SeaHealthUCD

Issue 47: December 2024: This e-bulletin is aimed at personnel in fisheries & aquaculture, at fish packers, processors, retailers, health professionals & finally, consumers.

Chitosan - - a versatile material!

Chitin is β-1,4-linked N-acetyl-d-glucosamine which is chemically similar to cellulose, except that one of the hydroxyl groups of each glucoside residue is replaced by an acetylated or deacetylated amino group. Chitin is the most abundant polymer in nature after cellulose and is the material that gives strength to crustacean and insect skeletons and to fungal cell walls. It is usually converted to chitosan by deacetylation. Chitosan is a very versatile material with many applications some of which are outlined below. Shrimp, prawn and crab shell waste are the main sources of chitin and these are abundant by-products of the seafood processing industry (Elieh-Ali-Komi & Hamblin, 2016).

Antimicrobial & anticancer properties

Antimicrobial properties: Chitosan is superior to many other biopolymers due to its excellent biocompatibility, biodegradability and adaptability. Chitosan is effective against *E. coli*, *S. aureus*, Salmonella, *C. albicans* and *A. niger,* and also against yeasts, moulds, and viruses (Confederat et al., 2021). Raising its degree of deacetylation and its concentration may further boost its antibacterial effectiveness (Li & Zhuang 2020). The antibacterial efficacy of chitosan preparations including nanoparticles, films, hydrogels, and chitosan-coated surfaces has been demonstrated, as has its use as a natural preservative in food (Yilmaz Atay, 2019). For example, addition of chitosan to bread inhibited *B. cereus* growth and rope formation over a 3–5 day period (Lafarga et al., 2013). Chitosan films also have applications in food packaging including films that are smart, edible and sustainable (Tamzid, et al., 2024).

Anticancer properties: Chitosan has a protective effect as a drug delivery vehicle for cancer treatment as only cancer cells are affected by the treatment and healthy cells are not harmed thereby enhancing the therapeutic effect (Yan et al., 2020). Chitosan is also used for non-invasive cancer cell imaging when coupled with fluorescent dyes or radiolabelled chemicals. (Moramkar et al., 2021).

Anti-inflammatory & antihypertensive properties

Anti-inflammatory properties: Chitosan's antioxidant properties enable it scavenge harmful free radicals (reactive oxygen species) thus preventing short and long term inflammation. However, chitosan can be anti-inflammatory or pro-inflammatory depending on concentration, administration method and dosage form used (Gull et al., 2020). In the former, chitosan reduces the production of inflammatory cytokines and chemokines such as tumour-related proteins while in the latter it stimulates the immune system to produce these (Sukul et al., 2021).

Antihypertensive properties: A recent study showed that consumption (>2.4g/day) of chitosan significantly decreased diastolic blood pressure in less than 12 weeks; however, systolic blood pressure was unaffected (Huang, et al., 2017). These authors suggest that results were inconclusive as it was a small trial and stress the need for large-scale randomised controlled trials. Previously, a study in 1998 showed that a chitosan trimer was an ACE inhibitor and reduced systolic blood pressure in spontaneously hypertensive rats (Sang-Pill et al., 1998).

Wound healing properties & tissue engineering

Chitosan stimulates cell growth, blood vessel formation and cell matrices thereby promoting repair of damaged tissues and shortening wound recovery time (Şalva et al., 2022). Chitosan increases collagen production and other extracellular matrices which give stability and tensile strength to the wound area. Chitosan films and hydrogels (three-dimensional networks of crosslinked chitosan molecules) placed directly on an injury provide a barrier against infection and aid healing via keeping the area wet and encouraging cell proliferation (Choi et al., 2020). Chitosan has application as a scaffold builder in tissue engineering and promotes cell development and tissue regeneration. Further studies are required to maximise chitosan usage in therapeutic applications (Elieh-Ali-Komi & Hamblin, 2016; Madni et al., 2021).

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Compiled by Adjunct Professor Ronan Gormley of the UCD Institute of Food & Health, School of Agriculture & Food Science, Belfield, Dublin 4. More information from ronan.gormley@ucd.ie