Seaweed information sheets

Introduction

The South Pacific seaweed industry is developing, and the untapped diversity of available native species offers many opportunities for value-added products that can stimulate local blue economies and food security by producing local nutritious and sustainable blue foods, agro and aqua-feed, fertilizers, biomaterials or nature-based environmental solutions. However, urbanisation, industrial development, agriculture, and the particular geology of some islands can release many contaminants into the marine environment (e.g., heavy metals, metalloids, pesticide residues, and persistent organic pollutants). Seaweeds are known to accumulate metals and other contaminants from their growing environment, which can be a major food safety concern and a barrier to developing seaweed-based products for food, feed, fertilizers, or cosmetics. However, despite the exponential growth of the seaweed market, regulations and standards about the safety of seaweeds for human consumption are still very poor globally and are virtually non-existent in tropical regions, highlighting the need for new data to enable the development of dedicated standards and regulations.

The southPACIWEED project was funded by the Global Seaweed Coalition to assess safety issues and the lack of standards that may hinder the development and diversification of the seaweed industry in the South Pacific region, particularly in French overseas territories. The project reviewed existing international regulations and produced new data (heavy metals, metalloids, persistent organic pollutants, pesticide residues, iodine) for a selection of tropical species from French Polynesia, New Caledonia and Wallis and Futuna. The risks associated with seaweed consumption across the region were assessed and the southPACIWEED working group produced a set of recommendations for the development of regional standards and opportunities.

Objectives of the factsheets: To raise awareness and make recommendations on the health benefits and risks of tropical seaweed species with known uses and economic potential in the South Pacific region

Target audience: Fisheries and other governmental bodies, industry and entrepreneurs, seaweed harvesters, users or consumers

Selected seaweeds: Two-page cards are provided for nine selected genera with known or potential uses and economic potential in French overseas territories:

- Chlorophyta > *Ulva, Caulerpa*
- Rhodophyta > *Acanthophora, Asparagopsis, Gracilaria*
- Phaeophyceae > *Cladosiphon, Padina, Sargassum, Turbinaria*





General recommendations

Species safe for consumption: Any species with a contaminant level exceeding the maximum limits recommended in France and set by the European Union (EU) should not be sold for human consumption in French Overseas. For species whose consumption is not recommended, non-food applications are to be preferred (e.g. biomaterials, extraction of molecules of interest, bioremediation). Although regulations for human consumption are more stringent than for animal or plant nutrition, specific regulations may apply and must be explored in greater detail before envisaging these types of applications.

Compulsory and recommended maximum limits: For food applications, we recommend that the following metals and pollutants be assessed in seaweeds from French Polynesia, New Caledonia and Wallis and Futuna: (i) compulsory: iAs (inorganic Arsenic), Cd (Cadmium), Pb (Lead), Hg (Mercury), I (Iodine), Sn (Tin), pesticide residues (French and EU regulations/recommendations with specific maximum limits for seaweeds); (ii) recommended: Cr (Chromium), Mn (Manganese), Ni (Nickel), Zn (Zinc), Polycyclic Aromatic Hydrocarbon (PAH: ∑ b[a]p,b[a]a,b[b]f, CR).

Cr, Mn, Ni, and Zn: Cr, Mn, Ni, and Zn in some of our samples exceeded international thresholds, and no specific French or EU regulations are available to apply to French overseas territories. Therefore, we recommend setting maximum limits specifically for seaweeds in New Caledonia, Wallis and Futuna, and French Polynesia.

global seaweed coalition

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PAH (∑ b[a]p,b[a]a,b[b]f, CR): An EU regulation exists for PAH (∑ b[a]p,b[a]a,b[b]f, CR) that sets a maximum limit in "food supplements containing plants and their preparations". We recommend that the prevalence of this pollutant in Pacific French overseas territories be assessed more extensively and that the need to set a maximum limit for seaweed food products be examined.

Assess contaminants at all harvested sites: Because contaminants may be highly site-dependent and vary depending on the water nutrient level (e.g. fertilized cultivation), we recommend measuring contaminants in the biomass growing at all harvested sites (wild or cultivated).

Hazard Index: When establishing a new regulation, recommendation or standard, consider the Hazard Index in addition to individual contaminant thresholds.

Build local datasets: Produce new data, where missing, to identify the strengths and weaknesses of the local species and make local recommendations.

Final product safety: Assess the impact of processing/transforming the biomass on contaminants loads (can reduce contaminant levels and vary according to the parts of the seaweed consumed).

Species selection tool: Build a regional species ranking tool to help select species according to economic potential and health risks.

Novel food seaweed list: Propose tropical species such as *Caulerpa* and other species safe for consumption to extend the European Novel food seaweed species list.

Raise awareness: Locally raise awareness on seaweed potential, and health benefits and risks.

Set up a regional working group: Set up a regional working group to develop regional recommendations on contaminants and the dietary value of seaweed.

References

These information sheets were built using results acquired during the southPACIWEED project and references listed in the final project report:

Mattio L., Zubia, M. Payri C., Whitford J., Vanderklift M. Steven A., Nine Doutreloux N., Jeaugeon B., Salvan C. and Lagourgue L. 2024. The southPACIWEED project, A South Pacific Seaweed Working Group to address seaweed safety and propose common standards. Final report. Global Seaweed Coalition. 38 p.

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Contributions

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Ulva

IDENTITY

Chlorophyta > Ulvales > Ulvaceae > *Ulva* Linnaeus

Morphology

Ulva, also formerly known as *Enteromorpha*, has foliose and tubular forms. Both forms are dark to light green and attach to the substrate with a discoid holdfast. Foliose species have thin to translucent blades with smooth or serrated margins. Tubular species have fine branches, ramified or not, one to several cells thick.

Diversity in French Polynesia, New Caledonia and Wallis and Futuna:

Ulva arbuscula, U. batuffolosa, U. chaetomorphoides, U. clathrata, U. compressa, U. finissima, U. flexuosa, U. intestinalis, U. lactuca, U. ohnoi, U. paradoxa, U. pennata, U. planiramosa, U. pluriramosa, U. prolifera, U. rigida, U. scolopendra, U. siganiphyllia, U. spumosa, U. tentaculosa

Common names in the South Pacific

Tubular forms > English: bright green nori, gut weed, hallow-green nori, link confetti, spiky tendrils, stone hair, tape weed, thread weed, winding nori; **Hawaiian:** limu pipilani; **Polynesian:** imutapaa (ripe algae), imu ketaha (encroaching algae), imu ouohu (hair algae); **French:** ulve en tube, laitue de mer; **French (New Caledonia):** herbes à picots.

Foliose forms > English: sea lettuce, green laver; **French:** laitue de mer, ulve en tube; **Tahitian:** rimu miti

ECOLOGY & DISTRIBUTION

Seasonality

More abundant in the warm season.

Reproduction

Vegetative reproduction by fragmentation or from persistent holdfasts. The sexual reproductive cycle alternates isomorphic and unisexual haploid gametophytes and diploid sporophytes.

Environmental risk

Some species are known to cause green tides when in specific conditions and to produce toxic gases during putrefaction (hydrogen sulfide).

Habitat

Lagoon, bay, reef. *Ulva* is ubiquitous in marine, brackish and freshwater environments and, as nitrophilic organisms, can proliferate in eutrophic environments.

Tropical South Pacific distribution

Cosmopolitan, species of *Ulva* are recorded from Central Polynesia, Easter Island, Fiji, French Polynesia, Line Islands, New Caledonia, Samoan Archipelago, American Samoa, Solomon Islands, Tuamotu Islands, Wallis and Futuna.

global seaweed coalition

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Ulva

PROPERTIES AND BENEFITS

Dietary information: *Ulva* can be a good source of protein, dietary fibres, and macro and microelements, particularly Cr, Fe, Mg, and Mn.

Main properties recorded in the literature: Antioxidant, antibacterial, antivirus, fungicide, anti-inflammation, anticoagulant, antihyperlipidemic, skin conditioning, emollient skin protecting, absorbent, binding, viscosity controlling, bleaching, miscellaneous, anti-ageing.

HEALTH RISKS

Contaminants: May accumulate some heavy metals and metalloids, including Cd, Cr, Pb, tAs, Mn, Ni, and Zn.

Toxicity: Produces toxic gases (hydrogen sulfide) during putrefaction.

ECONOMIC INFORMATION

Application sector: Food, feed (including methane reduction), agriculture (fertilizers), pharmaceutics, traditional medicine, nutraceuticals, cosmetics, bioenergy (biofuel), bioremediation, biomaterials (incl. bioplastics).

Traditional regional uses: Food in Cook Islands, Fiji and French Polynesia.

Market information: Medium value; well-developed market for food, cosmetics, nutraceuticals, feed, fertilizers and bioplastics.

STRENGTHS

- 10 applications recorded in the literature
- Numerous properties for pharmaceutics, nutraceuticals and cosmetic applications
- Market well developed
- Vegetative reproduction and rapid growth allow easy cultivation
- Ability to absorb contaminants and nutrients from the water
- Increase of protein contents when cultivated in food industry processed or any eutrophic waters
- Increased protein content when cultivated in food processing waters or eutrophic waters

WEAKNESSES

- Risk of accumulating contaminants (Cd, Cr, Pb, Mn, Ni, Zn)
- Risk of proliferation and green tides
- Tubular species may require long, careful, and delicate cleaning of accumulated sand
- Medium market value

RECOMMENDATIONS

- Take precautions during cultivation to prevent its proliferation in the natural environment.
- Check whether there are any sources of man-made or natural pollution upstream of the harvesting/cultivation site.
- Check water turbidity (indicative of organic matter load and the presence of potential heavy metals and metalloids associated with sediments).
- Co-cultivate or cultivate in process waters to increase protein content and provide bioremediation.
- Prioritise cultivation in low salinity to increase AA, protein, starch, and carbohydrate contents.

Caulerpa

IDENTITY

Chlorophyta > Bryopsidales >
Caulerpaceae > *Caulerpa* J.V.Lamouroux

Morphology

Caulerpa species are characterised by a coenocytic organization, meaning that they are composed of a giant multinucleated cell called a siphon. Externally, *Caulerpa* species consist of a creeping stolon from which upright fronds arise with a vertical axis (rachis) that can bear branchlets (ramuli). The thallus is anchored to the substratum by rhizoids.

Diversity in French Polynesia, New Caledonia and Wallis and Futuna:

Caulerpa ambigua, C. antoensis, C. bikinensis, C. biserrulata, C. brachypus, C. cactoides, C. chemnitzia, C. corynephora, C. cupressoides, C. cylindracea, C. diligulata, C. elongata, C. falcifolia, C. fastigiata, C. fergusonii, C. filicoides Yamada, *C. geminate, C. lentillifera, C. lessonii, C. lucasii, C. macra, C. macrodisca,C. manorensis, C. megadisca,C. mexicana, C. microphysa, C. nummularia, C. okamurae, C. oligophylla, C. opposita, C. pickerengii, C. racemosa, C. sedoides, C. serrulata, C. sertularioides, C. taxifolia, C. urvilleana, C. verticillata, C. vieillardii, C. webbiana.*

Common names in the South Pacific

English: green caviar, seagrapes, big parasol green seaweed, green feather alga, mouse plant, cactus tree alga, toothed spiral; **French:** raisins de la mer, caulerpe plume; **Fijian:** nama, nama wawa, nama levulevu, numa balavu, fuofua; **Filipino:** butbutones, saluysoy; **Indonesian:** lai lai; **Polynesian:** imu topua, imu pokupuku, konini, kinini; **Samoan:** limu, limu fuafua; **Tahitian:** rimu; **Tonga:** fuofua, kaka, louniu, toke.

ECOLOGY & DISTRIBUTION

Seasonality

Present all year round but less abundant in the cool season.

Reproduction

Vegetative reproduction by fragmentation of stolon. Holocarpic anisogamous sexual reproduction is described for some species.

Environmental risk

Some invasive species (*C. taxifolia* or *C. cylindracea*) have caused environmental problems in the Mediterranean Sea.

Habitat

Reefs (barrier intermediate, fringing, internal and external slopes, cave reef), coastal, in seagrass bed, reef flat, pinnacle; intertidal to at least 50 m deep.

Tropical South Pacific distribution

Cosmopolitan, species of *Caulerpa* are recorded from Central Polynesia, Easter Island, Fiji, French Polynesia, Line Islands, New Caledonia, American Samoa, Samoan Archipelago, Society Islands, Solomon Islands, Wallis and Futuna.

global seaweed coalition

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Caulerpa

PROPERTIES AND BENEFITS

Dietary information: Can be a good source of protein, dietary fibres, and macro and microelements particularly Ca, Cl, Cr, Cu, Fe, I, K, Mg, Mo, Na, P, Se, Zn, and vitamins (B12, C, E).

Main properties recorded in the literature: Antiviral effect of polysaccharides, film forming, skin conditioning, skin protection, humectant, astringent, hair conditioning, nail conditioning; antioxidant, ß-carotene, anti-fungal and anti-tumoral activities, painkilling and anti-inflammatory properties, inhibition of cholesterol absorption (plant stenol β-sitosterol), repellent, anti-neoplastic, antibacterial, and anti-proliferative activities, ichthyotoxic activity.

HEALTH RISKS

Contaminants: May accumulate heavy metals and metalloids, such as tAs, iAs, Mn, Zn, Cd, Hg, Pb, Se

Toxicity: Some species produce a poison called caulerpicin.

ECONOMIC INFORMATION

Application sector: Food, cosmetics, medicine, nutraceuticals, pharmaceutics, agriculture (fertilizers), aquarium trade.

Traditional regional uses: Consumed in many countries of the Pacific region: Fiji, French Polynesia, Hawaii, Japan, New Caledonia, New Zealand, Samoa, Tasmania and Tonga.

Market information: Well-developed market (e.g. food, cosmetics); high market value.

STRENGTHS

- Seven applications recorded in the literature
- Numerous properties for cosmetic applications
- High-value market products
- Vegetative reproduction facilitates cultivation
- Can be co-cultivated with benefits for increasing production and bioremediations
- Anteriority of consumption in the region could facilitate registration on the Novel food species list

WEAKNESSES

- Caulerpicin production
- Fragile and delicate to transport and keep (texture loss and becoming soft which can limit the market)
- Sensitive to salinity drops
- Cultivation conditions and environmental requirements specific to each species

RECOMMENDATIONS

- Include *Caulerpa* crops in integrated multitrophic aquaculture (IMTA) systems.
- Monitor the toxicity of the species in the final product.
- Use brine or salt for a longer conservation.
- Make careful choices for cultivation; take precautions to prevent proliferation in the natural environment.

Gracilaria

IDENTITY

Rhodophyta > Gracilariales >
Gracilariaceae > *Gracilaria* Greville

Morphology

Plant solitary, light to dark pink to reddish brownish (colour varies with species), erect to decumbent, attached by a discoid holdfast on rocky substratum or anchored in the sand or mud. The species are of diverse forms ranking from cylindrical to articulated or flattened thallus.

Diversity in French Polynesia, New Caledonia and Wallis and Futuna:

Gracilaria abbottiana, G. arcuata, G. caudata, G. canaliculata, G. chondracantha, G. corniculata, G. edulis, G. parvispora, G. salicornia, G. stipitata, G. textorii, G. vieillardii.

Common names in the South Pacific

English: ceylon moss; **Japanese:** hoso kabanori, kabonori, kanten, taiwan-ogonori; **Filipino:** goso-goso, kanutkanot, kinkintal, lablabig, lunglonggangan, samo sa lawod, susueldot-baybay; **Indonesian:** agar-agar, boeloeng, bulung-buka, ceylon, djanggoet, doejoeng, jafna moss; **Hawaiian:** gorilla ogo, limu ogo, long ogo, robusta.

ECOLOGY & DISTRIBUTION

Seasonality

Higher yields have been recorded in warm season.

Reproduction

Vegetative and sexual reproduction. Life cycle triphasic, including two free-living isomorphic generations.

Environmental risk

G. parvispora has become invasive in some regions (e.g. Hawaii).

Habitat

Lagoon, seagrass bed, bay, reef (intermediate fringing, barrier; internal and external slope); pass; reef plat; channel; intertidal and subtidal zones between 0.5 m and 10 m deep.

Tropical South Pacific distribution

Central Polynesia, Fiji, French Polynesia, Line Islands, New Caledonia, Wallis and Futuna.

global seaweed coalition

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Gracilaria

PROPERTIES AND BENEFITS

Dietary information: Can be a good source of protein, dietary fibres, carotenoids, sterols, polysaccharides, and macro and microelements, particularly K, Cl, Fe, Mn, and Cr.

Main properties recorded in the literature: Astringent, film forming, humectant, skin conditioning, viscosity controlling, ROS scavenger, antioxidant, anti-inflammatory, antidiabetic, antitumor, traditional laxative.

HEALTH RISKS

Contaminants: May accumulate heavy metals, including tAs, iAs, Cd, Hg, Mn, Ni, Pb, Sn, Zn, and iodine.

Toxicity: "Ogonori" poisoning caused by prostaglandins (type of eicosanoids). Rare but can be severe and lead to death if consumed with a rich source of arachidonic acid.

ECONOMIC INFORMATION

Application sector: Food, feed, food industry, cosmetics, bioremediation, pigments, pharmaceutics, medicine, agriculture (fertilizers).

Traditional regional uses: Food, medicine, painting.

Market information: Well-developed market (e.g. for polysaccharides); low market value.

STRENGTHS

- Nine applications recorded in the literature
- Numerous properties for cosmetic applications
- Market well developed
- Vegetative reproduction facilitates cultivation
- Cultivation mastered regionally (French Polynesia)

WEAKNESSES

- Low market value
- Considered as invasive in some regions

RECOMMENDATIONS

- Co-cultivate to provide bioremediation
- Take precautions to prevent proliferation in the natural environment.

Asparagospsis

IDENTITY

Rhodophyta > Bonnemaisoniales > Bonnemaisoniaceae > *Asparagopsis* Montagne

Morphology

In water, this sea vegetable looks like a forest of tiny pink trees, about 10–20 cm tall. Sometimes the colour can be yellowish-red or dark red. There is a creeping base with rigid upright branches. Each upright branch is covered in many fuzzy, soft, branchlets that get shorter towards the top. Tetrasporangial phase (known as 'Falkenbergia' stage) is diminutive, tufted, and uniaxial.

Diversity in French Polynesia, New Caledonia and Wallis and Futuna:

Asparagopsis armata,
A. taxiformis.

Common names in the South Pacific

English: harpoon weed, supreme limu;
Hawaiian: kohu koko, kohu lipeche, kohu lipehe, limu kohu, limu koko, limu lipaakai, limu nipaakai;
Japanese: kagikenori.

ECOLOGY & DISTRIBUTION

Reproduction

Sexual reproduction only. Life history triphasic, with an alternation of heteromorphic gametophytes and tetrasporophytes. The tetrasporangial phase is so different morphologically (purple-pink fluffy pompom) that it was described as a distinct genus, *Falkenbergia*, now recognised as a synonym.

Environmental risk

Invasive species in some regions (e.g. the Mediterranean Sea).

Habitat

Lagoon (patch reef, coastal island, pinnacle, channel), pass, coastal (bay, fringing reef, beach), reef (fringing, barrier, intermediate; external slope). Found in areas of constant water motion.

Seasonality

Yes.

Tropical South Pacific distribution

Central Polynesia, Easter Island, Fiji, French Polynesia, New Caledonia, Samoa, Wallis and Futuna.

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Asparagospsis

PROPERTIES AND BENEFITS

Dietary information: Can be a good source of protein, dietary fibres, and macro and microelements, particularly Ca, Mg, Na, Cl, and Cr.

Main properties recorded in the literature: Antimetanogenic, antiviral, anti-bacteria, skin protecting, antifouling, antimicrobial, anti-*Leishmania* compounds.

HEALTH RISKS

Contaminants: May accumulate heavy metals such as tAs, iAs, Cd or Mn, and iodine.

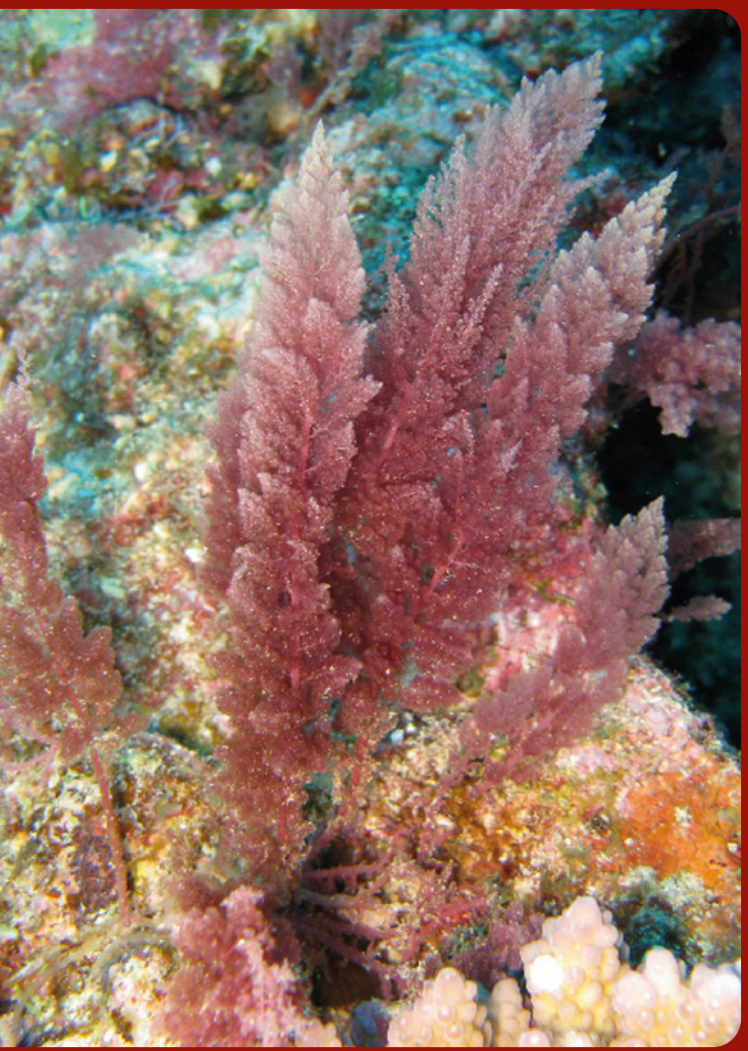
Toxicity: Highly volatile and toxic methane-busting chemical compounds; produce bromoform, which is a probable human carcinogen.

ECONOMIC INFORMATION

Application sector: Food, feed, functional food, cosmetics, pharmaceuticals, antifouling, bioremediation.

Traditional regional uses: Eaten in Hawaii and Indonesia; used for medicine in the Philippines.

Market information: Little developed for the time being, focused on feed, cosmetics, and food; high market value.



STRENGTHS

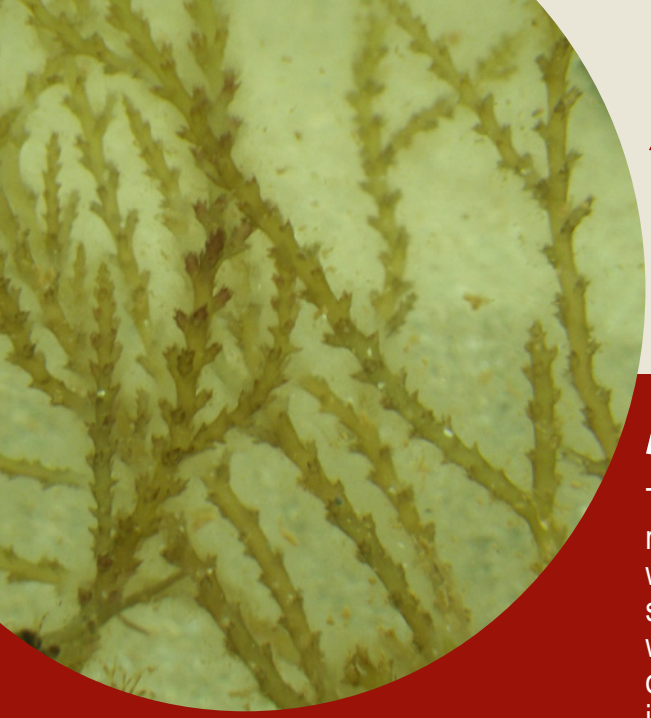
- Seven applications recorded in the literature
- Anti-methanogenic properties
- Promising feed market for livestock (sheep, cattle)
- High market value

WEAKNESSES

- Bromoform toxicity
- iAs, Cd, and iodine can be above recommended maximum limits
- Reproductive cultivation is still under research and development

RECOMMENDATIONS

- Co-cultivate to provide bioremediation
- Take precautions to prevent proliferation in the natural environment.



Acanthophora

IDENTITY

Rhodophyta > Ceramiales > Rhodomelaceae > *Acanthophora* J.V. Lamouroux

Morphology

Thallus erect, up to 40 cm tall, arising from a discoid stoloniferous or rhizomatous prostrate system. It has solid cylindrical branches, 2-3 mm wide, either sparingly or repeatedly branched. The main branches have short, determinate branches, which are irregularly shaped and spinose, with numerous and radially arranged spines. Colour ranges from shades of red, purple, or orange to brown, with usually darker colours in the intertidal and lighter colours in the shallows.

Diversity in French Polynesia, New Caledonia and Wallis and Futuna:

Acanthophora pacifica, A. spicifera.

Common names in the South Pacific

English: spiny sea plant, spiny seaweed;
Filipino: culot, kulot;
Fijian: lumikaro, lumi karokaro;
Indonesian: boeloeng, bideng; **Vanuatu:** kirokiro

ECOLOGY & DISTRIBUTION

Seasonality

Yes (more present during the wet than the dry season in New Caledonia). Blooms of the species during La Niña season in Hawaii.

Reproduction

Vegetative and sexual reproduction. Life cycle triphasic with alternating tetrasporophytic and gametophytic generations.

Environmental risk

A. spicifera has become invasive in some regions (e.g. Hawaii).

Habitat

Reefs (fringing, barrier, intermediate) or bays. In sand or sandy-silty substrate. Can grow on artificial supports such as rope and nets.

Tropical South Pacific distribution

Central Polynesia, Fiji, French Polynesia, New Caledonia, Samoa, American Samoa, Samoan Archipelago, Solomon Islands, Wallis and Futuna.

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Acanthophora

PROPERTIES AND BENEFITS

Dietary information:
Acanthophora is rich in macro and microelements such as Ca, Mg, Na, K, I, Fe, and Cr.

Main properties recorded in the literature:
Antibiotic, immunostimulant, antioxydant, fungicide.

HEALTH RISKS

Contaminants:
May accumulate heavy metals, including inorganic iAs and Cd.

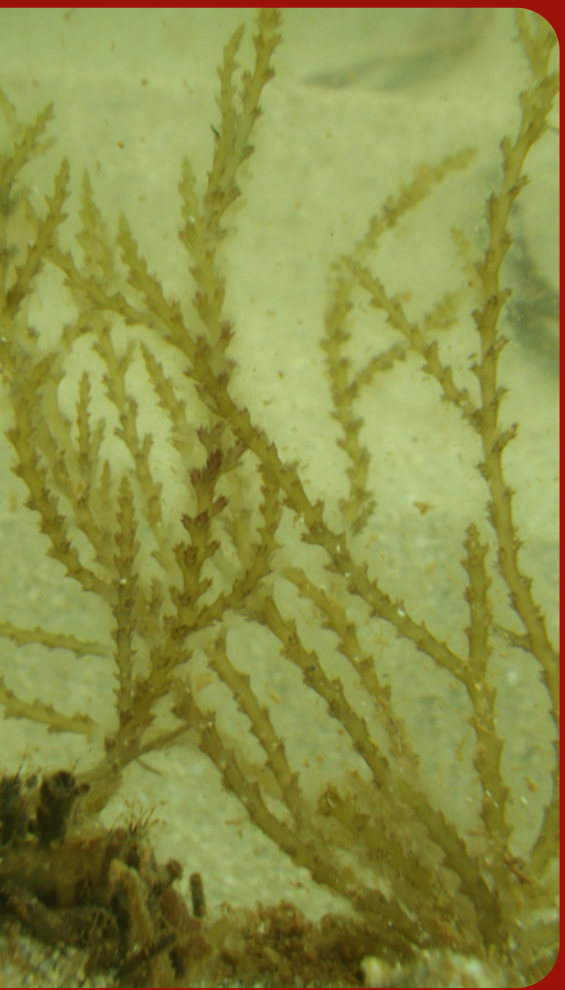
Toxicity: Unknown

ECONOMIC INFORMATION

Application sector:
Food, food industry, aquaculture, pharmaceutics, agriculture (compost), bioremediation, cosmetics.

Traditional regional uses:
Food in Tahiti, Fiji, Kiribati. *Acanthophora spicifera* is consumed in several tropical Pacific countries in the form of salads, spice, and as a thickening ingredient or emulsifying agent.

Market information:
Little developed market (food, aquarium trade, polysaccharides), with medium market value.



STRENGTHS

- Medium market value.
- Seven applications recorded in the literature.
- Anteriority of consumption in several countries (e.g. Indonesia, China, Philippines, Thailand, Fiji) could facilitate registration on the Novel food species list.

WEAKNESSES

- May be difficult to cultivate.
- Considered invasive in some regions.
- Market not well developed.
- iAs and Cd can be above recommended maximum limits.

RECOMMENDATIONS

- Take precautions to prevent proliferation in the natural environment.

Cladosiphon

IDENTITY

Phaeophyceae > Ectocarpales > Chordariaceae > *Cladosiphon* Kützing

Morphology

Plant erect, branched, slender, and pale to dark brown in colour. It is slippery to the touch and gelatinous or jelly-like. Branches are 1–2 mm wide and the plant is about 30 cm in length.

Diversity in French Polynesia, New Caledonia and Wallis and Futuna:

Cladosiphon novae-caledoniae, Cladosiphon sp.

Common names in the South Pacific

Japanese: – mozuku

Tongan: – limu tanga'u

ECOLOGY & DISTRIBUTION

Seasonality

Yes (August–November in New Caledonia; December in Tonga).

Reproduction

No vegetative reproduction. The sexual reproductive cycle is an alternation of heteromorphic generations with a microscopic discoid gametophyte and a macroscopic sporophyte forming the erect thallus most commonly found.

Environmental risk

Unknown.

Habitat

Shallow lagoon, sandy bottom or reef flats. Can attach to seagrass or other seaweed rather than the sea floor.

Tropical South Pacific distribution

French Polynesia, New Caledonia, Tonga.

global seaweed coalition

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Cladosiphon

PROPERTIES AND BENEFITS

Dietary information:
A good source of fucoidans, and macro and micronutrients including Mg, Na, Cr, and I.

Main properties recorded in the literature:
Anticancer, antitumoral, skin protecting, humectant, skin conditioning.

HEALTH RISKS

Contaminants:
May accumulate heavy metals, including tAs and iAs.

Toxicity: No significant toxicological changes were induced by fucoidan at a dose of 600 mg/kg of body weight/day. However, with concentrations at and above 1,200 mg/kg of body weight/day, clotting time was significantly prolonged. No other signs of toxicity were observed.

ECONOMIC INFORMATION

Application sector:
Food, feed, cosmetics, pharmaceutics, medicine.

Traditional regional uses:
Food (Japan, Tonga).

Market information:
Little developed market, focused on food and cosmetics; high market value.

STRENGTHS

- Four applications recorded in the literature
- Cultivation already mastered in Okinawa islands and Tonga
- Anteriority of consumption in Japan and Tonga could facilitate registration on the Novel food species list
- May represent a good opportunity for fucoidan extraction

WEAKNESSES

- iAs content can be above the recommended maximum limit
- The hazard index may be high (>1) and indicates that consumption can cause moderate to high side effects on human health

RECOMMENDATIONS

- Systematically assess iAs and tAs at any new harvesting or cultivation site
- Cultivate in nutrient-rich waters to lower As levels
- Try different processing methods of the biomass and assess the impact on As levels

blue weed
ALGAEDONIA
IRD Institut de Recherche pour le Développement FRANCE
UPF UNIVERSITÉ DE LA POLYNÉSIE FRANÇAISE
CSIRO
DSA WALLIS ET FUTUNA
Pacific Community Communauté du Pacifique

Padina

IDENTITY

Heterokontophyta > Phaeophyceae > Dictyotales > Dictyotaceae > *Padina* Adanson

Morphology

Padina is made of bunches of thin fan-like blades light brown in colour with apparent white zonations and lobed margins. It is attached to the substratum by a stipe and a rhizoidal holdfast.

Diversity in French Polynesia, New Caledonia and Wallis and Futuna:

Padina australis, P. boryana, P. gymnospora, P. jonesii, P. melemele, P. minor, P. pavonica, P. sanctae-crucis, P. stipitata.

Common names in the South Pacific

English: sea fan, fan-leaf seaweed, ear-like seaweed, limey petticoat, peacock's tail; **Portuguese:** orelha do mar; **Filipino:** dunggan-dunggan; **Indonesian:** agar-agar daun besar; **Spanish:** ova como ombligo; **Samoan:** limu lautaliga; **Japanese:** usuyukiuchiwa;

ECOLOGY & DISTRIBUTION

Seasonality

Yes

Reproduction

No vegetative reproduction. The life cycle is haplodiplontic isomorphic involving a gametophyte stage that produces male and female gametes, and a tetrasporophyte stage that produces spores.

Environmental risk

Unknown

Habitat

Can be found in a wide range of habitats from very shallow reef flats to deeper reef walls through lagoon sandy bottoms.

Tropical South Pacific distribution

Cosmopolitan genus, recorded throughout the South Pacific: Australia, New Caledonia, Papua New Guinea, Solomons, Vanuatu, Wallis and Futuna, Samoa, Fiji, French Polynesia, Tonga, Easter Island.

global seaweed coalition

The SouthPACIWEED project was funded by the Global Seaweed Coalition to assess the health risks associated with the consumption of macroalgae in the South Pacific and to make recommendations for sustainable and locally appropriate uses

Padina

PROPERTIES AND BENEFITS

Dietary information: *Padina* can have high carbohydrates and is particularly rich in Ca, and has interesting levels of other macro and micronutrients including Mg, Cl, I, Fe, Mn, and Cr.

Main properties recorded in the literature: Skin conditioning, humectant, collagen booster, anti-UV, antioxidant, anti-ageing, calcium supple-ment for osteoporosis, wound care, antimicrobial, anti-inflammation, antimethanogenic. Anticancer, antitumoral, skin protecting.

HEALTH RISKS

Contaminants: May accumulate heavy metals above recommended maximum limits, including tAs, iAs, Cr, Mn, Ni, Cd, Co, Cu, Pb, Zn, and PAH pollutants.

Toxicity: Unknown

ECONOMIC INFORMATION

Application sector: Food, feed, nanoparticle biosynthesis, bioremediation, cosmetics, pharmaceutics, natural dye, food industry, food supplement, agriculture (insecticides, biostimulants).

Traditional regional uses: Food (Bangladesh).

Market information: Little developed market, focused on food supplements; high market value.

STRENGTHS

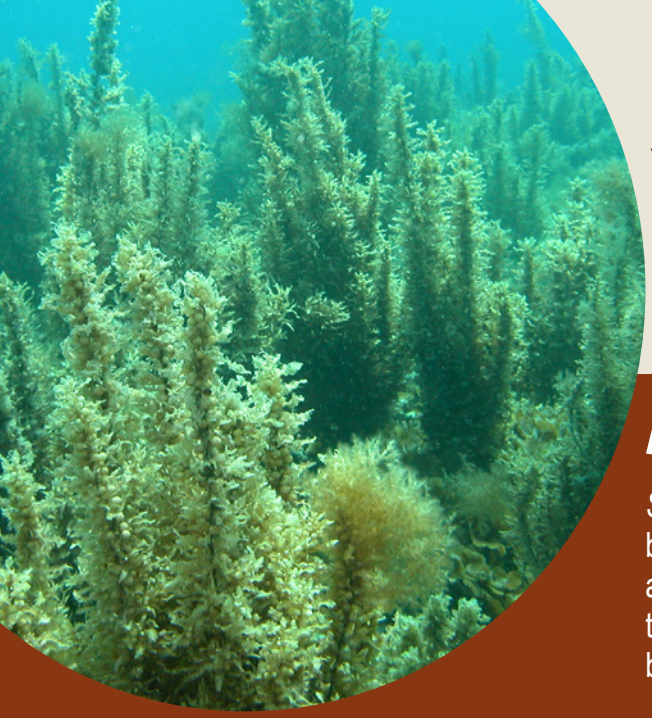
- Ten applications recorded in the literature
- Numerous properties for cosmetic applications
- Interesting Ca contents, exploited in the region for making food supplements

WEAKNESSES

- iAs content can be above the recommended maximum limit
- The hazard index may be elevated (>1) and indicates that consumption can cause moderate to high side effects on human health
- Can accumulate PAH pollutants above maximum limits

RECOMMENDATIONS

- Carefully choose the harvesting or cultivation site and systematically assess contaminants before starting a production.
- Evaluate cultivation and processing methods that may reduce contaminant levels.
- *Padina* species can be used as bioindicators of contaminants.



Sargassum

IDENTITY

Phaeophyceae > Fucales > Sargassaceae > *Sargassum* C. Agardh

Morphology

Sargassum species are characterised by an erect thallus, light to dark brown in colour, consisting of a holdfast (some species also have creeping axes) with one to several main axes (stipes) bearing primary branches that form leaflike laterals (blades), secondary branches, globose air bladders (vesicles), and fruiting branches (receptacles).

Diversity in French Polynesia, New Caledonia and Wallis and Futuna:

Sargassum aquifolium, S. carpophyllum, S. echinocarpum, S. howeanum, S. ilicifolium, S. obtusifolium, S. pacificum, S. polycystum, S. polyphyllum, S. spinuligerum, S. swartzii, S. turbinarioides.

Common names in the South Pacific

Indonesian: bebojot, arien harulu;

Filipino: aragan;

Chinese: agar-agar koepan.

ECOLOGY & DISTRIBUTION

Seasonality

Sargassum species are seasonal with a perennial holdfast.

Reproduction

Two species of the Caribbean region reproduce only vegetatively, all other species reproduce only sexually. The life cycle of *Sargassum* is diplontic with no alternation of generation. The thallus is diploid sporophytic. The reproductive organs are gametophytes; they produce male and female gametes.

Environmental risk

Sargassum proliferations or blooms have been observed in most tropical regions, with the most striking example being golden tide in the Caribbean since 2011. Environmental impacts include asphyxia of fauna and flora and the release of pollutants and heavy metals accumulated by the algae when dying off nearshore or stranded onshore.

Habitat

Only two species, whose distribution is restricted to the Caribbean region, are holopelagic. All other species are benthic and live attached to the substratum, including sandy and muddy bottoms, reef flats, and barrier reefs.

Tropical South Pacific distribution

Cosmopolitan genus, recorded throughout the South Pacific: Australia, Cook Islands, Easter Island, Fiji, French Polynesia, New Caledonia, Samoa, Solomon Islands, Tonga, Vanuatu, and Wallis and Futuna.

global seaweed coalition

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Sargassum

PROPERTIES AND BENEFITS

Dietary information: *Sargassum* species are nutritious and rich sources of bioactive compounds such as vitamins, carotenoids, carbohydrates (mainly dietary fibres), proteins, and macro and microelements such as Ca, K, Cl, Fe, Mn, and Cr. They also contain many biologically active compounds like terpenoids, flavonoids, sterols, sulfated polysaccharides, fucoidans, polyphenols, sargaquinoic acids, sargachromenol, and pheophytine.

Main properties recorded in the literature: Antimethanogenic, antioxidant, skin conditioning, skin protecting, anti-UV, anti-inflammatory, collagen booster, preservative, whitening, anti-ageing, humectant, miscellaneous, emollient, antimicrobial, antiwrinkle activities, emulsion stabilizing, antifouling, alginate, fucans; phenolic compounds, prebiotic, anticancer, anti-melanogenic, bone calcification, antiviral effect of polysaccharides.Antitumoral.

HEALTH RISKS

Contaminants: May accumulate heavy metals above recommended maximum limits, including tAs, iAs, Mn, Ni, Cd, Cr, Cu, Pb, Zn, and persistent organic pollutants such as Chlordecone (Caribbean region).

Toxicity: Produces toxic gases during putrefaction (hydrogen sulfide, ammonia), which is a health hazard to humans.

ECONOMIC INFORMATION

Application sector: Food, functional food, agrofood, agriculture (fertilizers), feed, cosmetics, natural dye, bioenergy (biogas), bioremediation, pharmaceutics, antifouling, and medicine.

Traditional regional uses: Traditional garlands for dancing in Rotuma (Fiji); stranded biomass is collected from the beach to be used as garden fertilizer. Some species of the same family are used for food in Asia.

Market information: Well developed for food, feed, fertilizer, and polysaccharide sectors; low market value.

STRENGTHS

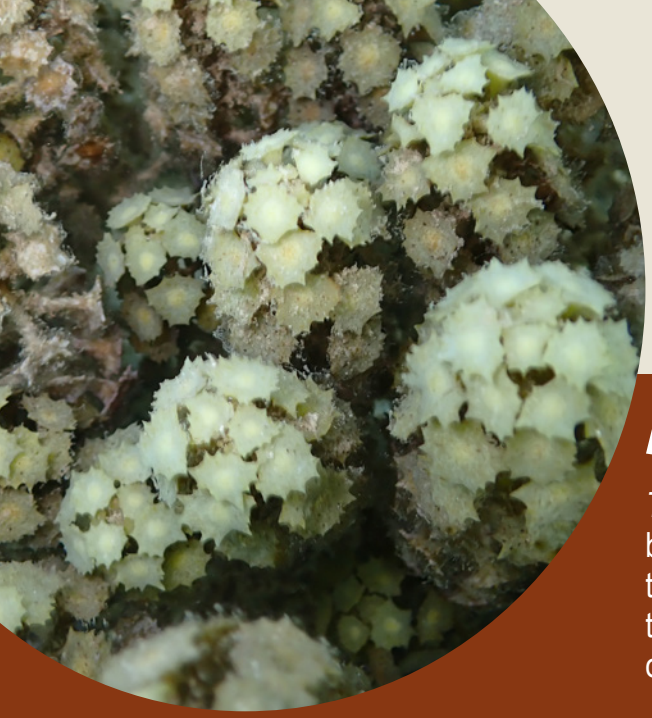
- Twelve applications recorded in the literature
- Numerous properties for cosmetic applications

WEAKNESSES

- iAs content can be above the recommended maximum limit
- The hazard index may be elevated (>1) and indicates that consumption can cause moderate to high side effects on human health
- Low market value

RECOMMENDATIONS

- Carefully choose a harvesting or cultivation site and systematically assess contaminants before starting a production.
- Evaluate cultivation and processing methods that may reduce contaminant levels.
- *Sargassum* species can be used as bioindicators of contaminants.



Turbinaria

IDENTITY

Phaeophyceae > Fucales > Sargassaceae > *Turbinaria* J.V. Lamouroux

Morphology

Turbinaria species are characterised by a cylindrical erect thallus, dark brown in colour, consisting of a holdfast with creeping axes giving rise to one to several main axes (stipes) bearing primary branches that form triangular or conical-shaped laterals that contain air bladders depending on species, and fruiting branches (receptacles).

Diversity in French Polynesia, New Caledonia and Wallis and Futuna:

Turbinaria conoides, T. decurrens, T. ornata.

Common names in the South Pacific

English: sea bells or crowded sea bells, ornate seaweed, turbinweed algae, spiny-leaf seaweed,
Hawaii: limu kahili,
Cook Islands: remu taratara, rimu taratara, limu.

ECOLOGY & DISTRIBUTION

Seasonality

Yes

Reproduction

Sexual reproduction; the life cycle of *Turbinaria* is diplontic with no alternation of generation. The thallus is diploid sporophytic. The reproductive organs are gametophytes; they produce male and female gametes.

Environmental risk

Turbinaria blooms have been observed in tropical regions, notably in French Polynesia, where they form large rafts when detached from the substrate.

Habitat

Reef flats, reef crest, and barrier reefs.

Tropical South Pacific distribution

Cook Islands, Fiji, French Polynesia, Kiribati, New Caledonia, Papua New Guinea, Samoa, Solomon Islands and Wallis and Futuna.

global seaweed coalition

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Turbinararia

PROPERTIES AND BENEFITS

Dietary information:
Turbinaria species are rich sources of bioactive compounds such as vitamins, carotenoids, carbohydrates (mainly dietary fibres), proteins, and macro and microelements such as Ca, Fe, Mg, and Cr.

Main properties recorded in the literature:
Antioxidant, anti-inflammatory, antidiabetic, antiproliferative, neuroprotective effects, anti-UV, prebiotic, fucoidans.

HEALTH RISKS

Contaminants:
May accumulate heavy metals above recommended maximum limits, including As, and excess quantities of Zn.

Toxicity:
Unknown.

ECONOMIC INFORMATION

Application sector:
Food, functional food, food industry, agriculture (fertilizers, insecticide), feed, cosmetics, natural dye, bioremediation, pharmaceutics, antifouling, medicine.

Traditional regional uses:
Fertilizer.

Market information:
Turbinaria could enter the alginate market.

STRENGTHS

- Twelve applications recorded in the literature
- Numerous properties for functional food applications

WEAKNESSES

- iAs content can be above the recommended maximum limit
- Market to be developed

RECOMMENDATIONS

- Carefully choose a harvesting or cultivation site and systematically assess contaminants before starting a production.
- Evaluate cultivation and processing methods that may reduce contaminant levels.
- *Turbinaria* species can be used as bioindicators of contaminants.