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Seaweed Toxicological Effects: Awareness of Protections for Human Consumption

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Abstract

One of the main contributors in terms of both food security and balanced diet is the source of seaweed for so many biologically active substances. Documented and consumed massively in many countries for their numerous benefits. However, their toxicity records, which may be attributed to toxic chemical compounds from seaweed, epiphytic bacteria or harmful algal bloom and ingested heavy metals from seawater, are without focus. The excess of these components could result in adverse interactions in the human body with drugs and hormone levels. It is important to resolve their dangerous and toxic aspects because of their global use and in order to meet growing needs.

Introduction

Aquaculture is defined by the Food and Agriculture Organization (FAO) as the cultivation of aquatic organisms such as fish, mollusks, crustaceans and aquatic plants. Phytoplankton is a primary source and a vital part of the food chain of the ocean. Water plants such as algae are the base of certain aquatic ecosystems and are part of the well-established aquaculture industry with a growth rate of about 10% (Ginneken and de Vries, 2016).

Functional Metabolites as Nutrients

Seaweeds are rich sources of minerals, lipids, proteins, terpenoids, alkaloids, carotenoids, xanthophylls, vitamins, laminarin, fucoidan, and carrageenan, including biologically active compounds (Manzelat *et al*., 2018) and exhibit antimicrobial, anti-coagulant, and antifouling behaviors. For example, Porphyra (Rhodophyta), Ulva (Chlorophyta), Ascophyllum (Ochrophyta), *Undaria pinnatifida* (Phaeophyte), all of which are rich in minerals, carbohydrates, dietary fibers and proteins that exhibit anti-inflammatory, immunomodulatory and anti-aging activity as antioxidants. They are used pharmaceutically to treat AIDS, arthritis, cancer, inflammation and pain in the development of drugs. They also provide specific benefits that encourage wellbeing, so that the daily use of these seaweeds fights deadly diseases.

Seaweed's Detrimental Impact

The presence of heavy metals in marine algae is a serious concern because of their associated potential health effects. There are several alarming incidents where avoiding high amounts of intake, while having such a wide range of health benefits, can prevent harmful effects on human health are summarized in table below.

Table 1: Seaweed compounds and its alarming incidents

Sl. No.	Alarming Incidents	Compound from Seaweeds
1	Goiter and transient hypothyroidism	Iodine (Japan)
2	Acute toxicity	Arsenic, Mercury (Italy)
3	Toxicity	Arsenite, Arsenate, Methylarsonate, Dimethylarsinate
4	Toxicity	Cu, Ni, Mn, and Pb.
5	Growth retardation in animals	Powdered samples

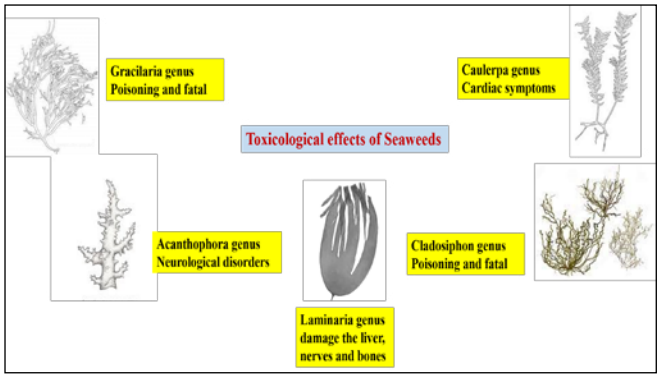

Figure 1: Toxicological effects of different seaweeds

Gracilaria Genus

It belongs to the family of Gracilariaceae and consists of approximately 160 taxonomically accepted species found in the tropical and subtropical regions and widely cultivated in Asia, South America and Africa. Significant chemical compounds such as phycocolloid, acrylic acid and other bioactive metabolites are shown to be present. Gracilaria, widely used in the food and pharmaceutical industries, is an essential source of agar (gelatinous in nature). To date, the consumption of *G. verrucosa* and *G. edulis*, also known as Polycarvernosatsudai (Cheney, 2016), has been found to be responsible for the maximum host of ailments and deaths in the Pacific Rim countries. Red algae *G. edulis* ingestion recorded 3 deaths and 13 illnesses in Japan in 1980, 1982 and 1993, with one in Guam in 1991 and two in the Philippines in 2002 and 2003, respectively. The other poisonings were recorded in 1992 in California, and in 1994 in Hawaii (Cheney, 2016).

Acanthophora Genus

It belongs to the family of Rhodomelaceae and is widely distributed in Guam, Houtman Abrolhos and Hawaii. It is a good source of β-carotene, antheraxanthin and carrageenan. *A. specifera* triggered two major outbreaks in the Philippines in 2002 and 2003. Thirty-three deaths were cumulatively caused by such outbreaks. The symptoms were very similar to poisoning with *G. edulis*, *viz*., Gastrointestinal conditions associated with neurological disorders such as nausea, vomiting, *etc*. (Cheney, 2016).

Caulerpa Genus

It belongs to the family of Caulerpaceae. It is widely distributed in the tropical seas. The poisoning of Ciguatera, a foodborne disease, is caused by ingestion of *Sarpa salpa* fish were infected with the toxin ciguatera. Chemically, it is a compound commonly formed by dinoflagellates that is lipid soluble. It normally induces nausea and pain, and can lead to human cardiac symptoms and neurological disorders such as hallucinations, vertigo and amnesia. It was later discovered, however that the causative fish had been feeding on *Caulerpa prolifera*.

Cladosiphon Genus

It belongs to the family of Chordariaceae and is eaten widely in Japan. Fucoidan is an important polysaccharide found in *Cladosiphon okamuranus*, being consumed since early times in countries like China, Korea and Japan. Two mozuku poisonings have occurred. In the first event, in Ogashi, Akita in 1967, *Nemacystus decipiens*, generally referred to as mozuku in Japanese, occurred. *Cladosiphon okamuranus*, also known as Okinawa-mozuku, triggered the second incident. It took place on the island of Yoron in 1974.

Laminaria Genus

It belongs to the family of Phaeophyceae. It is an economically significant seaweed which is cultivated in China and widely distributed in Korea and Japan. It contains algins, iodine, potassium, magnesium, calcium and iron in good amounts. They are also known to have cadmium and copper, apart from these. These metal ions are considered highly toxic because they can damage the liver, nerves and bones as they can interfere with the transport of membrane ions. This seaweed can block functional groups of diverse vital enzymes.

Conclusion

Seaweeds are extremely nutritious and have various advantages, such as thyroid activity, diabetes, digestive health, weight loss, and cardio protective action. They can suffer elevated risks due to the presence of excess iodine and heavy metals, along with high nutritional value and therapeutic properties. When boiled, edible seaweeds decrease by 43-50 percent in their arsenic content. The most critical public health issue has been the toxicity of poisonous algae, diatoms and dinoflagellates. Active testing systems to verify the amount of toxins in mussels, oysters, scallops, clams, *etc*. are prohibited from doing so. Without suffering any damage, organisms are also able to absorb and accumulate metals. This aspect includes constant monitoring

as a functional food of edible seaweeds and their restriction on heavy metals.

Seaweeds, if properly eaten, are a blessing to civilization, otherwise they may pose a major danger to humans. Many bioactive compounds are identified that are not present in other sources of natural food and are beneficial to human well-being by providing better health and preventing different diseases. Knowledge of the consumption of seaweed among people from countries where it still remains away from the regular food list is required. Guidelines on the restriction and quality of the ingestion of seaweed by regulatory bodies, including specific drug interactions with seaweed, are required.

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