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Review Paper

A Study on Characteristics of fish mucus and their Antifungal activity

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Abstract

In their aquatic habitat, the fishes are simultaneously exposed to environments comprising various pathogenic micro-organisms, so that they need a constant mechanism to combat these pathogens and eliminate potential infections. The integumentary layer in fishes is exchange between them and the external environment protects the fish from pathogenic attacks. Recently, this mucus of the fishes has gained importance in the field of biomedical research, because of its ability to tackle infections caused by bacteria, viruses, and fungi, by providing innate immunity to the fishes. It is being studied for its potential applications in human medicine. This review is an outline of the active potency of fish integumentary mucus and its and effective role against several human pathogens and the treatment of their resulting clinical infections.

Keywords: Mucin, Antimicrobial peptide, Immunological defense, Epithelial cells, Viscous colloid.

Introduction

Nature has been and still is a continuous source of medicinal products. From the ancient time plant is always used as medicine and people don't think towards animals. The main region of this is that the animals are yet poorly explored source for medicine. The animals are well known ingredients for many popular medicines some of them are used as medicinal purposes various insects, Spanish flies, leeches and fishes are listed as medicine. The therapy from animals is called Zoo therapy. Till Date, 109 animals and their medicinal uses are reported in different parts of India.

It an medicines alternative among many other therapies. When food products are used for treating disease owing to its medical and health benefits is called nutraceuticals they include the nutrients like vitamins, minerals, and dietary supplements specific diets.

The fishes are traditionally used to cure infections, reduce pain and given to patients recuperating from operation, injuries and wounds. Both freshwater and marine fish and shell fish contain nutrients essential for the proper growth and development of humans. It is required in adequate amount in all stages of human life from infancy to old age. Consumption of fish along with balanced diet ensures a healthy life with minimal susceptibility to disease. The medicinal quality of fish is harnessed to prevent and cure many harmful diseases like as arthritis, asthma, heart related disease, and various other ailments and they are also an important source of vital nutrients like the proteins, fats vitamins and minerals. But every person does not have knowledge related to the animal also used as medicine for curing different types of diseases.

Role of Fish Mucus

The skin mucus is mechanically protective in nature and a physical barrier between fish with their environment. It is an important component of the innate immune mechanism, provides a first physical and chemical barrier against harmful pathogens[3]. The Integumentary mucus of fish makes smooth the surfaces and slippery which are mechanical protective nature[4], prevents pathogen's attacks. It contains many important elements such as proteins, lysozyme, immunoglobulin, and lectins. Nature of the mucus is depending on the species of fish, mucus varies considerably in viscosity, thickness, and glycoprotein (mucin)[5]. Fish skin contains a variety of immune cells such as macrophages, lymphocytes, eosinophilic granulocytes, dendritic cells, and cytokine [6]. The antimicrobial property against infectious pathogens was demonstrated in rainbow trout[7].

Production of Mucus

The epidermal mucus is produced by the cell present in epithelial layer of fish (goblet, club, and sacciform cells)[8,9]. Goblet cells are special types of cell present on epidermal layer of skin and gills surfaces of the Fish. The chemical composition of mucus is depending upon the secretory cell. The Goblet cells contain dialkylated, sulphated, and glycoproteins[10]. Left the Goblet cells some other cells are also identified whose secretion blend with the goblet cell and give rise mucus. These include sacciform cells and acidophilic granular cells or serious goblet cells, whereas the acidophilic granular cells produce basic proteins rather than glycoproteins. One another mucus secretory cell is club cell whose secretion have larger protein and lesser carbohydrate components[11].

Table-1: List of medicinally important fishes[1].

Common name	Species name	Medicinal property
Snakehead murrel	*Channa stritas*	The analgesic and antitumor medicinal drug, wound healing properties and reducing postoperative pain, and antimicrobial properties.
Walking catfish	*Clarias batrachus*	Reduces inflammation, Diarrhea control, and antinociceptive and antitumor properties.
Climbing perch	*Anabas testudineus*	Reduces inflammation, analgesic, antimicrobial and antitumor properties.
Catla	*Catla catla*	Asthma, heart diseases, and mineral deficiency.
Stinging catfish	*Heteropneustes fossilis*	Antimicrobial, anticancer
Common wood cat	*Trachelypterus galeatus*	Umbilical hernia and Asthma.
Indian glassy fish	*Chanda raga*	Inflammatory and antimicrobial
Tunny	*Tuna*	Anti-inflammatory effect on the cardiovascular system, lowering blood pressure. Control the risk of stroke and heart attacks.
Tengra	*Mystus tengra*	Anticancer.
Common carp	*Cyprinus carpio*	Antimicrobial.
Cichild fish	*Tilapia*	Protect various diseases like Alzheimer's, Parkinson's and epilepsy. Anti-inflammatory effects and novel treatment for Cancer.
Marbled swamp eel	*Synbranchus marmoratus*	Bronchitis.

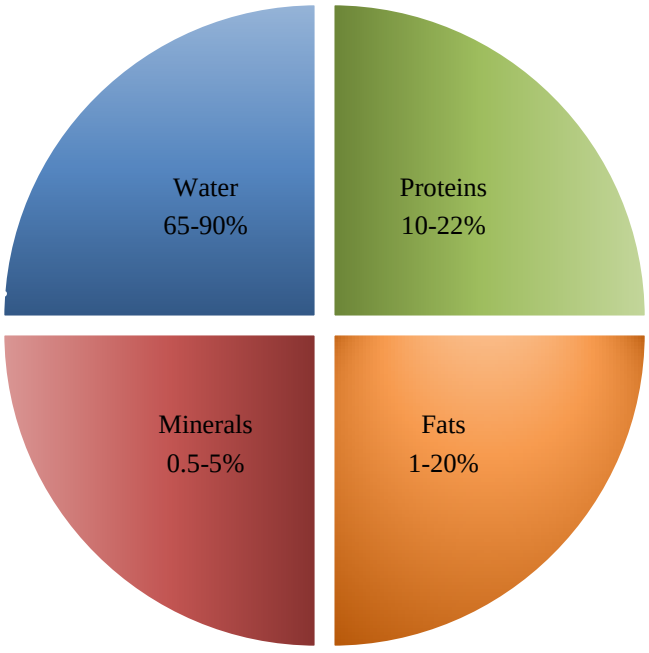

Figure-1: Composition of fish mucus.

Table-2: Different body parts of Fish are used as medicine they all are listed below[2].

Local name	Scientific name	Parts used	Application	Disease
Nujung	*Anguilla bengalesis*	Fats	Fat is applied and massage to relieve pain	Rheumatoid arthritis
Manthu fermented	*Puntinus sp.*	Whole fish	Whole fish are cooked with bamboo shoots and taken to purify the blood	Blood purifier
Ok-langso	*Channa gachua*	Whole fish, Bile	Boiled fish is prescribed to eat. The bile of the fish is applied to remove thorns	Abdominal pain when picked by a thorn
Ok-meklot	*Channa puntatus*	Eyes	Fish eyes are used to remove the corn	Corn or Clavus
Singki	*Heteropneustes fossilis*	Whole fish	Boiled fish is eaten up as a tonic	Anemia
Kunchirui	*Monopterus cuchia*	Whole fish, Raw blood	Raw blood is used to remove a leech from the anus	Entry of leech into the anus
Kunchirui	*Amphipnous cuchia*	Meat blood	Raw blood is consumed and boiled fish is prescribed to eat	Premenstrual abdominal pain, Anemia
Notun	*Labeo pangusia*	Flesh	Used as a tonic	Weakness
Seketa	*Wallago attu*	Head	The boiled fish head is taken routinely to improve liver activity	Liver tonic
Kokil mas	*Xenenthodon cancila*	Fish body	Spine and bone of fish are used to pick out the clotted blood	Joint pain, swelling
Mangur	*Claria batrachus*	Whole fish	Boiled fish is for regain strength. Cooked fish is consumed to cure smallpox	Smallpox, weakness after delivery
Moa	*Amblypharyngodon mola*	Whole fish	Boiled fish is prescribed to eat	Premenstrual pain
Tengana	*Mystus tengana*	Fish body	Used to cure small pox	Small pox
Kanduli mas	*Notopterus notopterus*	Whole fish	Burned and cooked fish are used	Delivery pain. Abdominal pain
Kurkuri mas	*Chaca chaca*	Fish body	Whole dried fish is used as food	Polio
Climbing perch	*Anabas testudineus*	Whole fish	The fish head part is boiled with spices and taken to eat	Dysmenorrhoea

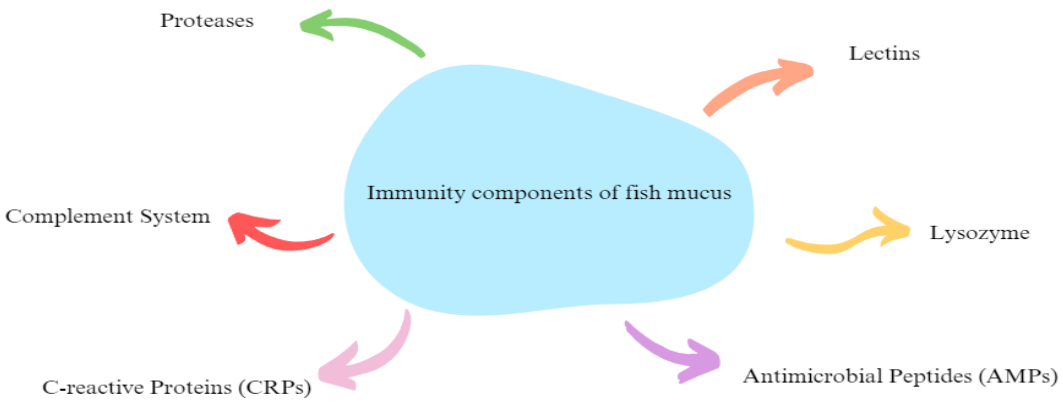

Figure-2: Components of the mucus.

Proteases: Proteases are groups of proteolytic enzymes present of epidermal layer, hydrolysed the peptide bonds present in proteins, converting them to shorter polypeptides and amino acids. Proteases of skin mucus are natural resistance of fish against different types of pathogens[13], they directly or indirectly act on pathogen or preventing invasion of pathogen by changing mucus consistency and destroy pathogens from the body surface[14]. The protease activity of integumentary mucus of *L. rohita* was comparatively higher than C. *mrigala* and *C. catla*, The protease enzyme play active role against the pathogenic organisms on the skin of climbing perch[16]. Proteases are also believed to activate and enhance the production of innate immune components like complement, and immunoglobulins in the piscine system. The presence of aminopeptidase, cathepsin B, and L-like proteases in the epidermal cell layer of the Japanese eel (*Anguilla japonica*) and dorsal surface of the European eel (*A. anguilla*) was also reported[17].

Lectins: Lectins are special type of protein also present in skin mucus of fish, containing a non-catalytic carbohydrate-recognition domain (CRD)[18]. Varieties of lectins have been reported in the fish integumentary mucus[19]. In catfish, *Silurusasotus* Calcium-dependent mannose-binding activity reported the occurrence of Fructose binding lectin in sea bass skin mucus. lectin (pentraxin) of with molecular mass 25 kDa lectin (pentraxin) was obtained from the integumentary mucus of a cartilaginous fish, *Raja kenojei*by[20,21].

Host defense peptides (AMPs): Antimicrobial peptides (AMPs) are a group of peptides, present in nature and part of the innate immune system of a variety of organisms[22]. It was observed that fishes are a great source of these Peptide and all major classes of peptides like defensins, cathelicidins, hepcidins, histone-derived peptides are present in fish-and called piscidins[23]. It was found that the antimicrobial peptides are appear and attached to the membrane surface and displace the outer bilayer[24], form the channel and depolarizing the target cells[25]. Piscidin-1 and piscidin-2 attach with cell membrane surface of the fungus and destroy it[26]. Fish peptides show antimicrobial activity by preventing both fish and human pathogens[27].

A new linear antimicrobial peptide Pelteobagris purified from mucus was found to show antibacterial activity against gram-positive and gram-negative bacteria and fungi[18]. It has been recently revealed in many studies, that there are several AMPs in the mucus fish that can be potentially used as an antibiotic for humans to cure diseases, especially skin diseases. For example, the hybrid striped was investigated to exhibit strong antifungal activity against human pathogenic fungi. Monocidins are another AMP showed wide spectrum activity against the Fungus, yeast, Gram +ve and Gram -ve bacteria, fungi. A 19 residue AMP parasin was discovered in the mucus of the injured fish and found to be quite similar to Buforin I which are an H2A-derived peptide present in toads[28].

Lysozyme: Lysozyme is a lytic enzyme, functioning as antimicrobial agent, break the peptidoglycan component cell walls of bacteria. Enzyme-containing muramic acid is hydrolyses glycol chitin and effect on chitin, present in cell wall and chitin of Invertebrates[29]. It was also reported that in addition to bacteria lysozyme inhibit viruses[30], parasites[31]. Lysozyme was reported in the skin mucus of five marine teleost fish by[32] and three freshwater fish highlighting the variations in the considered fish to furnish important information for the aquaculture industry[33].

C-reactive proteins (CRPs): In this study (CRPs), C-Reactive Proteins are a group of proteins (pentraxins) and bind various ligands in a Ca^{2+} -dependent binding capability. C-reactive protein is a part of the innate immune defense activity of the complement pathways and recognition and clearance of apoptotic cells[34]. Presence of pentraxin-like molecules was also reported in different teleost fish species including common wolfish (*Anarhichas lupus*), Atlantic salmon (*S. salar*), halibut (*H. hippoglossus*), cod (*Gadus morhua*), and Indian major carp (*Catla catla*)[35].

Complement System: Protein and non-protein elements of the complement system contain both adaptive immunity and innate. Approximately thirty- five plasma and membrane-bound proteins present in it[36]. Immune-related complement proteins (C3, C7, and C1q) are reported in the skin mucosa of Atlantic halibut (*H. hippoglossus*), Siberian sturgeon (*Acipenser baerii*) and grass carp (*Ctenopharyngodon idella*), respectively[37-39.]

Antifungal activity of Fish skin mucus: In this study we review the antifungal activity of skin mucus of various fish species against *Candida brusei, Saccharomyces cerevisiae Candida albicans, Candida tropicalis,* and *Issatchenkia orientalis*, and find *Gadus morhua* were most active against the fungi[40].

Antimicrobial activity of epidermal mucus extract of *Maculabatis gerrardi* and *Pastinachus sephen* was also reported againstthe fungal strains *viz., Candida tropicalis, Aspergillus niger, Penicillium sp., Trichophyton mentagrophytes, Alternaria alternata, Candida albicans, Rhizopus sp., Mucor sp.,* and *Trichophyton rubrum* and showed a potent activity also against fungal pathogens[41].

The antifungal activity catfish (*Clarias batrachus*) was tested against pathogenic fungi: *Aspergillus niger, Aspergillus nidulans, Fusarium moniliforme, Candida albicans,* and *Trichoderma koningi*, and maximum zone of inhibition was observed against both *A. niger* and *C. albicans*; followed by *A. nidulans* and *F. moniliforme*. While *T. koningi*, showed the minimum zone of inhibition[42].

Antifungal activity of skin mucus extracts of *Mastacembalus armatus* against 6 fungal strains viz. *Aspergillus niger, Aspergillus flavus, Candida albicans, Cryptococcus*

neoformans, and *Mucor sp* and it was observed that the acidic mucus extract inhibited the growth of *Mucor sp*. better than the organic extracts. However, the organic mucus extracts of the same fish were found to be more effective against *A. niger* and *A. flavus* than the acidic extracts[43].

The antifungal activity of skin mucus of fish *Dasyatis pastinaca* is a great inhibitor of *Candida albicans, Candida glabrata, and Candida tropicalis* was observed[44].

The antifungal properties of epidermal mucus of freshwater fish species viz., *Catla catla, Cyperinus carpio,* and *Heteropneustes fossilis* against fungal strains: *Aspergillus niger, A. clavatus, A. flavus, Candida albicans, C. tropicalis, C. auris,* and *Mucor ramosissimus* was also studied and observed that both the acidic and organic extracts showed a vast range of antifungal effects against all the selected pathogenic fungi. However, acidic extracts of all the specimens exhibited a higher antifungal effect against the selected fungal strains. It was considered that the basic peptides were responsible for antifungal action of all fishes. The skin mucus extracts of *C. catla* showed the highest antifungal effect out of the three[45].

Conclusion

As an alternative to antifungal drugs, it is necessary and also wants attentionto the animal sources of antifungal components from the above-mentioned studies, it is evident that the fish skin mucus possesses strong antifungal activities against pathogenic fungal strain, it could be noted as a source of novel antifungal components. The mucus is usually discarded from the fisheries and hence is wasted. This skin mucus can be efficiently employed for the antifungal agents, with a low risk of developing resistance, which would be beneficial in the case of drug resistance.

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