Teleost Fish: The Importance Of Fish Skin Mucus

Teleosts are fin fishes comprise 96% of all known fish species exist in earth. Fish were the first vertebrates of this world and through evolutionary adaptation it still remains in almost all aquatic bodies including freshwater and marine water. Currently, based on fishbase.org, there are more than 34,000 fish species present in our earth whilst many species are waiting to be explored. The water body contains many microorganisms than terrestrial and fish is known to survive in it by virtue of its nonspecific immune mechanisms. The components of nonspecific immune mechanism include epidermis, scales, and mucus of skin and gills. Among them the mucus act as a first defense barrier between fish and the aquatic environment. Mucus is secreted by goblet cells and covers the entire epithelial surfaces. It is routinely produced and sloughed off to prevent the adherence and colonization of microbes.

The fish skin mucus involves in multifunction ranging from food for younger fish to protection from pathogens. The mucus also helps in osmoregulation, communication, respiration etc. in fish. These initial discoveries of fish skin mucus in 20th century attracted many scientists and during the last two decades, a number of investigations were made in fish skin mucus to identify its components and its characteristic features. Every investigation opens a new dimension of fish mucus and helps to understand its mechanism and functions. One of the important property of fish skin mucus is its antimicrobial activity. Fish skin mucus contains immunological enzymes such as lysozyme, alkaline phosphatase, protease etc., which interrupts with the microorganisms and eventually destroy the interfering pathogens. The previous studies also revealed that the fish skin mucus has a number of antimicrobial peptides that can directly act upon the membrane of pathogens and inhibit its growth. The composition and characteristics of fish skin mucus is important to maintain the immune functions of fish. The secretion of skin mucus is higher in freshwater species when compared to marine species due to exchange of water across fish skin is larger in freshwater teleosts fish and production of mucus increases when expose to stressful situations such as reducing pH, infection etc. Moreover, the composition and characteristic features of skin mucus vary among fish species.

Based on the previous available literature about fish skin mucus, the Laboratory of Aquabiotics/Nanoscience under the guidance of Prof. R. Thirumurugan, Department of Animal Science, School of Life Sciences, Bharathidasan University, Tiruchirappalli involves in evaluating and comparing the mucus properties of various freshwater fish species and revealing the fish species which have high immunological enzymes and better antimicrobial activity towards bacterial pathogens. The writer of this article is a part of the research team.

In this study, common freshwater species namely common carp (Cyprinus carpio), rohu (Labeo rohita), and mrigal (Cirrhinus mrigala) were selected due to their adaptive capabilities, easy availability, high commercial values and frequently being used in polyculture fish farming system in India. The fishes were collected from fish farms in Thanjavur and allowed to acclimatize aquarium conditions for a period of two weeks. After acclimatization period, the mucus was collected from each fish species and processed for analysis of its protein profile, antibacterial capacity and immunological enzyme parameters.

The crude mucus sample of three fish species were evaluated in fourier transform infrared

spectroscopy, an analytical technique in which the functional groups of samples will be identified. The spectra of these fish species skin mucus revealed that they share similar patterns of functional groups in their mucus with no major differences. For further analysis of enzymes and proteins, instead of going with crude sample, extraction of proteins by precipitation method using solvents was chosen. Therefore, an extensive review of literature of previously used solvents for evaluating fish mucus proteins was done and most of them were in combination of organic and inorganic solvents. So, in this study, it was decided to select simple organic solvents acetone and methanol (separately) which have high efficiency of protein recovery. But direct usage of these solvents on proteins at room temperature will affect the dielectric constant, ionic strength and cause protein loss due to low solubility. However, these effects can be minimized if the solvents are used in high concentration and at low temperature. During the period of precipitation of proteins with organic solvents, the experimental temperature was maintained at 0 – 4 ?C. The precipitated proteins were then solubilized with suitable buffers along with the help of sonicator, an instrument which uses sound energy for complete solubilization of samples.

The protein profile of the solvent extracted skin mucus of three fish species was done by the technique of sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE), an analytical technique to separate proteins based on molecular weights. In the solvent extracted mucus samples, this technique revealed the presence of low molecular weight proteins and it attributes to the novel source of antimicrobial peptides. The antibacterial activity of three fish skin mucus extracted with acetone and methanol against pathogens in agar well diffusion method showed the distinct features of their inhibitory activity towards microorganisms. The methods of previous literature were adopted to evaluate the innate immune enzymes, lysozyme, alkaline phosphatase and protease. Enzymatic analyses illustrated the changes of their mucus enzymes correspond to the solvent extraction. This study also helps to compare the solvent's efficiency to recover proteins from fish skin mucus. It was noticed that in the protein profile analyses, the methanol extracted mrigal fish skin mucus showed visible low molecular weight bands, an indication of the existence of antimicrobial peptides. Likewise, the Cirrhinus mrigala (mrigal) fish skin mucus methanol extract displayed significant antibacterial activity against the experimental pathogens. And, in the enzymatic parameters, the mrigal (Cirrhinus mrigala) fish skin mucus extracted with methanol showed significant increased enzyme activity than other two fish common carp (Cyprinus carpio) and rohu (Labeo rohita). This is the first manifestation of antimicrobial peptides in mrigal fish. Through this study, we suggest that methanol extraction followed by centrifugation is most effective approach to recover proteins from samples.

The prevailing use of antibiotics for treating diseases is inevitable and it produces a greater number of antibiotic-resistant microorganisms so the application of antibiotics become an impediment. Therefore, we are in the urge to look for alternative antimicrobial agents to hinder the pathogens and the peptides from fish skin mucus could be a potential alternative pharmaceutical agent. The skin mucus is easy to collect and give no harm to the fish and it is continuously secreted. The diversity of fish species is an added advantage as it may be a repository for novel antimicrobial peptides with medicinal applications.