EUROPEAN ALGAE BIOMASS ASSOCIATION

#EU4Algae

Food safety regulation and recommendations involving Algae and Algae based products

Chemical and microbiological contaminants in Algae for food

EU4Algae | Working Group 3 | Algae for Food

WG Leader - Vitor Verdelho
vitor.verdelho@eaba-association.org

November 2023

Summary

1. Context

Algae biomass or algae based products are progressively entering a large variety of recipes and even staple diets when considering vegan or vegetarian communities. Several EU countries already have their national recommendations and regulations in terms of Food safety regarding algae, notably France which is advanced on the topic due to the historical and growing algae food industry in Brittany. However, maximum levels of certain contaminants allowed in algae for Food vary between countries, which creates confusion and in some cases threats in terms of competition. An official harmonised EU regulation can release these tensions which exist in the algae sector throughout the EU.

This document has the aim to bring forward the existing regulation on contaminants applied to any food product. In addition, complementary information is brought by certain countries already applying internal regulations or recommendations. Indeed, **algae biomass commercialised as food or food supplements must comply with all food product regulations with regards to contaminants**. Some contaminants are not specific to algae (general regulation), others are present in algae with levels which need to monitored. Algae as stated in the below tables is the term extracted from published documents and refers to all algae forms (microalgae and seaweed biomass) unless it is specifically indicated seaweed (notably for the iodine levels).

Contaminants are defined as "substances that have not been intentionally added to food" (EFSA, Codex) and "hazardous and/or undesired substance, material or organism that can result in physical, chemical and/or biological modifications of properties" (EN 17399). Food production processes can lead to substances entering the food at any moment: during manufacturing, handling, storage, processing or distribution. Contaminants can also enter the food from the environment. Most issues related to contamination are not algae-specific but common to all agrofood system, some contaminants however are typical of algae e.g. microcystins.

Contaminants can be grouped in three categories

1. Physical contaminants, e.g. glass particles, plastics, etc.
2. Chemical contaminants, e.g. heavy metals, pesticide residues, dioxins, toxins (mycotoxins, phycotoxins), perchlorate, etc.
3. Biological contaminants, e.g. bacteria, fungi, yeasts and moulds

NB

Contaminants in food are managed according to their impact to human health. The first in the light of this perspective Maximum Levels (MLs) for specific contaminants are set by Codex and Regulatory Authorities e.g. EU. ML is the maximum content of a contaminant allowed in food to ensure global its safety. This is expressed in sub-units of kg of the contaminant per kg of food. This value is estimated by summarising all daily consumed products.

In certain cases, e.g. iodine, the same substance behaves as micronutrients that can have an impact on human health depending on their bioavailability. Certain minerals, such as iron and zinc, are essential nutrients that the body needs to function properly. However, consuming too much of these minerals can be harmful to health. Therefore, it is important to establish safe intake levels for these micronutrients to avoid potential toxicity.

2. Microbial contamination and biotoxin regulation

This section presents the official list of contaminants found in any food product (bacteria and toxins from mould occurring during preservation). A list of biotoxins produced by naturally occurring micro-algae species are specified in the table. Some biotoxins are able to contaminate seaweed biomass when grown at sea. Terrestrial plant toxins (tropane alkaloids, hydrocyanic acid, pyrrolizidine alkaloids, opium alkaloids, TCH) were judged not relevant in terms of algae-based food and not added in the below table. Only erucic acid, an omega-9 fatty acid is found is certain microalgae species and detailed in section C. Organic contaminants.

Microbial contaminants and toxins	Maximum levels	Targeted product	Reference	Limits for Algae as Food (French recommendation)*
Salmonella, Salmonella typhimurium and *enteritidis*	Absence in 25g of final product	Meat, dairy, egg, spouted seeds, precut fruits and vegetables and juices, live and cooked bivalves and crustaceans; Products placed on the market during their shelf-life	EUROPEAN COMMISSION REGULATION (EC) No 2073/2005 (1)	Absence in 25g of final dry product
Listeria monocytogenes	Absence in 25g of final product	All ready to eat foods. Products placed on the market during their shelf-life		Not available
Escherichia coli	230 MPN/ 100 g of flesh and intervalvular liquid	Live molluscs, echinoderms, tunicates and gastropods placed on the market during their shelf life.		Not available
Shiga toxin produced by *Escherichia* coli	Absence in 25g of final product	Sprouts, Products placed on the market during their shelf-life		Not available
Aerobic mesophilic germs	Not available			< 100 000 cfu / g DW
Faecal coliforms	Not available			< 10 cfu / g DW
Sulphite reducing anaerobic bacteria	Not available			< 100 cfu / g DW
Staphylococcus aureus	Not available			< 100 cfu / g DW
Clostridium perfringens	Not available			< 1 cfu / g DW

Microbial contaminants and toxins	Maximum levels	Targeted product	Reference	Limits for Algae as Food (French recommendation)*
Cyanotoxins (2) produced by cyanobacteria blooms (environment)				
Microcystins (MC) produced by *Microcystis*, *Aphanizomenon*, *Dolichospermum* (ex. *Anabaena*), *Nostoc*, *Limnothrix*, *Phormidium*, *Oscillatoria*, and *Planktothrix*)	Provisional guideline 1µg /L (long term exposure) and 12µg/L (short term exposure)	Drinking water	WHO Guidelines for Drinking-Water Quality: Geneva, Switzerland, 2003. European Union Directive (EU). 2020/2184, EU (revised) Drinking Water Directive	Preparations of *Aphanizomenon flos-aquae* are only authorised if it can be demonstrated by analytical reports that they do not contain microcystin (< 1µg/g) and other marine toxins (Arreté du 24 Juin 2014)
Anatoxin-a (ANTX) produced by *Dolichospermum*, *Oscillatoria*, *Cylindrospermum*, & *Aphanizomenon*	30µg/L (short term exposure)			
Saxitoxin (STX) produced by *Dolichospermum*, *Aphanizomenon*, *Cylindrospermopsis*, *Lyngbya*, *Planktothrix*, *Raphidiopsis*, *Fischerella*, *Geitlerinema* and *Scytonema*	3 µg/L (short term exposure)			
Cylindrospermin (CYN) produced by *Cylindrospermopsis*, *Aphanizomenon*, *Dolichospermum*, *Lyngbya*, *Rhadiopsis*, *Planktothrix*, and *Umezakia*	0.7 µg/L ((long term exposure) and 3 µg/L (short term exposure)			
Nodularins (NODs) produced by *Nodularia spumigena* and *Nodularia sphaerocarpa*	Not available			

Microbial contaminants and toxins	Maximum levels	Targeted product	Reference	Limits for Algae as Food (French recommendation)*
Biotoxins from Dinoflagellates				
Brevetoxins (BTX) from Karenia brevis formerly *Gymnodinium* breve and *Ptychodiscus brevis* (cause neurotoxic shellfish poisoning)	200 mouse units (MU3)/kg	Shellfish or fish (meat) Shellfish (meat)	International Food Regulation Standard CODEXSTAN 292–2008. ● No EU regulation ● US, Australia/New Zealand and Mexico apply a threshold of 800 µg /kg ● ANSES guidance level of 180 µg BTX-3 eq./kg	
Ptychodiscus brevis (cause neurotoxic shellfish poisoning)				
Yessotoxins (cause gastrointestinal symptoms)	3.75 µg/kg		COMMISSION REGULATION (EU) No 786/2013 amending (EC) No 853/2004	
Pectenotoxins (cause diarrhetic shellfish poisoning)	160 mg/kg		COMMISSION REGULATION (EU) No 853/2004	
Okadaic acid (cause diarrhetic shellfish poisoning)	160 mg/kg			
Azaspiracids from Azadinium spinosum (cause gastrointestinal symptoms)	160 mg/kg			
Gymnodimines from *Alexandrium ostenfeldii* and *Karenia selliformis* (cause diarrhetic shellfish poisoning)			Not found	
Ciguatoxins (cause ciguatera fish poisoning)			Not found	
Saxitoxin			Not found	
Mycotoxins produced during storage				
Patulin (produced by molds)	10-50 µg/kg	Fruit juices, spirit drinks and baby food.	EUROPEAN COMMISSION REGULATION (EU) 2023/915	
Ochratoxin A	0.5-80 µg/kg	Unprocessed and processed cereals, vine fruits (dried and juice), roasted coffee beans, soluble coffee, dietary foods, spices, liquorice, wheat gluten.		
Deoxynivalenol	200-1750 µg/kg	Unprocessed cereals, Patsa, bread, maize,		

		processed cereals and maize based products		
Citrinin	100 µg/kg	Fermented rice with red yeast food supplements		
Fumonisins	200-4000 µg/kg	Unprocessed and processed maize based food products.		
Zearalenone:	20-400 µg/kg	Unprocessed cereals, bread, maize oil,		
Aflatoxins (sum)	4-15 µg/kg	Cereals, nuts, oilseed, dried fruit, maize, rice, processed cereals and dairy based foods		

(1) EC regulation COMMISSION REGULATION (EC) No 2073/2005 describes general microbiological food safety criteria for foodstuffs. Micro-organisms means bacteria, viruses, yeasts, moulds, algae, parasitic protozoa, microscopic parasitic helminths, and their toxins and metabolites. Food safety criterion means a criterion defining the acceptability of a product or a batch of foodstuff applicable to products placed on the market.

(2) Cyanotoxins and Food Contamination in Developing Countries: Review of Their Types, Toxicity, Analysis, Occurrence and Mitigation Strategies. Toxins 2021, 13(11), 786; https://doi.org/10.3390/toxins13110786

(3) The mouse bioassay is an analytical method used to detect marine biotoxins in shellfish.
A mouse unit (MU) is the amount of raw extract required to kill 50% of mice.

3. Inorganic contamination regulation including algae specificities

The content of some inorganic contaminants is found to be specific to certain algae species. Notably, Arsenic and Iodine content in brown seaweed have been under the light due to inherent levels which can be found beyond health regulation thresholds.

Inorganic contaminants	Maximum levels	Targeted product	Reference	Limits for algae as food (French recommendation)*
Metals				
Mercury Hg	0,1 -1 mg/kg	Fish, meat, food supplements	EUROPEAN COMMISSION REGULATION (EU) 2023/915	0.1 mg/kg DW
Mercury Hg	0,01 mg/kg	0290000 Algae and prokaryotes organisms Note: the ML 0,01 applies to fresh algal biomass as food. If the biomass is dried, the factor FW/DW applies e.g if dry weight is 20% the ML is 0,05 mg/kg	EUROPEAN COMMISSION REGULATION (EC) 2005/396	
Inorganic tin Sn2: when tin is combined with chlorine, sulphur, or oxygen, it is called an inorganic tin.	50 - 200 mg/kg	Canned foods and beverages	EUROPEAN COMMISSION REGULATION (EU) 2023/915	5 mg/kg DW of Tin
Cadmium Cd	3 mg/kg for algae food supplements (consisting of at least 80% dried seaweed inclusion)	Vegetables, fruits, cereal grains, fungi, chocolate, meat, fish, molluscs, crustaceans, food supplements	EUROPEAN COMMISSION REGULATION (EU) 2023/915	0.35 mg/kg DW (1)
Lead Pb2+	0.02 - 3 mg/kg	Milk, meat, fish, molluscs, crustaceans, vegetables, cereals, wine, food supplements	EUROPEAN COMMISSION REGULATION (EU) 2023/915	5 mg/kg DW
Arsenic (inorganic)	0.03-0.5 mg/kg	Cereals, rice, juices, salt	EUROPEAN COMMISSION REGULATION (EU) 2023/915	3 mg/kg DW (2)
Arsenic (total) As2O3 and As2O5	0.5 mg/kg	Salt but level applied to all food stuff	EUROPEAN COMMISSION REGULATION (EU) 2023/915	
Nickel Ni2+ (3)	2.8 µg/kg			
Other inorganic contaminants				

Iodine (metaloid) elemental diatomic iodine (I2) and ionic monoatomic iodide (I-)	20 mg/kg DW	Dried algae	COMMISSION RECOMMENDATION (EU) 2018/464 of 19 March 2018. Levels extracted from the Scientific committee for food in 2006	2 000 mg/kg DW (4)
Nitrate NO3-	200-7000 mg/kg	Spinach, lettuce, processed foods	EUROPEAN COMMISSION REGULATION (EU) 2023/915	
Perchlorate	0.05-0.75 mg/kg	Fruits and vegetable, herbs, Tea, dried herbal and fruit infusions, processed cereal based food.		

*French regulation: AVIS de l'Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail relatif au risque d'excès d'apport en iode lié à la consommation d'algues dans les denrées alimentaire. Saisine 2017-SA 0086. Link in French

(1) Cadmium in Algae

Results from an EU-Regional funded project named QUALITALG assessing the content of heavy metals and Iodine in a large selection of harvested seaweed in Britany has been provided to the French National Agency of Food Security (ANSES) as well as the EFSA in the scope of revising the current legislation. The request involves not only cadmium but also inorganic arsenic and mercury. From this study, a paper published in May 2023, specifies this request for revision with new recommended values of 1 mg/kg dw for cadmium, 10 mg/kg dw for inorganic arsenic, and 0.3 mg/kg dw for mercury (Ficheux et al., 2023).

(2) Arsenic in Algae

Certain algae species naturally bio-accumulate Arsenic to levels which do not comply with regulation. Arsenic in Algae can be found under organic forms (generally called arseno-sugars) and under inorganic form. Arsenic, only in its inorganic form, is a carcinogen and the consumption of food is the primary source of arsenic exposure for the general public. Inorganic arsenic levels in algae can reach roughly 0.3 mg/kg DW algae, while the total organic arsenic reaches up to more than 50 mg/kg DW mainly in Laminaria type species (brown seaweed).

Rice is also known to accumulate high concentrations of arsenic (As) and its consumption can be a vector of exposure to inorganic arsenic. The present regulation is based on rice food stuff and stipulates a threshold of 0.1 mg of inorganic arsenic/kg for rice intended to be used for the production of food products. Well known cooking practices of rice can reduce the proportion of inorganic arsenic in algae too (paraboiling for 5 minutes, rinsed and cooked again).

However, the question of organic arsenic is still pending. Although not carcinogen, organic arsenic when digested can circulate under its inorganic form in the digestive tractus and hence become a health issue. Indeed, if the total organic arsenic is transformed to inorganic arsenic, exposure levels inside the body would be up to 500-fold the regulation threshold.

(3) Nickel: an upcoming topic

According to the European Food Safety Authority (EFSA), food is the main source of nickel intake by the general population. Based on their risk assessment, EFSA determined that the tolerable daily intake (TDI) of nickel from all sources is 2.8 µg/kg body weight. This means that for an adult, the TDI would be 196 µg, while for a child it would be 56 µg. In most food products, the nickel content is less than 0.5 mg/kg fresh weight. However, cacao products and nuts may contain as much as 10 and 3 mg/kg respectively (Food as a source of exposure to nickel - PubMed (nih.gov) - https://pubmed.ncbi.nlm.nih.gov/31961102/ and 6.10-Nickel.doc (who.int): www.euro.who.int/__data/assets/pdf_file/0014/123080/AQG2ndEd_6_10Nickel.pdf).

(4) Iodine in Algae

The satisfactory intake (AI) of iodine in Europe is fixed at 150 µg for adult men and women. The upper safety limit is set to 600 µg (EFSA, 2014; ANSES 2017). France also recommends a maximum iodine content in algae of 2000 mg / kg dry. Laminaria species (brown seaweed) can reveal high levels of iodine exceeding the French regulation. This maximum level is recommended if consumers do not exceed 0.3 g of seaweed (Kombu) per day.

It is possible to reduce iodine content in brown algae before consuming the algae. Indeed, cooking practices can drastically reduce iodine content. Blanchiment has been demonstrated as the most effective process to reduce iodine content. Applying 80°C during 2minutes reduced iodine content by more than 10-fold which enables the algae to be in line with health regulations (Nielsen et al., 2020) but such treatment can reduce the nutritional value of the seaweed by destroying bioactives

or removing nutrients. However more mild treatments to reduce iodine content and preserve the nutritious aspects have been investigated by soaking the biomass for 1 hour at 32°C in fresh water (Stevant et al., 2018).

Iodine – references

1. Stévant Pierrick, Hélène Marfaing, Arne Duinker, Joël Fleurence, Turid Rustad, Ingrid Sandbakken, Annelise Chapman. 2018. *Biomass soaking treatments to reduce potentially undesirable compounds in the edible seaweeds sugar kelp (Saccharina latissima) and winged kelp (Alaria esculenta) and health risk estimation for human consumption*. Journal of Applied Phycology 30 (1).

2. Nielsen Wirenfeldt Cecilie, Susan Løvstad Holdt, Jens J. Sloth, Gonçalo Silva Marinho, Maren Sæther, Jon Funderud and Turid Rustad. 2020. *Reducing the High Iodine Content of Saccharina latissima and Improving the Profile of Other Valuable Compounds by Water Blanching*. Foods, 9, 569.

3. Ficheux Anne-Sophie, Bruno Boniou, Gaël Durand, Raphaële Le Garrec, Ophélie Pierre, Alain-Claude Roudot. 2023. *Dietary exposure and risk assessment to trace elements and iodine in seaweeds. Journal of Trace Elements in Medicine and Biology 78* (2023) 127-187.

4. European position: The European Food Safety Authority (EFSA) has established an upper limit of 600 micrograms per day. The maximum level of iodine allowed in food varies by country.

EFSA (European Food Safety Authority), Dujardin B, Ferreira de Sousa, R, Gómez Ruiz JA, 2023. Scientific Report on the dietary exposure to heavy metals and iodine intake via consumption of seaweeds and halophytes in the European population. EFSA Journal 2023; 21(1):7798, 47 pp. https://doi.org/10.2903/j.efsa.2023.7798

5. France position: The recommendations of ANSES for an adequate iodine intake are age-dependent and increase from 70 to 90 micrograms per day for children; from 120 to 150 micrograms per day for adolescents and adults and to 200 for a pregnant or breastfeeding women. Upper intake level is defined between 200 and 600 micrograms per day in function of the age. There is a legal iodine limit of 150 micrograms in food supplements.

ANSES, May 07 2021, Dietary reference values for vitamins and minerals https://www.anses.fr/en/content/dietary-reference-values-vitamins-and-minerals

Food compliance international, Aug 01, 2018, FRANCE RECOMMENDS TO LIMIT IODINE INTAKE FROM ALGAE, https://foodcomplianceinternational.com/industry-insight/news/1036-france-recommends-to-limit-iodine-intake-from-algae

6. Germany position: The recommendations of the German Nutrition Society (DGE) for an adequate iodine intake are age-dependent and increase from 40 to 80 micrograms per day for infants to 200 micrograms per day for adolescents and adults. As women need more iodine during pregnancy and while breastfeeding, an intake of 230 and 260 micrograms per day is recommended here. A maximum daily intake of up to 500 micrograms of iodine is regarded as safe in Germany, also for people who react sensitively to an iodine load. This quantity is not exceeded with a normal diet. The Federal Institute for Risk Assessment recommends a maximum level of 100 micrograms (µg) of iodine per daily recommended dose of an individual food supplement. For pregnant and lactating women, a maximum level of 150 µg iodine per recommended daily dose of a food supplement is recommended.

German Federal Institute for Risk Assessment (BfR), A-Z index to iodine: https://www.bfr.bund.de/en/a-z_index/iodine-129903.html

German Federal Institute for Risk Assessment (BfR), March 15 2021, Proposed maximum levels for the addition of iodine to foods including food supplements, https://www.bfr.bund.de/cm/349/proposed-maximum-levels-for-the-addition-of-iodine-to-foods-including-food-supplements.pdf

7. United States position: the Food and Drug Administration (FDA) developed Daily Values (DVs) to help consumers compare the nutrient contents of foods and dietary supplements within the context of a total diet. The DV for iodine is 150 mcg for adults and children aged 4 years and older: NIH publication.

National Institutes of Health, US, Iodine : Fact Sheet for Health Professionals, March 02 2018, updated May 01 2024 https://ods.od.nih.gov/factsheets/Iodine-HealthProfessional/

4. Organic contamination regulation

Organic contaminants	Maximum Levels	Targeted product	Reference
Persistent contaminants			
Sum of Dioxins (WHO-TEQ/g)	1-5 pg / g fat 0.1-3.5 pg/wet weight	Meat and meat products, Marine oils, Milk	EUROPEAN COMMISSION REGULATION (EU) 2023/915
Sum Dioxin + Dioxin-like PCBs (WHO-TEQ/g)	1.25-10 pg / g fat 0.5-20 pg/g wet weight		
Non-dioxin-like PCBs: (ng.g)	40-200 µg/kg fat 3-300 µg/kg wet weight		
Sum of all Perfluoroalkyl substances (PFOS, PFOA, PFNA, PFHxS)	1.3-50 µg/kg	Meat, Fish meat, crustaceans and molluscs, eggs	
Processing contaminants			
Polycyclic Aromatic Hydrocarbons (PAH) (benzo(a)pyrene) and sum of 4 PAHs)	1-50 g/kg	Food supplements containing botanicals and their preparations (powdered plants, plants parts, algae, fingi, lichen, tinctures…) Food supplements containing propolis, royal jelly, spirulina or their preparations	EUROPEAN COMMISSION REGULATION (EU) 2023/915
3-monochloropropane-1,2-diol (3-MCPD) (1)	20 (for liquid product containing 40% dry matter)	Hydrolysed vegetable proteins, soy sauce	
Sum of 3-MCPD and fatty acid esters	15-2500µg/kg	Vegetable oils, fish oil and oils from marine organisms	
Glycidyl fatty acid esters, expressed as glycidol	6-1000 µg/kg	Vegetable oils and fats, fish oils and oils from other marine organisms	
Histamine	200 - 400 mg/kg	Fishery products from fish species associated with a high amount of histidine.	EUROPEAN COMMISSION REGULATION (EC) No 2073/2005
Other relevant organic contaminants			
Melamine C3H6N6	0.15 - 2.5 mg/kg	All food products	EUROPEAN COMMISSION REGULATION (EU) 2023/915
Erucic acid C22H42O2 (2)	20 - 50 g/kg	Vegetable oils and fats, mustard	
Bromoform CHBr3 (3)	100 µg/litre	Drinking water	Guideline value - WHO/SDE/WSH/03.04/64

(1) 3-MCPD (3-monochloropropane 1,2-diol) is a carcinogenic contaminant of acid hydrolysed vegetable protein (acid-HVP), producing genotoxic intermediates on metabolism such as epoxide glycidol1. It was first identified as a contaminant of soy sauce and acid-hydrolysed vegetable protein (a savoury food ingredient) and has since been detected at low levels in a number of foods and ingredients. 2- and 3-MCPD and Their Esters in Vegetable Oils | Eufic - www.eufic.org/en/food-production/article/process-contaminants-in-vegetable-oils-and-foods-qa; Bioaccessibility and Bioavailability of Minerals in Relation to a Healthy Gut Microbiome - PubMed (nih.gov) - Int J Mol Sci . 2021 Jun 24;22(13):6803. doi: 10.3390/ijms22136803.

(2) Erucic acid is an omega-9 unsaturated fatty acid general found as a biotoxin in oil rich seeds from terrestrial plants (Rapeseed, Colza …) with levels able to reach 60% of the total fatty acids (FA). Selected varieties are now cultivated to respond

to health concerns now exposing levels less than 2%, i.e below the 5% recommendation level (https://www.cfs.gov.hk/english/multimedia/multimedia_pub/multimedia_pub_fsf_162_02.html). Certain micro-algae are also able to naturally produce this compound: erucic acid content in Gloeocapsa (cyanobacteria) for instance was reported with 8% of the total FA (10.47832/2717-8234.12.16)

(3) Bromoform is found in certain seaweed species, notably Asparagopsis. It is a volatile compound therefore the content measured in algae samples can vary (between 1µg / g DW algae to 23 mg / g DW) greatly depending on the biomass storage conditions but also depending on the growth temperature as well as geographical origin of the isolates, even on small spatial scale (doi.org/10.1007/s10811-022-02706-1). Bromoform is considered as the most important contributor to the anti-methanogenic activity of Asparagopsis when used in animal feed.

5. Regulation and Recommendations

EC Regulation - EUROPEAN COMMISSION REGULATION (EC) No 1881/2006 - of 19 December 2006 Setting maximum levels for certain contaminants in foodstuffs.

EC Regulation - COMMISSION REGULATION (EU) 2023/915 of 25 April 2023 on maximum levels for certain contaminants in food and repealing Regulation (EC) No 1881/2006

EC Regulation - COMMISSION REGULATION (EC) No 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs

EFSA Journal - Dietary exposure to heavy metals and iodine intake via consumption of seaweeds and halophytes in the European population, 2022.

EC Recommendations - COMMISSION RECOMMENDATION (EU) 2018/464 of 19 March 2018 on the monitoring of metals and iodine in seaweed, halophytes and products based on seaweed.

Anses Opinion - Opinion of the French Agency for Food, Environmental and on the state of knowledge on brevetoxins in shellfish, data on toxicity, occurrence and brevetoxin-producing microalgae; Request n° 2020-SA-0020

WHO Guidelines - Trihalomethanes in Drinking-water Background document for development of WHO Guidelines for Drinking-water Quality

Centre for the Promotion of Imports from developing countries (CBI), (2022), Entering the European market for seaweed - https://www.cbi.eu/market-information/fish-seafood/seaweed/market-entry

The European Rapid Alert System for Food and Feed (RASFF). The European Union offers one of the highest food safety standards in the world. One of the key tools for achieving this high standard is the RASFF - the European Rapid Alert System for Food and Feed. More than 3,500 RASFF notifications and more than 10,000 follow-up notifications annually, with a rising trend, are shared among network members. https://webgate.ec.europa.eu/rasff-window/screen/consumers

NOTIFICATION 2022.6268. Excessive iodine content in dried seaweed from China Notified 26 OCT 2022 by Germany | last update 25 NOV 2022https://webgate.ec.europa.eu/rasff-window/screen/notification/575103

Cressey, Wright, Gautam, Horn, Wheeler, Hampton and Harwood (2023) Evaluation of food safety risks associated with seaweed and seaweed products, New Zeland Food Safety Technical papar № 2023/01
https://www.mpi.govt.nz/dmsdocument/55825-Evaluation-of-food-safety-risks-associated-with-seaweed-and-seaweed-products

Hogstad, Solbjørg & Cederberg, Dorthe & Eriksen, Helle & Kollander, Barbro & Ólafsson, Grímur & ikkelsen, Bjørg. (2023). A Nordic approach to food safety risk management of seaweed for use as food. 10.6027/temanord2022-564

6. Conclusions

1. Need for Harmonized Regulation: The variability in maximum contaminant levels across EU countries poses challenges and threats to competition within the algae sector. Harmonizing regulations at the EU level is crucial for consistency and clarity.

2. Microbial Contamination Risks: Algae-based products are susceptible to microbial contamination, including bacteria like Salmonella and Listeria monocytogenes, necessitating strict adherence to regulations to ensure food safety.

3. Toxin Management: Biotoxins produced by micro-algae species present significant risks, requiring clear guidelines and monitoring to prevent contamination, particularly from cyanotoxins and dinoflagellate biotoxins.

4. Heavy Metal Concerns: Certain algae species accumulate inorganic contaminants such as arsenic and iodine, raising health concerns.

5. Regulations need to address specific contaminant levels in algae-based products to mitigate health risks

6. Iodine Management: Brown seaweed, a common algae type, contains high levels of iodine, necessitating regulations to ensure consumer safety. Cooking practices may reduce iodine content while preserving nutritional value.

7. Organic Contaminants Awareness: Awareness of persistent organic contaminants like dioxins and non-dioxin-like PCBs in algae-based products is essential, along with regulations to limit exposure and ensure food safety.

8. Erucic Acid Monitoring: Erucic acid, present in certain algae species, requires monitoring to prevent potential health risks. Regulations should address safe levels in algae-based foods and supplements.

9. Processing Contaminant Control: Algae-based food supplements may contain processing contaminants like 3-MCPD and PAHs, highlighting the importance of regulation to ensure product safety.

10. Melamine Concerns: Regulatory measures are necessary to control melamine levels in all food products, including those containing algae, to prevent health risks associated with its consumption.

11. Bromoform Awareness: Bromoform found in certain seaweed species requires attention due to its variability in content and potential health implications. Regulations should ensure its monitoring and control in algae-based products.

7. Contributors

Monique Ras, EABA Scientific Advisor
monique.ras@eaba-association.org

Hélène Marfaing, Food Applications Project manager, CEVA, France
helene.marfaing@ceva.fr

Silvio Mangini, Scientific Officer, Archimed Ricerche, Italy
mangini@archimedericerche.com

Céline Rebours, Researcher at NIBIO BIOFORKS, Norway
Celine.Rebours@moreforsking.no

Françoise Duchemin, General Secretary of the 'Chambre Syndicale des Algues et des Végétaux Marins', France
secretariat.algues@gmail.com

Ronan Pierre, Director of Algae Innovation and Products, CEVA, France
ronan.pierre@ceva.fr

Rui Costa, Professor at Politécnico de Coimbra, Portugal
ruicosta@esac.pt

Florence Dufreneix, CEVA, France
florence.dufreneix@ceva.fr

Antonio Luca Langellotti, University of Naples
langello@unina.it