

Seaweed: The Marine Commodity

Voiceover: [00:00:02] This podcast is brought to you by the University of Aberdeen. Thank you very much for joining us today and welcome to the Explorathon podcast, a chance for you to hear about some of the latest research projects coming from the University of Aberdeen. Explorathon 2021 is a programme of events, online content and activities being brought to you by the University of Aberdeen and other Scottish universities as part of European Researchers' Night, which this year takes place on Friday, the 24th of September.

[00:00:50] European Researchers Night is a Europe wide public festival, which brings researchers closer to the public. All events run as part of Explorathon 2021 can be found on the website at www.explorathon.co.uk and the programme is funded by the European Union's Horizon 2020 Research and Innovation Programme under grant agreement 101036101.

[00:01:20] After listening today, please let us know any comments or feedback by tagging us on Twitter using the hashtag Explorathon21. This year is the youth of Scotland's coastal waters, marking the vital role our water courses play in our lives. Seaweed's play an important part in that marine environment as well as in products. Did you know that Seaweed's is a vital ingredient for a variety of products, including food, cosmetics, soil, fertilizers and much more?

[00:01:51] Today, I'm joined by Dr. Puja Kumari, a research fellow at the School of Biological Sciences, thank you for joining me.

Puja Kumari: [00:02:02] Thank you for having me.

Voiceover: So tell me a bit about your research.

Puja Kumari: [00:02:07] So I am a research fellow in the School of Biological Sciences at the University of Aberdeen. I'm working on Horizon 2020 funded ITF project. And on this project, I am working on different disease models, trying to identify genetic, molecular and metabolite markers that can be exploited to develop viruses for early detection of pathogens in seaweed.

[00:02:35] In this context, I am particularly focussing on elucidating the role of halogen metabolism, in brown seaweed pathologies. Since these brown seaweeds accumulate a large amount of halogen metabolites and molecules cancer in their tissues which may have a role in shaping a defence against pathogens.

Voiceover: [00:02:57] And what our seaweed's and how many types of seaweed's are there?

Puja Kumari: Seaweeds are submarine, multicellular, microscopic, photo synthetic algae. Basically they grow in sea water, along the sea shores, often attached to a rocky surface. They vary in size from a few centimetres to approximately 30 metres. For example, the giant kelp, and basically there are three types of seaweed, green red and brown, mainly based on their pigments. For example, green seaweeds For example, green seaweeds are green due to chlorophyll just like land plants. Red seaweeds are red due to the presence of phycoerythrin that masks the effect of other pigments. Similarly, brown seaweeds appear brown due to fucoxanthin. This is to note that the classification of seaweeds into green, red and brown is not merely based on the pigments. There are quite distinct in their ultra structure, biochemical features like cell wall composition,

[00:03:57] storage compounds, and they also have the genetic code of the evolutionary history. Green and red seaweeds are derived from primary endosymbiosis, while brown seaweeds are derived from the secondary endosymbiosis of red algal lineage.

Voiceover: [00:04:12] And what are seaweed's important for?

Puja Kumari: Firstly, seaweeds are important from marine ecosystem perspectives. They form huge seaweed forests under the sea and provide habitat to a variety of marine organisms like barnacles, snails, sea urchins, crabs mussels etc. They absorb a large amount of CO₂ for photosynthesis and act as carbon sinks and thereby reduces ocean acidification. It is estimated that seaweeds sequester 200 million tonnes of CO₂ every year, which is equivalent to annual CO₂ emission of many cities.

[00:04:54] Secondly, they are economically important to the aquaculture sector. Currently, seaweed holds approximately 6 billion US dollar (USD) market. Of which, 85% comprise of food applications mainly for human consumption. They are the nutritional bombs and are rich sources of vitamins, minerals, protein, dietary fibres, w3 fatty acids and various health beneficial bioactive compounds. It's no wonder that they are considered as superfoods.

[00:05:25] In fact, they have been consumed as food in the coastal community for centuries, especially the East Asian countries like Japan, China and Korea. They are also excellent sources of animal and fish feed. Apart from food, they're also used commercially in a variety of cosmetic products, nutraceuticals and pharmaceuticals. Seaweeds are also commercial sources of hydrocolloids like agar-agar, agarose, carrageenan, alginates and are used in biodegradable packaging and biofuel generation. So, overall, seaweeds are sustainable source of a variety of value-added products from the ocean.

Voiceover: [00:06:03] And in Scotland, what seaweed species are there? Is there anything that makes Scottish seaweed special?

Puja Kumari: [00:06:11] Scotland is the home for a variety of seaweeds, such as those belonging to genus Alaria, Fucus, Laminaria, Sargassum, Chondrus and many others. Most of these species are fundamentally important and are used for various industrial applications. For example, Chondrus and Laminaria species are extensively utilized for carrageenan and alginate production respectively, which are used in food, cosmetics and pharmaceutical industries mostly for their gelling properties.

[00:06:41] Then, we have edible sea lettuces, Ulva species, Palmaria sp., Irish moss, which are used in a variety of products from ice-creams, soups, salads and bread, to tooth-paste, shaving foams, shampoos, and cosmetics. Also, in Scotland, seaweeds have long been utilized as animal feed especially in dairy farms.

Voiceover: [00:07:04] How has seaweed populations changed over the years and what factors are impacting on any changes?

Puja Kumari: [00:07:12] Actually, there is always a constant dynamic shift in seaweed biodiversity, their abundance, species variations and invasion of non-native species at local or regional levels. In the past few decades, especially since the global climate change. Our oceans are getting warmer, The heat waves, sea temperatures have increased by two degrees Celsius. Also, seawater pH is expected to decrease by 0.4 units by another 100 years. These changes may impact some seaweeds especially those thriving in intertidal regions where they are more vulnerable to environmental perturbation. Though, it is difficult to paraphrase the long-term

effects of these changes; the impact hugely depends on the scale of climate change, intensity, duration and frequency of heat waves. To far extent, such changes may lead to replacement of large long-lived habitat forming seaweeds with small ephemeral seaweeds.

[00:08:14] There have been more such incidences in the past. In 2011, rising sea water temperatures and heat waves caused Western Australia to lose 43% of its kelps. Moreover, this climate change has also led to increase in the incidences and spread of seaweed diseases. There has been an approximately 10-20% of annual crop loss in the last decade in aquaculture farms due to diseases.

Voiceover: [00:08:41] So tell us a bit more about your work focussed on seaweeds.

Puja Kumari: [00:08:46] Basically, my work is mainly focussed on seaweed diseases. Seaweeds are vulnerable to numerous pathogens in the sea including bacteria, viruses, fungi, oomycetes and algal endophytes, which are threat to the development of sustainable aquaculture farms and cause great economic losses globally as well as to the seaweed farmers

[00:09:07] I am investigating different host-pathogen interactions in brown seaweeds, focussing on oomycetes and algal endophytes. The prevalence of these infections is very high in brown algae, in fact, oomycetes infect almost most of the brown seaweeds and are lethal to aquaculture farms. The prevalence of algal endophytes especially in kelps is as high as 100% and causes morphological anomalies in host seaweeds and interfere with their fertility. This algal endophyte infection not only effect crop yield but also reduces the commercial quality of products, which is a serious issue for kelp farms.

[00:09:49] So, basically, I am trying to understand how these different pathogens attack different brown seaweeds, hijack the host system, and cause damage to the tissues. In this context, I am trying to identify some genetic molecular as well as chemical metabolite markers using high-throughput transcriptomics and metabolomics approaches. These biomarkers can be useful to detect these pathogenic diseases in seaweeds as well as may help in finding solutions to develop some bio-security measures against these pathogens. For this, I am focussing particularly on halogenated compounds and their metabolism in brown seaweeds because brown seaweeds have a unique highly evolved halogen metabolism. They not only accumulate halogen molecules but also emits them to the environment. For ex, kelps of genus *Laminaria* are one of the strongest accumulators of iodine known. They accumulate approximately 1% dw of iodine, which represents 30,000 fold accumulation from seawater. They are also one of the major emitters of both molecular iodine and iodinated organics into the atmosphere. Moreover, the halogenated compounds in brown seaweeds have defense roles against oxidative stress and are involved in innate immunity. So, I am looking forward to decipher what compounds are actually there in the repertoire of halogenated compounds in brown seaweeds and their significance in defence against pathogens, if any.

Voiceover: [00:11:26] It sounds like really interesting work. What are the next steps for your research?

Puja Kumari: [00:11:33] I have established different brown seaweed host and pathogen systems at the laboratory scale and how the infection progress with time. Now, I am focussing on identifying chemical metabolite markers for pathogenicity and whether any of them are halogenated. After this, I am planning to do some transcriptomics work with kelp-algal

endophyte pathosystem to find some genetic markers that can be used to develop bioassays (if possible) to detect the infection in the field or aquaculture farms.

Voiceover: [00:12:05,590] And what efforts are being made to protect seaweeds?

Puja Kumari: [00:12:09] Actually, there is no recommended protocol available for early detection of pathogens, or diseases in seaweeds, or any real monitoring system to prevent them (especially in the field and aquaculture farms). This is mainly because of limited knowledge available about different pathogens, their mode of action and lack of genetic information. But, now we do have some molecular tools to diagnose some of the pathogens in the laboratory and GIS software systems to monitor over aquaculture farms. But these may be quite expensive especially for small aquaculture farmers. However, the positive fact is, researchers across the globe are working together in close association with aquaculture farmers as well as sharing knowledge and trying to understand in depth the disease problem. An excellent example is the initiative started by Scottish Association of Marine Sciences, called "My seaweed looks weird" under the framework of GlobalSeaweed Star project, where anyone working with seaweeds can report and submit samples to them for identification of pathogens and their in-depth analysis at genetic and molecular level. They have also drafted a policy brief for seaweed disease management and biosecurity measures. Similar various efforts are being made at different scales across the globe to address the seaweed disease problem. Hopefully, soon in near future, we may have recommended aquaculture practice guidelines for protecting seaweeds.

Voiceover: [00:13:49] So we're now out of time but Puja, thank you very much for joining us today.

Puja Kumari: [00:13:53] Thank you for having me.

Voiceover: [00:14:00] We hope you find today's podcast interesting, but for now, thanks for joining us and keep an eye out for the other Explorathon podcasts being launched in September. As I said at the beginning, we'd love to get your comments and feedback on today's podcast, so please use the hashtag Explorathon21 to tag us on social media.

[00:14:18] If you're interested in finding out more about the other events taking place as part of Explorathon 2021 then you can visit the website at www.explorathon.co.uk. Bye for now.

[00:14:46] This podcast is brought to you by the University of Aberdeen.