Imported food risk statement
Brown seaweed of the *Phaeophyceae* class and iodine

Commodity: Brown seaweed of the *Phaeophyceae*[1] class, alternatively referred to as *Phaeophyta, Phyophycea,* kelp or brown algae. Common names for some types of seaweed of the Phaeophyceae class are provided in Appendix 1.

Analyte: Iodine

Recommendation and rationale
Is iodine in brown seaweed of the *Phaeophyceae* class a medium or high risk to public health? ☑ *Yes* ☐ *No* ☐ *Uncertain, further scientific assessment required* **Rationale:** • Exposure to excessive iodine primarily disturbs normal thyroid gland function but its severity depends on the iodine status of the individual and any pre-existing thyroid dysfunction • Cases of excess iodine induced illness from the consumption of brown seaweed have been reported in Australia • There have been three food recalls in Australia of brown seaweed of the *Phaeophyceae* class due to the presence of excessive iodine levels

General description
Nature of the analyte: Iodine is naturally occurring in the environment but is also commonly found in food at low levels. It is an essential trace element required for normal thyroid function in the human body (NHMRC and MOH 2006). The thyroid is highly sensitive to iodine such that exposure to either excess or insufficient iodine can negatively impact human health. Given this sensitivity to iodine exposure, recommended iodine intakes for a variety of age groups have been established (NHMRC and MOH 2006). Exposure to excess iodine has also gained worldwide interest particularly from naturally occurring sources such as brown seaweed from the *Phaeophyceae* class. It is the exposure to excess iodine from this source that is the focus of this risk statement.
Adverse health effects: Thyroid hormones from the thyroid gland regulate many important biochemical reactions in the body, including protein synthesis and enzymatic activity. They are also required for proper skeletal and central nervous system development in fetuses and infants.

[1] This is in accordance with the classification system outlined in Algaebase (Guiry & Guiry 2015). Algal taxonomy is constantly evolving with changes in classification and terminology.

Exposure to excessive iodine primarily disturbs normal thyroid gland function but its severity depends on the iodine status of the individual and any pre-existing thyroid dysfunction (JECFA 1989; Roti and Uberti 2001; Markou et al. 2001; Topliss and Eastman 2004). Some sub populations, such as individuals with underlying thyroid disorders, may have a more adverse response to high iodine intake.

In 2006 the National Health and Medical Research Council (NHMRC) established an Upper Level (UL) for iodine intake in Australia for a range of age groups. A UL is the highest average daily nutrient intake level likely to pose no adverse health effects to almost all individuals in the general population. The UL for adults (aged 19+ years), including lactating women is 1100 µg/day (NHMRC and MOH 2006).

Consumption patterns:

Since there was an insufficient number of respondents in either the 2007 Australian National Children's Nutrition and Physical Activity Survey (DOHA 2008) or the 2011 – 2012 Nutrition and Physical Activity Survey (part of the 2011-2013 Australian Health Survey) to permit reliable estimates of seaweed consumption in Australia, an alternative approach was adopted (DoHA 2008; Australian Bureau of Statistics 2011-12). FSANZ has assumed in its risk assessment that all population groups consume an amount of seaweed that is likely to be an upper level of consumption (FSANZ 2010; FSANZ 2011a). In the absence of any additional data in relation to seaweed consumption in Australia, alterations to the existing ML for iodine in brown seaweed cannot be justified at this time.

Key risk factors:

There are a number of risk factors related to the presence of iodine in brown seaweed (*Phaeophyceae* class). These include:

- The inconsistent uptake of iodine by *Phaeophyceae* seaweed varieties and the unpredictable influence of external factors (e.g. temperature and season) on the degree of uptake (Teas et al. 2004; Dawczynski et al. 2007)
- Physical similarities between some *Phaeophyceae* seaweed species and the potential difficulty in differentiating between those that typically contain high levels of iodine than those with lower levels. This may impact all points in the food chain from seaweed harvesters, importers and potentially consumers
- Use of generic/non-specific terms such as 'kelp' and 'seaweed' in product ingredient lists which gives no indication of the type of seaweed and whether it is of the *Phaeophyceae* class
- Individual consumer sensitivity to effects of iodine

Risk mitigation:

There have been a number of risk management strategies used in Australia to reduce the risk of high iodine exposure from brown seaweed. These have included:

- Introduction and maintenance of a maximum level (1000 mg/kg) of iodine in imported brown seaweed of the *Phaeophyceae* class in October 2010 at the Australian border. There is currently no permitted maximum level in the Australia New Zealand Food Standards Code for naturally occurring iodine in brown seaweed
- Consumer advisory and media statements have been released by FSANZ in relation to high iodine levels in products containing brown seaweed (FSANZ 2011b; FSANZ 2013)
- Advisory statements released by other countries prior to and following the iodine in brown seaweed incident in Australia (Crawford et al. 2010; DoHA 2010a; DoHA 2010b; Emder and Jack 2011) have been identified. These included:
    - In July 2012, a warning in the South China Morning post was released regarding high iodine levels in roasted seaweed (Lam Wan 2012)
    - In October 2006 EFSA supported the European Union (EU) UL's for iodine (Adult- 600 µg/day) in a range of sources including seaweed. It was recognized that seaweed can have excessive iodine intakes which can be unsafe for the consumer. EFSA considered the UL's established in 2002 by the EU as still relevant and applicable (EC 2002; EFSA 2006)

- In May 2008, a warning advisory was released by Health Canada in relation to kelp supplements which contained high iodine levels. There has been no warning to date in relation to high iodine in kelp as food (Health Canada 2008)
- The Vietnam Food Administration conducted further investigations in July 2011 by testing all seaweed products and releasing appropriate consumer warnings (Thanh Nien News 2011)

Compliance history:

The imported food compliance data sourced from the Imported Food Inspection Scheme of the Australian Department of Agriculture and Water Resources for October 2010 – May 2013 showed that of the 1170 samples tested under the risk category for iodine applied to brown algae/seaweed there were 139 fails, a failure rate of approximately 12%.

There were 12 notifications on the European Commission's Rapid Alert System for Food and Feed (RASFF) for iodine in seaweed (in fruit and vegetables RASFF category) from October 2010 – May 2013 (EC 2014). In these cases, the seaweed originated from Korea, China, Japan or Hong Kong. Australia has rejected some imports of *brown algae* from these countries in addition to others due to non-compliance with the maximum iodine concentration of 1000 mg/kg implemented at the border.

There have been three food recalls in Australia of imported *Phaeophyceae* seaweed (fruits vegetables and herbs category) due to the presence of excessive iodine levels from 1989 – April 2015. The recalls have included:

- Voluntary recall in Heng Fai dried brown seaweed from China (March 2010)(ACCC 2010)
- WANG dried kelp Varech Speche from Korea (June 2011) (FSANZ 2011c)
- Good Luck dried seaweed stripe from China (November 2011) (FSANZ 2011d)

A related recall of a soy based beverage which was manufactured in Japan also occurred in December 2009. The final product contained high iodine levels which was linked to the use of kombu seaweed in the manufacturing process. Consumption of this imported product in Australia resulted in an increased number of cases presenting with thyroid problems (FSANZ 2010).

Surveillance information:

Illness associated with consumption of seaweed of the *Phaeophy*ceae class and excessive iodine

Illness associated with excessive iodine intake from brown seaweed of the *Phaeophyceae* class is not a notifiable disease in Australia. However cases of foodborne illness in two or more related cases is notifiable, which therefore may capture some cases.

Between 23 December 2009 and 6 October 2010, 50 cases of thyroid dysfunction suspected to be associated with the consumption of brown seaweed products containing excessively high iodine were recorded in Australia. Forty seven (47) of these cases were related to the consumption of a specific soy milk product (where seaweed was used in the manufacturing process), two with an unknown brand of soy milk and two cases of soup consumption made from dried seaweed (Crawford et al. 2010; DoHA 2010a; DoHA 2010b; Emder and Jack 2011). The majority of cases were reported in Victoria (25) and New South Wales (20), with two cases each in both South and Western Australia and one case in the Australian Capital Territory.

In some cultures, the consumption of seaweed following the birth of a child is encouraged as it is believed to enhance breast milk production, however excess iodine can be transferred to the baby via the mother's breastmilk (Soojae and Jungyeon 1999; Chung et al. 2009; Rhee et al. 2011). In some of these aforementioned cases, infants were also affected.

Data on the prevalence of brown seaweed of the *Phaeophyceae* class and excessive iodine levels

In response to the cases of illness associated with excess iodine exposure from the consumption of seaweed products, FSANZ in consultation with all Australian States and Territories, conducted two analytical food surveys:

- Survey of iodine levels in beverages enriched with seaweed (FSANZ 2010)
- Survey of iodine levels in seaweed and seaweed containing products (FSANZ 2011a)

- New Zealand has also conducted some investigative work into iodine levels of seaweed and seaweed containing products (NZFSA 2005; Smith et al. 2010)

Other relevant standards or guidelines
Not applicable

Approach by overseas countries
In Europe, foods and food ingredients that are derived from algae are considered a novel food if they were not available in the marketplace before 15 May 1997. Such foods are required to undergo a safety assessment and be approved for use before they are sold in the marketplace (EC 1997; EC 2003a; EC 2003b; EC 2007; EC 2008). Production and harvesting guidelines for organic seaweed production is also stipulated, however it does not seem that a maximum concentration for iodine is set (EC 2007). Although part of the EU, Germany and France have separate recommendations for the maximum level of iodine permitted in seaweed. Germany has advised that iodine concentrations above 20 mg/kg dry weight may have health implications and recommends that seaweed products with concentrations higher than this be restricted from the marketplace. Germany has also recommended a uniform maximum level for iodine in seaweed for the EU (BfR 2007). In contrast, France recommends that all edible seaweed species have a maximum level of 2000 mg/kg dry weight (AFSSA 2009). In France, approximately 21 macroalgae have been considered safe for consumption, of which eight are from the *Phaeophyceae* class (Fleurence et al. 2012; CEVA 2014; Cyber Colloids LTD 2014). In the US, algae (*Phaeophyceae* or *Rhodophyta* (red)) has been affirmed as generally recognized as safe (GRAS), and kelp is permitted for direct addition to food for human consumption (U.S GPO 2015a; U.S GPO 2015b; U.S GPO 2015c). Regulations in the US recommend a limit of <5000 mg/kg (dry weight) (U.S.Pharmacopeia 2014).

Other considerations
Biosecurity requirements apply to certain products under this commodity. Refer to the BICON database. It is noteworthy that all dried seaweed for commercial use must be packaged and labelled with full botanical name, including genus and species.

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Scientific name	Examples of common names used for different types of brown algae & uses[‡]
Laminaria spp *(eg.Laminaria japonica)*	Aokombu, Atlantic kombu, common kelp, Cow's tail, cuvie, cuvy, fingered tangle, Haidai Dashima, Horsetail tangle, horsetail kelp, kelp, Kombu, kombu Breton, Konbu, may weed, oarweed, oarweed kelp, *Saccharina japonica* (previously recognised name), sea club, sea girdle/s, sea-girdles, sea rod/s, sea tangle, sea wand, slack marrow, Suboshi kombu, tangle, Wild kelp, southern stiff-stiped kelp, split blade kelp, split-fan kelp, split kelp, stiff-stiped kelp, red ware, red wrack, redware, Hai-tai. *Uses: Dashi, salads, fried, soups, sauces, added to rice, beverages , sashimi, Kombucha (seaweed tea)*
Undaria spp	apron-ribbon vegetable, Asian kelp, Japanese kelp, sea mustard, wakame, precious sea grass, fougère des mers, kada-me, , mekabu, niki-me, wakame, haiboshi wakame, haijiecai, Quandai-cai, miyeok. *Uses: Miso soup, salads*
***Sargassum* spp** (eg. *Sargassum fusiforme)*	Binder's Sargassum Weed, common kelp, cattle sargassum weed, gulf weed, gulfweed, holly limu, Japanese sargasso weed, Japanese weed, Japanese wireweed, japweed, sargassum algae, sargassum grass, strangleweed, tuna weed, turtle limu, wireweed, Sargasse, Sargasso, Hijiki, hiziki, Hoshi hiziki, Deer tail grass, Sheep nest grass, Hizikia fusiformis, hondawara, tama-hahaki-moku, , hai ti tun, hoi tsou. *Uses: Vegetable, Soup, stir fries*
Cladosiphon okamuranus	Mozuku *Uses: Salads, supplements*
Alaria spp. *(eg. Alaria esculenta)*	Atlantic wakame, badderlocks, bladder locks, bladderlochs, bladderlock/s, dabberlocks, daberlocks, drilly kelp, edible focus, edible kelp, henware, honey ware, honeyware, horsetail kelp, Irish wakame, keys, murlins, oarweed, Pacific coast wakame, Pacific wakame, ribbon kelp, short stipe alaria, stringy kelp, tangle, wakame, wild Atlantic wakame, wing kelp, winged kelp, American wakame *Uses: Salads, vegetable*
Eisenia spp. (e.g. *Eisenia bicyclis)*	Kelp, sea oak, southern sea pal, Arame, Kajimi, Sagarame *Uses: Vegetable, Garnish, Salads, pickles*
Ecklonia spp. *(eg. Ecklonia maxima)*	common kelp, leather kelp, paddle weed, sea bamboo, Kajime, kamtae
Fucus spp. *(e.g. Fucus vesiculosus)*	Arctic wrack, black tang, black tany, black wrack, blackweed, bladder fucus, bladder wrack, bladderwrack, bubble kelp, dyer's fucus, dyers fucus, flat wrack, fucus, fucus tips, horned wrack, jelly bags, kelp, kelp-ware, lady wrack, paddy tang, popping wrack, popweed, red fucus, rock weed, rock wrack, rockweed, rockwrack, saw wrack, sea oak, sea ware, sea wrack, sea-ware, serrated wrack, spiral wrack, spiraling rockweed, spiralled wrack, swine tang, toothed wrack, varech, Wrack, Cut weed. Uses: *Additives , Flavourings, food supplements*
Durvillaea spp. *(e.g. Durvillaea Antarctica)*	Antarctica algae, bull kelp, Cape kelp, Cape, Thonged, Cochayuyo, Huilte, Ulte, coyofe,Cochajugo, Chamisso, Hulpe, rimurapa, rimuroa, southern bull-kelp *Uses: Stews, salads*
Ascophyllum spp. *(e.g. Ascophyllum nodosum)*	Asco, egg wrack, Grisetang, knobbed wrack, knotted kelp, knotted wrack, lichen belt, Norwegian kelp, pigweed, rock weed, rockweed, sea whistle, wrack, yellow tang *Uses: Alginate, seaweed meal*
Postelsia spp. *(e.g. Postelsia palmaeformis)*	sea palm, sea palm kelp, Palm seaweed *Uses: Chinese dishes*

[‡] This list is not exhaustive and other common names exist. Information taken from: (Teas et al. 2004; FSANZ 2011e; Fraser 2012; Guiry and Guiry 2015).