TECH OFFER

Leapfrogging Aquaculture Side-Stream Wastage

KEY INFORMATION

TECHNOLOGY CATEGORY:
Waste Management & Recycling - Food & Agriculture Waste Management
Materials - Bio Materials
Sustainability - Circular Economy
Personal Care - Cosmetics & Hair
Healthcare - Pharmaceuticals & Therapeutics

TECHNOLOGY READINESS LEVEL (TRL): TRL4
COUNTRY: SINGAPORE
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OVERVIEW

In the aquaculture industry, tons of inedible components and by-products are being generated and discarded as waste every day. Some of these side-streams, such as skins, bone and scales contain numerous bioactive compounds. The research team found that skin from farmed American bullfrog is highly enriched with type I collagen. Despite being a rich source of collagen, current extraction process and the technological utility of American bullfrog collagen is scant.

Using a patent-pending mechano-chemical process, they were able to extract up to 70% (w/w) of type I collagen from the bullfrog skin. Additionally, the process is straightforward, cost-effective, scalable and the extraction time could be shortened by 40% compared to traditional acid solubilisation method. The extracted collagen was found to be highly soluble and stable in its

tropocollagen-like state for easy tailoring of its chemistries and properties.

As proof-of-concept, the lab has successfully processed bullfrog collagen-based products that are amendable for wound healing and bone grafting applications, thereby demonstrating its utility as a renewable, sustainable, and valuable “waste-to-resource” biomaterial. They hope to bring their entire technological pipeline closer to commercialisation by partnering with potential manufacturers and/or offtakers of the products for non wound healing applications.

TECHNOLOGY FEATURES & SPECIFICATIONS

The main source of collagen is commonly derived from mammalian tissues, which is associated with high production cost with prolonged extraction time and highly labor extensive due to the complexity of the tissues. By using American bullfrog skins, which has a simpler form of tissue structure, rapid processing with a high extraction yield is achieved, particularly with the introduction of mechanical blending into the traditional extraction process by using a basic blender. The extracted collagen fibers are found to be stable in its nano-form with mean thickness of approximately ~15 nm, which is significantly thinner as compared to commercially available mammalian collagen (~0.5 – 1 µm). Nano-features are highly important in tissue regeneration as it has been shown to enhance the cell-material interactions such as the adhesion and migration.

Both *in vitro* and *in vivo* evaluation of the bullfrog collagen in the form of wound dressings have successfully shown rapid cell migration, wound closure, and tissue remodeling compared to conventional mammalian collagen with minimal immune response. This would enable the rapid healing process in the patient's wound upon injury. In addition, bioactive components such as hydroxyapatite, the inorganic component of human bone tissue, can be easily incorporated into the nanofibrous collagen to form a 3D porous biocomposite. Preliminary results showed homogeneous distribution of the hydroxyapatite, which in turn supported the growth and maturation of bone cells. Most importantly, by keeping to the theme of waste-to-resource, the hydroxyapatite was isolated from inedible fish scales, thus improving the sustainability of this material system.

POTENTIAL APPLICATIONS

The extracted American bullfrog skin-derived collagen has the potential to be realised in the following applications:

- As bioactive additives for biomedical, cosmeceutical, nutraceutical, skin-care applications, amongst others.
- When processed as gels, sponges, flakes or thin films, it can serve as an effective wound dressing material or generic scaffold for tissue engineering.
- When combined with hydroxyapatite from calcium phosphate rich side-streams such as fish scale or fish bone, it can function as grafting material for bone repair and/or periodontal tissue regeneration.

UNIQUE VALUE PROPOSITION

- A resource- and cost-effective approach to maximise recovery of type I collagen from aquaculture waste side-stream.
- Developed technological pipeline can support aquaculture sustainability and circular economy.
- Innovative solutions to valorise aquaculture side-streams into high value products.
- The process is environmentally safe, highly scalable and commercially viable.