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Fish Technology Newsletter

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Contents

Editorial Committee

News from the Research Front

Customised Nutritional-mix from Collagen Peptide

Fish scale and bone contain protein, mainly in the form of collagen and minerals like calcium (Ca), phosphorus (P) and magnesium (Mg) along with traces of sodium (Na) and sulphur (S). Collagen contains relatively high amounts of amino acids such as glycine, proline and hydroxyproline. Hydrolysis of collagen molecules yields peptides with bioactive, functional and sensory properties that are better than those of native proteins from which they are obtained. Bioactive collagen peptides have great potential in pharmaceutical, neutraceutical and food processing industries. Now a days, collagen peptide is being incorporated in to a wide array of products, including protein bars, cereal bars, protein drinks, smoothies etc. Apart from their nutritional benefits, collagen peptides exhibit a wide range of physiological functions including antihypertensive, antioxidative, opioid agonistic, anticancer immunomodulatory, antimicrobial, prebiotic, mineral binding, antithrombotic and hypocholesterolemic effects. Collagen peptide as a food supplement may improve low bone density in people under malnutrition and those suffering from degenerative joint diseases.

The waste generated from fish processing is around 50% of the starting material by weight, and is more costly to dispose. On an average, 30% of fish processing waste accounts for the protein collagen, which is mainly seen associated with scales, bone, skin, and connective tissue of the animals. It has been observed that collagen peptide from fish processing discards can be absorbed to blood stream much better than those

Nutritional mix prepared with collagen peptide from fish scales

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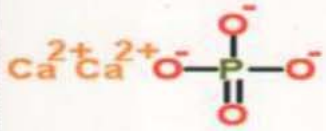

Fish bone

Calcium capsules

muscle function. In general, the basic source of calcium is the diet.

Calcium levels are tightly controlled by a complex interaction of hormones and vitamins. Dietary requirements vary throughout the life of humans and are greatest during periods of growth and pregnancy. Generally, calcium is obtained from the diet and it is severely deficient in most of regular diets. Therefore, to improve calcium intake, several calcium-fortified products are in the market and demand for these products is growing continuously. The major source of calcium is the diet, and the most common and trusted source of calcium is milk or other dairy products. Wheat and maize are very poor sources of calcium. Most of the calcium provided by cereal foods comes from the calcium containing ingredients that are added to bread and biscuits as functional ingredients, such as calcium propionate and calcium phosphates.

It is well documented that consumption of small fish is nutritionally beneficial in providing a rich source of calcium. Calcium in fish could be absorbed to the body as tested *in vivo*. Fish bone, which was separated after removal of muscle from the frame, is a valuable source of calcium as "Dicalcium phosphate," which has the ideal calcium phosphorus ratio of 2:1. The organic component of fish bone, which accounts for 30% of the material, is mainly collagen.

CIFT, Cochin has optimized the process to extract calcium from fish bones which is mainly treated as processing discard during filleting operation of large fishes *viz*., tuna, carps etc. Before packing the material was powdered and supplemented with vitamin D for enhancing the absorption and bioavailability. *In vivo* studies conducted at CIFT in albino rats have shown that fish calcium powder supplemented with vitamin D has improved the absorption and bioavailability. Since calcium supplementation in diet is having high significance especially for women and aged, this product from fish bone is a viable and affordable option for dietary calcium supplementation.

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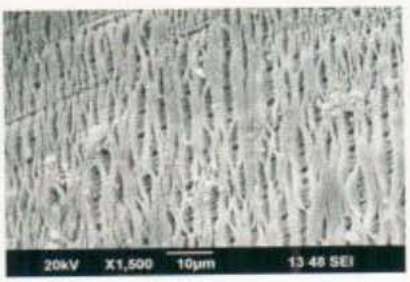
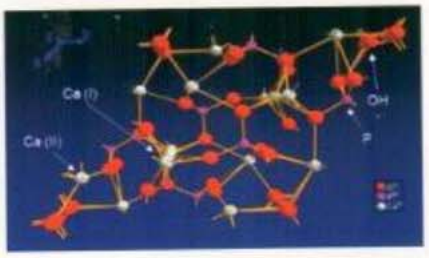
Multifunctional Hydroxyapatite Crystals from Fish Processing Discards

Hydroxyapatite (HAP) is seen embedded in the organic matrix of collagen, normally associated with the natural materials such as bone and fish scales. These mineral crystals are responsible for the bone hardness, strength and rigidity, and collagen fibres provide flexibility. It is one of the few materials, classified as a bioactive natural material that supports bone in growth and osseo-integration; hence, popularly known as the 'second generation calcium supplement'. Hydroxyapatite and calcium phosphate based biomaterials have attracted considerable interest in the field of tissue engineering. Among the main areas of application of HAP, the most promising ones are orthopaedics and orthodontics, where bone tissue has to be replaced, partially or totally. The studies indicate that the total global biomaterials market is expected to be worth US$ 58.1 billion by 2014, growing at a Compound Annual Growth Rate (CAGR) of 15% from 2009 to 2014. Interestingly, Asian market size is estimated

Raw scales from Rohu fish (Labeo rohita)



Scanning electron micrograph of hydroxyapatite crystals



Crystalline structure of hydroxyapatite

Artificial bone

Dental capping

Hydroxyapatite

to increase at the highest CAGR of 18.2% in the same period. The manufacture of biomaterials and devices depends on both cost-effective production technology and the availability of cheaper raw materials. Fish processing waste offers a rich source of this highly valuable mineral composite. The content of hydroxyapatite in fish scales and bones ranges from 40 to 45% (w/w). Hydroxyapatite from such natural sources is biologically safe and economical as it is prepared from cheaper raw materials. Worldwide, fish industry waste is considered as an important pollutant having serious impact on the environment. The Fish Processing Division of CIFT, Cochin has developed and standardized a novel low cost method for preparing hydroxyapatite crystals from fish processing waste which otherwise causes serious environmental problems.

Hydroxyapatite as natural mineral supplement

Human body need a balance of calcium and phosphorus. The Recommended Daily Intake (RDI) for calcium and phosphorous for an adult is 1000 mg each (FDA). Research has indicated that 85% of women over the age of 20 and at least 50% of men from age 35 consume less calcium than this RDI value. The major role of calcium in the body is building healthy bones and teeth. The lack of calcium quite often leads to osteoporosis, which is the main cause of bone fractures in adults. Women are at much higher risk for osteoporosis, especially after menopause. Calcium is also critical for many other biological functions, including muscle contraction, blood clotting and neural transmission. Almost 99% of the total calcium taken by the body is being stored in the bones, the remaining 1% circulates in the body as serum component. If the body does not get enough calcium through food to keep the right amount circulating in the blood, the body will strip calcium from the bones where it is stored, causing the bones to get weaker. Although many foods supply various calcium and phosphate salts, human and animal hard tissues are the only natural source of calcium hydroxyapatite which is much easier for the body to absorb. There is increasing evidences to suggest that hydroxyapatite is more effective than calcium supplements in maintaining the bone mass.

Hydroxyapatite as bio-ceramic material

Bone is comprised of three basic building blocks - collagen fibrils, mineral plates, and a matrix of unmineralized, non-fibrillar organic material, mostly made of proteoglycans and glycoproteins. Hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$), comprises 67% of the weight of human bone, and the collagenous fibers make up the remaining 33%. Hydroxyapatite is identified as an ideal raw material for the development of artificial bone implants and bone filling material. The idea is to create physicochemical links, between ceramic and surrounding bone tissue, promoting their integration and growth of new tissue. Over time they are partially resorbed and replaced by natural bone. The major challenge in the development of a bio-ceramic material is to create a totally non-immunogenic material that is as similar as possible to the natural bone tissue, so as to get maximum compatibility with the host body. The

ideal bio-ceramic material could be easily fabricated and preserved and should be biocompatible and biodegradable. Since, hydroxyapatite is the basic bone mineral, it is totally biocompatible and nontoxic and becomes an integral part of the living bone tissue. However, the synthetic form of hydroxyapatite has been shown to be chemically and crystallographically similar, but not identical, to naturally occurring HAP. These materials should have high porosity (the order of hundreds of microns) to allow the development of bone within and across them. The multifunctional hydroxyapatite prepared by CIFT is multiporous and have high degree of interconnectivity. The high porosity of HAP permits the bone tissue grow into the pores of the implant once inserted.

Artificial tooth enamel

Dental caries represents the most prevalent chronic disease in both children and adults. Roughly 97% of tooth enamel and 70% of dentin comprises of hydroxyapatite. At the initial stage of dental caries, bacteria cause the damage of enamel which is scarcely being self-repaired by living organisms. Therefore, the remineralization of enamel minerals by using synthetic apatite is always suggested in dental research. The native structure of enamel is too complex to be remodeled. The synthesized apatite crystallites often have different dimensions, morphologies, and orientations from the natural ones, which result in poor adhesion and mechanical strength during the restoration. Additionally it has been documented to possess antibacterial potentials and hence is a potential candidate for pulp capping and cavity lining.

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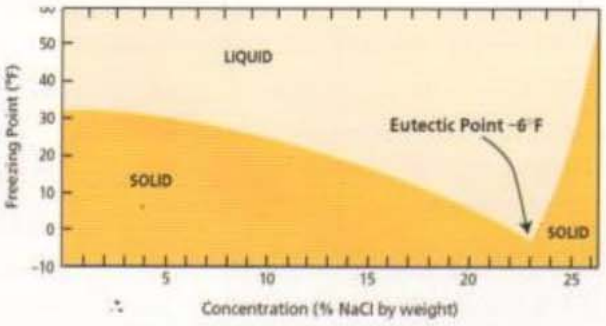
Brine Freezing Improves the Quality of Tiger shrimp (*Peneaus monodon*)

Shrimps are most sought after seafood products due to its their unique taste and culinary properties. They decompose quickly due to various factors like enzymatic and microbiological activities. The highest shrimp quality can be obtained in the shrimp preserved immediately after harvesting. Freezing is one of the best methods to retain sensory and nutritional quality of the food. In the processing plants, it is frozen either in block by glazing with water and freezing in an air-blast freezer, plate freezer or individually frozen (IQF). Although freezing is an effective method of preserving foods for longer duration, some deterioration in quality occurs during storage. The extent of quality loss depends on many factors, including the rate of freezing and thawing, storage temperature, temperature fluctuations, freeze-thaw abuse during storage, transportation, retail display and consumption. For any food, rapid freezing is recommended to prevent the formation of large ice crystals that can damage cells which degrade the quality by allowing loss of moisture during the frozen storage and upon thawing. Cryogenic freezing method like brine freezing will be useful in reducing the freezing time and maintaining better quality of fishery products compared to conventional air blast freezing.

Use of salt brine for preserving fishery products are known from centuries. However, the use of salt brine for refrigerant has not been widely adopted. It promises a bright future as this can be used to freeze fishery products rapidly maintaining its texture and sensory quality. The freezing point of water can be lowered predictably with given salt concentration. An optimum temperature of -21 °C can be reached with brine solution at 23.3% (w/v) of salt concentration, which is known as eutectic point. Any concentration above or below will result in higher



Freezing point of salt brine solution