Notes for “We Can’t Kelp Ourselves” Podcast Episode
Go Forth and Science
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Carrageenan

- Necas, J., Bartosikova, L. 2013. Carrageenan: a review. Veterinarni Medicina; 58 (4): 187-205. http://vri.cz/docs/vetmed/58-4-187.pdf
    - “The functionality of carrageenans in various applications depends largely on their rheological properties. Carrageenans, as linear, water-soluble, polymers, typically form highly viscous aqueous solutions. Viscosity depends on concentration, temperature, the presence of other solutes, and the type of carrageenan and its molecular weight (Lai et al. 2000). Viscosity increases nearly exponentially with concentration and decreases with temperature. Carrageenans are susceptible to depolymerisation through acid-catalysed hydrolysis. At high temperatures and low pH this may rapidly lead to complete loss of functionality (Stanley 2011).”
    - There isn’t any nutritional value
    - There is a wide range of responses to natural carrageenan in small rodents like rats and rabbits. Depending on the species of red seaweed they were given and the amount, some showed weight gain or diet changes, an uptake of the carrageenan into their bodies, and lesions and ulcers in their intestines. But others just pooed it all out. When tests were done on monkeys and baboons in the 70’s and 80’s, the monkeys’ bodies didn’t hold on to any of the carrageenan and they were fine.
    - When we move into the food-grade stuff, which is broken down differently than the natural stuff, there wasn’t any affect on the stomach, where it was broken down instead of the intestines and livers.
    - Used to cause health issues in rodents for other studies such as ulcer studies, swelling studies, and pain studies.
    - A few studies have also shown that carrageenan may stop tumor growth and cancer, though this is a topic that can certainly benefit from more research.
    - Carrageenan is antiviral. Can also be used as a solution to viruses such as flu, HIV, HPV, herpes, and the common cold because the carrageenan blocks the places in cells where those viruses would try to get into our cells.
    - Some carrageenan helps the white blood cells in immune systems, and some types harm them.
    - Carrageenan can be used to make vinegar, beer, and fermented milk products, and ethanol.
    - “In the language of food chemists, carrageenan is variably called an emulsifier, stabiliser, colloid, or gum. Many products that we now take for granted – especially soymilk, chocolate and other flavoured milks, dairy products, infant formulas, and nutritional supplement beverages rely upon carrageenan for their uniform consistencies. They could not be made, packaged and stored for long periods of time without this ingredient. Carrageenans are used to gel, thicken, or suspend; therefore they are used

in emulsion stabilisation, for syneresis control, and for bodying, binding and dispersion. The major uses are in foods, particularly dairy applications."
    - "Carrageenan is unique in its ability to suspend cocoa in chocolate milk at very low concentrations"
    - Carrageenan from Irish moss seaweed has been used for hundreds of years as a gelatin.
    - Used in toothpaste
    - Used to make pudding in Scotland
    - Safe for use in foods
    - "The results of the few parallel studies suggest that there are no large differences in the effects of the different forms of carrageenan or in the effects of carrageenans prepared from different species of seaweed. Carrageenans have very low toxicity, and have been shown not to be teratogenic. Carrageenan is used in many dairy products such as cream cheese, cottage cheese, skimmed milk, and yogurt as well as desserts and sweets such as custards, ice cream, milk shakes, pie fillings and chocolate products."
    - "carrageenan is also used in air freshener gels, toothpaste, fire fighting foam, shampoo, cosmetic creams and shoe polish"

- Koenighofer, Martin., Lion, T., Bodenteich, A., Prieschl-Grassauer, E., Grassauer, A., Unger, H., Mueller, C.A., Fazekas, T. 2014. Carrageenan nasal spray in virus confirmed common cold: individual patient data analysis of two randomized controlled trials. Multidisciplinary Respiratory Medicine; 9(1): 57. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4236476/
    - says reduces time of common cold by almost 2 days, and reduced the number of relapses
    - tested 3 types of viruses: human rhinovirus, human coronavirus (which was 25% of the study), and influenza A.
    - Carrageenan nasal spray was most successful for treating coronavirus, where people got better 3 days faster and three-times less likely to get it again.
    - Note: this is previously known forms of coronavirus, not the new one we're facing now.

Sea urchin – kelp relationship

- Kriegisch N., Reeves S.E., Johnson C.R., Ling S.D. 2019. Top-down sea urchin overgrazing overwhelms bottom-up stimulation of kelp beds despite sediment enhancement. Journal of Experimental Marine Biology and Ecology; 514-515: 48-58
    - Even though humans are putting extra nutrients into the water near our coasts, the extra growth that kelp can get from those nutrients is still overshadowed by the damage that urchins can do to a kelp forest when they eat it.

- Filbee-Dexter, Karen., Pedersen, M.F., Frediksen, S., Norderhaug, K.M., Rinde, E., Kristiansen, T., Albretsen, J., Wernberg, T. 2020. Carbon export is facilitated by sea urchins transforming kelp detritus. Oecologia; 192: 213-225.

- Urchins can eat kelp because they have a jaw and teeth, which help them gnaw through tough kelp tissue. “They generally feed on kelp fragments or whole dislodged blades, stipes, and whole plants that are freely drifting along the seafloor (Harrold and Reed 1985). Under some conditions, sea urchins also destructively graze on attached plants, creating ‘barrens’ devoid of standing algae (Norderhaug and Christie 2009; Filbee-Dexter and Scheibling 2014b).”
- 80% of kelp forests ends up decomposing in one way or another, and gets put back into the ecosystem as nutrients, or buried and stored in the ground (marine sediment).
- Sea urchins have population booms when there is food available (a kelp bed) and then population drops when they eat through all the food.
- Kelp forests produce 170 million tons of organic carbon each year, but none of that kelp carbon is buried in the kelp forests.
- If there are more than 4 urchins per m^2 in a kelp forest, then all the kelp detritus will be gone
- “sea urchins can capture moving kelp as easily as anchored kelp.”
- Most of what the urchins forage is eaten, pooped out, and then floats away to other part of the ocean. But 2.6% of what the urchins graze doesn’t actually make it to the “eating stage” and is just broken up into tiny pieces. These tiny pieces also float away though, and can then become food for other organisms.
- As this torn apart or digested kelp floats away from the coast, it has more of an opportunity to sink into deep ocean basins or get buried in sediment, meaning the carbon is sequestered, or stored long-term.
- 1.3 – 10.8 kg/m^2 of kelp are shredded annually from reefs by urchins (based on a study in Norway).
- Some sea urchin populations in Norway are dropping because the water is warming
- In Nova Scotia, climate-change driven disease has wiped out urchin populations
- Warm waters in California have led to an increase in sea urchin populations, which has decimated kelp forests.
- “Of course, the importance of sea urchins for kelp-carbon export depends on a delicate balance between sea urchins being abundant enough to capture significant amounts of kelp detritus and being too abundant to persist by grazing detritus alone (Harrold and Reed 1985). When sea urchins are too abundant, they can destructively graze attached kelps, decreasing overall standing stock of carbon, and drastically reducing the amount of kelp available to be exported as detritus (Krumhansl et al. 2014). If they are absent, an important collector–shredder is absent from the ecosystem, and the distance of carbon transfer from intact kelp forests is reduced.”