Seaweed Type (as indicated on product packaging)	*Form*[€]	*Iodine concentration (mg/kg)*[¥]
Kombu[‡]	Fresh/frozen	110
	Dried	2100
	Prepared (cooked)	200
	Broth	190
	Dried	4300
	Prepared (cooked)	190
	Broth	210
Hijiki/Hiziki[‡]	Dried[†]	790
	Prepared (cooked)[†]	160
	Broth[†]	9.2
Sargassum fusiforme[‡]	Dried[†]	140

Seaweed Type (as indicated on product packaging)	*Form*[€]	*Iodine concentration (mg/kg)*[¥]
	Prepared (cooked)[†]	17
	Broth[†]	0.6
	Dried[†]	1900
	Prepared (cooked)[†]	160
	Broth[†]	170
Nori	Dried	9.4
	Dried	20
Wakame[‡]	Fresh/frozen	1.2
	Dried	220
	Prepared (cooked)	27
	Broth	0.3
	Dried	280
	Prepared (cooked)	31
	Broth	0.5
Arame	Dried	540
	Prepared (cooked)	38
	Broth	21
Seaweed dried (type not specified)	Dried	2500
	Prepared (cooked)	76
	Broth	96
	Dried	2800
	Prepared (cooked)	96
	Broth	190
Sea Vegetable	Dried	83
	Prepared (cooked)	18
	Broth	0.23

[‡] includes: roasted/ baked/flakes/crispy/seasoned; [†] only two individual purchases were in this composite sample; [¥] Concentration values are for composite samples, unless otherwise indicated. [€] For each dried seaweed type, dried, prepared and broth made from the dried seaweed was analysed. Iodine concentrations from these three forms that have been derived from the same seaweed sample are grouped together and indicated by the same colour shading.

Table 2: Iodine concentration (mg/kg) in seaweed containing products.

Product containing seaweed	*Form*	*Iodine concentration (mg/kg)* [¥]
Wakame Soup	Prepared (cooked)	0.8
	Prepared (cooked)	1.3
Miso Soup	Prepared (cooked)	0.2
	Prepared (cooked)	0.3
Seaweed Soup	Prepared (cooked)	1.3
	Prepared (cooked)	1.4
Soup base	Prepared (cooked)	0.7
	Prepared (cooked)	0.7
Dashi powder	As purchased[†]	110
Seasoning sauce (containing seaweed)	As purchased	2.6
Salt containing seaweed	As purchased	3.9
	As purchased	6.6
Soybean paste	As purchased	14
Seaweed paste	As purchased	2.8
Miso paste	As purchased	1.2
Furikake	As purchased	3.6
Seaweed/glazed seaweed rice crackers	As purchased	0.7
Noriten Wasabi	As purchased	5.8
Seaweed chips	As purchased	3.1
	As purchased	5.1
Desserts containing seaweed	As purchased	0.01
	As purchased	0.02
Japanese Tea	Prepared[^]	3.0
Dulse Flakes	As purchased[^]	100

[‡] includes: roasted/ baked/flakes/crispy/seasoned; [¥] Concentration values are for composite sample, unless otherwise indicated; [†] only two individual purchases were in this composite sample;
^ individual sample analysed (not a composite).

Further analysis was conducted on the three individual seaweed samples that made up the four composite samples of dried seaweed. These composite samples contained iodine at a concentration of >500 mg/kg. This additional analysis was conducted for the purposes of providing more detailed information for the risk assessment. The results from the additional analysis of individual samples are provided in Table 3. From the 12 individual additional analyses that were conducted, 10 samples of dried seaweed had iodine concentrations >500 mg/kg, with the concentration ranging from 650 to 6800 mg/kg.

Table 3: Iodine concentration in individual seaweed samples from composites with >500 (mg/kg) iodine levels.

Seaweed Type	*Form*	*Composite sample iodine concentration (mg/kg)*	*Individual sample iodine concentration (mg/kg)*[¥]
Kombu[‡]	Dried	4300	2500
	Dried		3800
	Dried		3200
Kombu[‡]	Dried	2100	3000
	Dried		650
	Dried		6800
Seaweed dried (type not specified)	Dried	2500	13
	Dried		2700

Seaweed Type	*Form*	*Composite sample iodine concentration (mg/kg)*	*Individual sample iodine concentration (mg/kg)*[¥]
	Dried		2700
Seaweed dried (type not specified)	Dried	2800	4600
	Dried		3100
	Dried		31

5. HUMAN HEALTH SIGNIFICANCE OF SURVEY RESULTS

An assessment was undertaken to establish an appropriate maximum iodine concentration in dried seaweed, and the broth prepared from dried seaweed. This was done to ensure that when consumed, it would not result in an intake that was consistently in excess of the UL for iodine intake. For the purposes of this assessment, a value of three times the UL set by the NHMRC and New Zealand Ministry of Health (NHMRC, 2006) was taken, based on earlier investigations by FSANZ of the basis on which the UL was set[5].

It is noted that:

- children aged 2-3 and 4-8 years are at greatest risk of exceeding the iodine UL for their respective age groups because of the relative high energy requirement for growth. As a result, their food consumption per kg bodyweight will always be higher than for older age groups;
- infants have an increased risk of thyroid dysfunction via milk from their mothers consuming seaweed with high levels of iodine (*Crawford et al*., 2010). Therefore, maternal iodine intake was also assessed for females >19 years, to represent lactating women (the UL for all adults, including lactating females, is 1100 mg iodine/day);
- other population groups at risk of thyroid dysfunction include older population groups and women of childbearing age, in particular those with pre-existing thyroid conditions.

5.1 Calculation of maximum tolerable daily iodine intakes from seaweed sources

The maximum tolerable intake of iodine per day from seaweed consumption without exceeding a multiple of three times the UL[5] for the age group of interest can be calculated as follows, taking into account background iodine intake from other dietary sources, including iodised salt added to bread:

Maximum tolerable intake from seaweed (µg/day) = (UL × 3) – Background intake (µg/day)

Maximum tolerable iodine intakes were estimated at between 470 µg/day (0.47 mg/day) and 3125 µg/day (3.125 mg/d) for 2-3 years and females aged 19 years and over (taken to represent lactating women) respectively. FSANZ estimated population mean background iodine intakes as part of consideration of mandatory iodine fortification of salt used in bread making (FSANZ, 2008b). Table 4 summarises the ULs, background iodine intakes and maximum tolerable iodine intakes from seaweed.

[5] Although it is generally undesirable to exceed the UL, there is evidence to indicate that young children are able to exceed their respective estimated ULs by 2-3 fold without apparent adverse consequences. This, and the reversible nature of the endpoint (sub-clinical hypothyroidism), means such intakes are unlikely to represent a health and safety risk to young children, though a reduced margin of safety exists (FSANZ, 2007; FSANZ, 2008c). FSANZ continues to monitor the available information on the safety of dietary iodine, including safety for neonates whose exposure to iodine is via their mother's milk. FSANZ is currently working with the National Health and Medical Research Council to review Nutrient Reference Values, which includes a review of the current ULs.

Table 4. Upper Levels of Intake (ULs), background dietary iodine intake and maximum tolerable iodine intakes from seaweed in early childhood and lactation

Population group	UL (µg/day)*	ULx3 (µg/day)	Background dietary iodine intake (µg/day)**	Maximum tolerable iodine intake from seaweed (µg/day)
2-3 years	200	600	130	470
4-8 years	300	900	140	760
Females >19 years (representing lactating women)	1100	3300	175	3125

* NHMRC (2006)
** Excludes intake from dietary supplements (FSANZ, 2008b)

5.2 Calculation of maximum tolerable iodine levels in dried seaweed and seaweed soup

Seaweed and products containing seaweeds are a relatively new feature of the mainstream Australian diet and there is little or no information available on the amounts of seaweed consumed and the proportion of the population who consume it.

In the 2007 National Children's Nutrition and Physical Activity Survey of children aged 2-16 years (CSIRO, 2008), a small number of children (<2%) reported consuming sushi (which typically contains nori), miso soup and miso paste. No consumption of any other type of seaweed or seaweed products was reported. The number of children consuming these foods, particularly the miso products, is inadequate to reliably estimate usual or 'high' consumption amounts.

Given the lack of reliable, nationally representative data on seaweed and seaweed product consumption, FSANZ estimated what seaweed consumption might be using recipes, product labels and anecdotal information.

5.2.1 Dried seaweed and broth

It is assumed that children could consume 1.4 g of dried seaweed per day, an assumption broadly in line with the consumption information available from suppliers (approximately the amount in one small bag of dried seaweed). Based on this assumption, the maximum tolerable iodine level that could be present in dried seaweed consumed by 4-8 year olds is calculated as:

> *Maximum tolerable iodine level =*
> *Maximum tolerable intake from seaweed (mg/day) ÷ estimated daily seaweed consumption (g/day) × 1000 (g/kg)*
> *= 0.76 ÷ 1.4 x 1000 =* ***540 mg/kg***

For 2-3 year olds, the maximum tolerable iodine level in dried seaweed would be lower, at 340 mg/kg. For adult females, consumption of 1.4 g dried seaweed per week leads to a maximum tolerable iodine level of 2230 mg/day. The highest consumption of dried seaweed for adults was assumed to be 7 g per day, based on typical recipes for seaweed broth made from dried seaweed; this leads to an estimate of maximum tolerable iodine level in dried seaweed of 450 mg/kg, assuming all the iodine in the dried seaweed is retained in the broth.

It is recognised that seaweed is a natural product with a range of iodine levels both within and between species and that seaweed and seaweed products are consumed infrequently rather than daily, particularly by young children. An initial level of 500 mg iodine/kg was established as a threshold to identify seaweed samples that required further investigation in the risk assessment. A level of 1000 mg iodine/kg in dried seaweed was established as a maximum tolerable iodine level, above which could pose a public health risk. Referring to Tables 1 and 3, those dried seaweed products having iodine concentrations above this maximum tolerable level can be identified. These include kombu, *Sargassum fusiforme* and seaweed (type not specified).

Twenty-two other types of seaweed and seaweed products were also analysed as part of this survey including nori, hijiki, wakame and arame. The levels of iodine found in these products were below the maximum tolerable level identified.

5.2.2 Seaweed soups

Seaweed soup is reported to be a traditional food for breastfeeding women in some cultures and there is at least one report of neonatal thyroid toxicity associated with maternal seaweed soup consumption, although the amount of soup consumed was not reported (Crawford *et al*., 2010). For seaweed soup, mean serve sizes were estimated from national nutrition survey consumption data for consumers of all types of soups – 110 g/day for 2-3 year olds, 150 g/day for 4-8 year olds and 375 g/day for females 19 years and above (mean for soup consumers only) (CSIRO, 2008; McLennan & Podger, 1999).

Based on these consumption amounts and the above equation, the maximum tolerable iodine levels in the seaweed soup were calculated. These were 4.3 mg/kg for 2-3 year olds, 5.1 mg/kg for 4-8 year olds and to 8.3 mg/kg for females >19 years of age (representing lactating women). None of the soups analysed in this survey (excluding broth) had iodine levels exceeding 4.3 mg/kg (Table 2).

Table 5 summarises the estimated consumption amount of dried seaweed and seaweed soup and their maximum tolerable iodine levels required for consumption at the maximum tolerable intake of iodine for different population groups. Iodine levels in dried seaweed and seaweed soup above these levels when consumed in these amounts on a daily basis are likely to lead to total iodine intakes in exceedance of 3 x UL.

Table 5. Estimated consumption and maximum tolerable iodine level for dried seaweeds and broths prepared from dried seaweed.

Form	*Population group*	*Estimated amount consumed (g/day)**	*Maximum tolerable iodine level in product (mg/kg)*
Dried	2-3 years 4-8 years Females>19 years	1.4 1.4 1.4 7 (in broth)	340 540 2230 450
Seaweed soup	2-3 years 4-8 years Females> 19 years	110 150 375	4.3 5.1 8.3

* Maximum tolerable levels in each product are estimated from the amount of additional iodine that could be consumed daily before intake exceeds three times the UL for that population, taking into account estimates of serving size and background iodine intakes.

5.2.3 Uncertainties

There are a number of key uncertainties with this risk assessment:

- The absence of robust consumption and frequency of consumption data is a major limitation that prevents a full dietary exposure assessment from being conducted and contributes to significant uncertainty around the identified maximum tolerable level of iodine in these foods.
- The way that many of the foods included in the survey are prepared is not well known. Foods were prepared according to the manufacturing instructions where provided on the packaging, however there will be variation to some extent amongst consumers in the method used to prepare the food. As a result, this variation may influence the concentration values in products actually consumed.
- There is uncertainty around physiological responses to habitual high iodine intakes and in the establishment of the UL, particularly for young children; there is no UL for infants.

- The high level of variability in iodine concentrations observed in this survey suggests that a larger number of samples would be helpful to better establish the range of iodine levels and the probability of exceeding certain iodine concentrations in each product range.

5.3 Risk assessment conclusion

It is recognised that seaweed is a natural product with a range of iodine levels both within and between species and that seaweed and seaweed products are consumed infrequently rather than daily, particularly by young children. A level of 1000 mg iodine/kg was established as a maximum tolerable iodine level in dried seaweed, above which may pose a public health risk. In this survey, seaweed types such as; kombu, *Sargassum* and seaweed (type not specified) were identified to have iodine levels of >1000mg/kg. Twenty two other types of seaweed and seaweed products analysed were found to contain iodine levels below the maximum tolerable level identified.

6. RISK MANAGEMENT

In anticipation of the outcomes of the risk assessment, the National Food Incident Response group developed a risk management matrix in order to encourage and enable a consistent risk management approach by all jurisdictions.

National Food Incident teleconferences were held to discuss the results of the individual risk assessments for products containing iodine above the referral level of 500 mg/kg for dried seaweed. In consideration of factors such as consumption variation and seaweed batch variation, which are likely to impact on the risk assessment results, the jurisdictions decided on a cautious enforcement approach focusing primarily on consumer education messages in relation to safe consumption of seaweed products. This included follow up with the relevant manufacturers and importers.

FSANZ also provided AQIS with risk assessment advice regarding iodine levels in brown algae/seaweed vegetables. The risk assessment advice concluded that brown algae / seaweed vegetables are considered medium to high risk products. AQIS has subsequently placed brown algae / seaweed vegetables on the imported food 'Risk List' for iodine tests (1000 mg/kg dried weight). Test results above 1000 mg/kg are considered to fail and are not imported into Australia. Details of the Imported Food Notice can be found on the AQIS website:
http://www.daff.gov.au/aqis/import/food/notices/2009/2010/ifn-10-10

Risk list foods are referred to AQIS by Customs at a rate of 100% of consignments and are tested to ensure iodine levels do not exceed the permitted level. Once five consecutive consignments have passed inspection, the inspection rate is reduced to 25%; after a further 20 consecutive passes, the inspection rate is reduced to 5%. Consignments of risk food which fail inspection cannot be imported. These foods will be re-exported or destroyed. Any consignments that fail, result in a return to 100% testing of that product from that manufacturer until a history of compliance is re-established for the producer of the food.

7. RISK COMMUNICATION

FSANZ is working with the State and Territory food and health agencies to develop and distribute advice to consumers, particularly pregnant and breastfeeding women, not to over consume brown seaweeds with potentially high levels of iodine.

For further information relating to this incident and iodine generally, please refer to the FSANZ website and the relevant fact sheets at http://www.foodstandards.gov.au/scienceandeducation/factsheets/factsheets2011/adviceonbrownseaweedforpregnantwomenbreastfeedingwomenandchildren27june2011/

8. CONCLUSION

The findings from the survey of iodine levels in seaweed and seaweed containing products indicate that while most seaweed and seaweed products have iodine levels that are considered to be safe for consumption, there are some seaweeds with very high iodine levels that may be unsafe for human consumption. This advice has been provided to the relevant jurisdictions and AQIS for appropriate action.

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