Value Addition of Fishery Waste – Way Forwards and Backwards

[1]Dr. A.A. Zynudheen and [2]Dr. P.K. Binsi
[1]Principal Scientist & Head, QAM, [2]Scientist, ICAR-Central Institute of Fisheries Technology, Cochin – 682 029
Email: zynucift@gmail.com

Introduction

Historically, fish has always been an important food source and even today it is one of the most traded commodities in international markets. Currently, fish contributes around 16.6% to the total animal protein supply and 6.5% of all proteins consumed by humans world-wide. In parallel with the increasing global demand for seafood, there are growing concerns about the sustainability and management of the fishing industry. Recent studies have only discussed wastage in general terms and suggest that waste could be as large as US$ 50 billion each year due to poor management of seafood resources. However, if appropriate management changes are undertaken, losses from the fishery sector can be reduced in a sustainable way. Different types and quantities of fish waste are produced throughout the food supply chain, commencing with capture and ending with consumption. Wastes are produced at different points in the value chain, *viz*. through by-catch, onboard processing, transport, storage, retailers, and consumers. Fish waste generation begins during wild catching, with by-catch or unintentional catch of marine species being discarded. It is estimated that globally around 17.9 to 39.5 million tonnes of whole fish is discarded each year by commercial fishing operations. Following capture, processing is the main stage in the food supply chain where maximum waste gets generated. During processing, only the fillets are preserved and the remainder of the fish is thrown away as waste. Global fish waste generation is estimated to be in excess of 100 mMT and in the Indian scenario it is >4 mMT. It is estimated that fish processing waste after filleting accounts for approximately 75% of the total fish weight. About 30% of the total fish weight remains as waste in the form of skins and bones during preparation of fish fillets (Table 1). Bio-conversion of these wastes is an environmental friendly and profitable option for the utilization. Some viable options for generating wealth from waste are discussed in this chapter.

Value addition options and opportunities

Generally two different methods, mass transformation and sorting, have been developed to improve the economic value of fish wastes. Mass transformation involves the conversion of fish waste into a single product. Typical examples of transformed fish waste include fishmeal, fish oil, fertilizers, and hydrolysates such as protein hydrolysate. Alternatively, sorting involves utilizing various fish body parts such as bones, guts, and fins separately to enhance their economic value. For example, sorting enables the production of specialized products such as liver oil, gelatin, omega-3 fatty acids, protein containing sports food and drinks, calcium, cosmetics, and pharmaceuticals. Wider acceptance and adoption of both methods could lead to significant reductions in wastes going to landfill and reduce the damaging impact of fish wastes on the environment.

Table 1. Waste generation in industrial fish processing in India

Products	Waste generated (%)
Shrimp products (PD, PUD, HL, etc.)	50
Fish fillets	70
Fish steaks	30
Whole and gutted fish	10
Cuttlefish rings	50
Cuttlefish whole	30
Cuttlefish fillets	50
Squid whole cleaned	20
Squid tubes	50
Squid rings	55

Source: Anon. (2005)

Fish meal: Fish meal is highly concentrated nutritious feed supplement consisting of high quality protein, minerals, vitamins of B group and other vitamins and other unknown growth factors. Fishmeal is rich in essential amino acids. It is produced by cooking, pressing, drying and grinding the fish, by-catch fish, and miscellaneous fish, filleting waste, waste from canneries and waste from various other processing operations. The composition of fishmeal differs considerably due to the variations in the raw material used and the processing methods and conditions. Better quality fish meal has been a prominent item of export from the very beginning of this industry. BIS has brought out the specification for fish meal as livestock feed for facilitating proper quality control. The proximate composition of fish meal, in general, is protein 50-60%; fat 5-10%; ash - 12-35% and moisture - 6-10% (Mathew, 2014). Around 15% of the global fish meal demand is met from fisheries resources alone. The projected (2030) annual growth rate in fishmeal use in aquaculture is 1.7%, where the current usage is at a tune of 3.9%.

The recent development in captive breeding and rearing high value species such a cobia, grouper, pompano, Nile tilapia, lobster, Asian seabass etc. implies that there is good scope for flourishing finfish and shellfish production through aquaculture in th near future. This in turn highlights the bright future of fish meal industry in coming years, as most of these species demand high protein feeds for their optimum growth.

Table 2 Yield of fish hydrolysate from different fish species

Species	Yield of hydrolysat (g.100g^{-1})
Lizardfish (*Saurida tumbil*)	13.3
Large spined flathead (*Platycephalus macracanthus*	11
Ribbonfish (*Trichiurus* sp.)	9.9
Barracuda(*Sphyraena* sp.)	11.9
Jewfish (*Johnius* sp.)	9.9
Threadfin bream (*Nemipterus japonicus*)	12
Catfish (*Tachysurus* sp.)	10.9
Anchovies (*Thrissocles* sp.)	9.7
Sole (*Cyanoglossus* sp.)	8.6

Fish protein hydrolysate: Fish protein hydrolysates are obtained by the controlled hydrolysis of fish protein either by employing acid, alkali or commercially available proteolytic enzymes. Hydrolysates find application as milk replacement and food flavouring. Enzymes like papain, ficin, trypsin, bromelein and pancreatin are used for hydrolysis. The process consists of chopping, mincing, cooking and cooling to the desired temperature, hydrolysis, sieving, pasteurizing the liquid, concentrating and drying (by vacuum or spray drying). Fish protein hydrolysates have desirable functional properties with potential applications as emulsifiers and binder agents; and can be used in place of diary-based and plant-based protein hydrolysates as well as protein powders currently available in market (Binsi *et al*., 2016). The yield of hydrolysate is a critical parameter which decides the economics of operation. The yield is primarily dependent on factors such as enzyme-substrate ratio, temperature, pH, hydrolysis period, enzyme used etc. (Table 2).

The peptides formed by the hydrolysis of fish proteins are proven to have bioactive properties like antihypertensive, antithrombotic, immuno - modulatory and antioxidative properties. Also, they are good source of nutritional and functional properties. A variety of nutraceuticals from FPH are commercially produced and are available in international markets. Oyster peptide extract developed by ICAR-CIFT possessed antioxidant and anti-inflammatory activities (Asha *et al* 2016). Similarly, hydrolysate made from squilla meat effectively reduced oil absorption in breaded and battered products, when incorporated in the batter mix.

In the industrial process of preparation of hydrolysates, enzyme hydrolysis is followed. Papain, bromelein, pepsin, ficin and trypsin are used for hydrolysis. Most hydrolysates are bitter in taste. Hence flavouring agents like cocoa, malt and sugar are used during the fortification in food preparation to mask the bitter taste as given in Table 3. Protein hydrolysate has special application in sports medicine because its consumption allows amino acids to be absorbed by the body more rapidly than intact proteins, thus maximizing nutrient delivery to muscle tissues. Bioactive peptides are generally short peptides (3–20 amino acids) derived from proteins that can exert biological activities over and above their expected nutritional value. From a nutritional perspective, these peptides are more bio-available than proteins or free amino acids and at the same time, less allergenic than their native proteins. Apart from their nutritional benefits, bioactive peptides exhibit a wide range of physiological functions including antihypertensive, antioxidative, opioid agonistic, anticancer immuno-modulatory, antiproliferative, antimicrobial, prebiotic, mineral binding, antithrombotic, hypolipidemic and hypocholesterolemic effects. These beneficial properties of fish protein hydrolysates may be due to the unique combination or high proportions of certain amino acids such as arginine and taurine with low levels of branched-chain amino acids found in fish meat.

Table 3. Composition of beverage based on fish protein hydrolysate

Species	**Composition by weight (%)**
Fish protein hydrolysate	30
Malt	20
Sugar	20
Milk powder	10
Fat	05
Cocoa	05

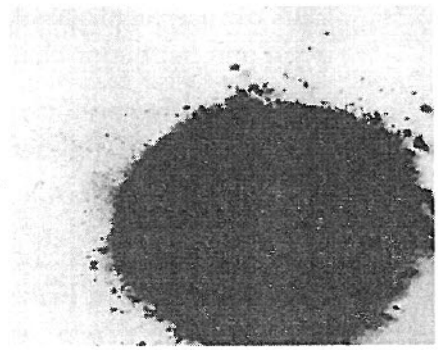
Enzymes: There is a great demand for enzymes with right combination of properties for a number of industrial applications. Enzymes from marine fisheries resources have wide biotechnological potential as they have some unique properties for industrial applications, e.g. in the detergent, food, pharmaceutical, leather and silk industries. Among the enzymes derived from various sources, marine enzymes have certain technological advantages. Some of the distinctive features of enzymes derived from fish include, the higher catalytic efficiency at lower reaction temperatures, and stability at wide range of pH and in the presence of surfactants or oxidizing agents. The high catalytic activity at lower temperature is a unique property that further permits to process foods at low temperatures such as fruit juices, thereby protects heat-labile food components and reduces the energy cost. Similarly, the lower thermo-stability of marine enzymes would permit their complete inactivation by mild heat treatments, whereas the enzymes from microbial and plant resources often requires heating at above 90 °C for a minimum duration of 10 min. for stopping the enzymatic reaction. World-wide the sales of industrial enzymes are growing at a fast rate. Presently, industrial enzymes are mostly derived from microorganisms and to a lesser extent from plant and bovine sources. So far, there is only very limited use of marine-derived enzymes by the industry. The reason may be the limited basic information on these enzymes, the seasonal nature of raw material availability, the psychological inertia of the public towards fish offal and to a greater extent, due to the lack of proper techniques for the recovery of enzymes from fish processing waste which comprises of a complex mixture of various biomolecules such as proteins, lipids, minerals, glyco-proteins etc. It is suggested that future research may be focused on the development efficient and cost-effective technologies for the recovery of various enzymes from fishery resources, so that some of the unique properties of marine enzymes may be exploited in various food applications, and thereby, obtain a share of lucrative industrial enzyme market to increase the profit for fish processing industry.

Taurine: Taurine is a sulfur-containing non-protein amino acid (2-amino ethane sulfonic acid), with multiple functions like neuro-transmission, cell volume regulation, stabilization of cell membranes and in the transport of ions such as calcium, sodium, potassium and magnesium. Taurine is one of the most abundant amino acids in the brain, retina, muscle tissue, and organs throughout the body, and taurine deficiency is associated with cardiomyopathy, retinal and tapetum degeneration, renal dysfunction, immune deficiency, muscle atrophy, developmental abnormalities, premature aging, and impaired reproduction. It can be synthesized from methionine and cysteine with the help of vitamin B6. The importance of taurine in biological system has been recognized in the recent past only and is now considered as a 'conditionally essential amino acid' having key functions in the visual pathways, the brain and nervous system, cardiac function, and cholesterol metabolism. The osmoregulatory role of taurine in facilitating the passage of sodium, potassium, calcium and magnesium ions into and out of cells, thereby stabilizing the structural and functional integrity of cell membranes was well discussed in earlier reports. It is involved in detoxification of xenobiotics and also essentially required for efficient fat absorption and solubilisation. Taurine has a protective effect on the tissue damage that results from oxygen-free radicals in mercury-induced toxicity. It plays a crucial role in pre-natal and infant development. Epidemiological studies have shown that increased taurine intake is associated with diminished risk of hypertension. The deficiency of taurine does not impose immediate health issues. However long-term deprivation can affect a multitude of metabolic pathways. It is a key ingredient of bile and has a major role in the maintenance of normal gastrointestinal development and functions. Taurine is found in greater concentrations in all animal products. Meat, breast milk, dairy products, and fish are good sources of taurine. Shellfish contain higher concentration of taurine compared to that of finfish. Zhao *et. al*. (1998) determined the taurine concentration of a variety of common marine fish species and reported the highest content in crustacean and molluscs, ranging from 300-800 mg per 100 g meat. Apart from that red algae is considered as a good edible source of taurine. A possible beneficial action of taurine against Parkinson's and Huntington's disease by attenuating oxidative stress and apoptosis is proposed. Eventhough, the cellular and biochemical mechanisms mediating the actions of taurine are not fully revealed, mounting evidences suggest that taurine might be a key functional ingredient for use as a nutritional supplement to protect against oxidative stress, neurodegenerative diseases, atherosclerosis and hypertension.

Glucosaminoglycans: Glucosaminoglycans (GAGs) are linear polysaccharides with repeating sequences of disaccharides consisting of an amino sugar (N-acetylglucosamine, or N-acetylgalactosamine) and uronic acid (glucuronic acid or iduronic acid) or galactose. The major members of GAGs are hyaluronic acid or hyaluronan (HA), keratin sulfate (KS), chondroitin (CS), dermatan sulfate (DS), heparin and heparin sulfate (HS). HA is a high molecular weight molecule, typically with 2 -10 x 10^7 Da and 2–25 im chain length, whereas, other GAGs are short-chain molecules with of less than 50 kDa, more commonly 15–20 kDa. Hyaluronan lacks sulfate groups and is not covalently linked to protein, but the rest of the glycosaminoglycans are covalently linked to a protein core and contain sulfates at various positions. Dermatan sulphate is distinguished from chondroitin sulfate by the presence of iduronic acid. Keratan sulfates contains sulfated galactose and N-acetylglucosamine in place of uronic acids. GAGs are primarily considered as the components of various structural and connective tissues. Apart from the structural role, GAGs have been found to be associated with the regulation of a number of proteins, including chemokines, cytokines, defensins, growth factors, enzymes, proteins of the complement system and adhesion molecules. Apart from that, a few members like heparin possess anticoagulant, and anti-inflammatory properties. Dermatan sulfate (chondroitin sulfate B), also has a range of biological properties, although it has not yet been considered for therapeutic purposes. Marine heparin extracted from shrimp and sea squirt has proven anti-inflammatory properties.

Melanin: Cephalopods comprising mainly squids and cuttlefishes form an important resource of world oceans and their economic importance is growing exponentially. Consequently, cephalopods have emerged in recent years as an important component of the marine products, and are considered as a major delicacy in export markets. While several products (fillets, tubes, rings etc.) are made from cuttlefish, squid and octopus, considerable quantity, including the ink sac is disposed as waste. Interestingly, the cephalopod ink was identified as the most useful resource for the commercially important pigment melanin. Basically, squid ink is an mixture of melanin, proteins, lipids, carbohydrates, glycosaminoglycans, various minerals etc. The predominant components are melanin and protein-polysaccharides complex. Each ink sac of sepia has ~1 g of melanin, and melanin constitutes ~15% of the total wet weight of ink with other proteins.

The basic structure of melanin comprises of covalently linked indole structure (Takaya *et.al.*, 1994). Melanin performs a number of biological functions in the body, the main function being protection of the organism from harmful agents such as ultraviolet (UV) radiation. Melanin is capable of dissipating over 99% of absorbed UV light. Besides, in the biological system, melanin plays a vital role in providing mechanical strength and protecting proteins from degradation. Numerous reports published in last 30 years reveal the therapeutic, prophylactic and curative value of cephalopod ink. The anti-ulcerogeneic properties and anti-inflammatory activity of squid melanoprotein against paw edema was demonstrated in 80's by Mimura *et al.* through a series of rat model studies. Later on, several researchers confirmed the effect of squid melanin on both phenyl butazone-induced ulceration in gastric mucosa and secretion of gastric juice in rats. Apart from that, melanin has been reported to have radio-protective activity, antitumor activity, immuno-modulatory activity, procoagulant function and so on. Natural melanin has been reported to have defense activity, protection function and metal chelating ability. It could participate in physiological and pathological activities in human body and even in the treatment of Acquired Immune Deficiency Syndrome (AIDS). A new generation photo-thermal dopamine-melanin colloidal nanospheres was developed by Liu *et. al.* (2012) which could efficiently damage tumour cells at low power density and short duration, without damaging healthy tissues. Melanin also functions as photoprotective and chemoprotective pigment, protecting the body from damaging radiations, as observed at an effective dose of 50 mg/kg body weight in mice model. Similarly, oral administration of melanin for protection against radiation was reported by Dadachova *et. al* (2016). The protective activity of melanin is primarily attributed to the inhibition of radiation-induced hematopoietic damages. Several other physiological studies conducted on squid ink also revealed significant effects on granulopoiesis of hemopoiesis impaired mice induced by ^{60}Co γ irradiating or cyclophosphamide, but has no effect on erythropoiesis. Melanin has been widely and conventionally used as an antioxidant and natural colourant in food formulation. The most interesting thing is that melanin can be used as food additives to prevent the rancidity caused by the presence of bacteria by quenching the bacterial quorum sensing. Squid melanin was reported to have hemopoietic function in iron deficient anaemic rats, which might be exploited as a safe, efficient new iron tonic. Deficiency of melanin is associated with disorders such as vitiligo and oculocutaneous albinism. Interestingly, melanin is thought to play a protective role against the age-associated and noice-induced hearing loss. Recently, the anti-ageing property of melanin was demonstrated in mice model, suggesting it's use in neutracosmetic formulations. Eventhough melanin is a part of normal human diet, research on dietary intake of melanin is not much explored.



Melanin

Challenges and way forward

The key to successful seafood waste utilisation and management is to develop appropriate eco-friendly reprocessing technologies that can convert all the valuable components present in the waste into valuable products and reduce the amount of waste going to disposal route. However, there are many challenges that we must overcome to achieve this goal.

1. Consumer awareness and education is one such challenge. Without consumer acceptance of food waste reduction approaches, no sustainable eco-friendly food waste utilisation and management strategy can succeed. This demands proper extension efforts from the research and extension organizations.

2. Seafood sector is a poorly organized sector. The highly scattered nature of seafood processing operations (across domestic market and processing acilities) poses problems in collection and processing.

3. Seafoods are highly perishable in nature owing to its unique richness in terms of protein, peptides, enzymes and microbial flora. This quite often leads to the mass resistance from public in starting up a business venture in the vicinity.

4. Stringent legal and environmental restrictions from the regulatory bodies as seafood waste is not categorized as "inactive/inert" waste is a major discouraging factor for the entrepreneurs to invest upon this resource

5. Inappropriate cold chain management from the source of generation to the point of conversion as the processors are least interested to invest further on discards

6. There is no baseline data on the availability and economics of production collected over the past years, which poses uncertainty about economics and market demand of secondary products

7. Lack of clear legal classification of secondary products in the international market is yet another major challenge to the investors

8. Lack of unified protocols for quality assurance (such as HACCP) for secondary products leads to frequent rejections from the buyers.

References

Anon. (2005) - Assessment of Harvest and Post Harvest Losses in Marine Fisheries. Central Institute of Fisheries Technology, Cochin: 122 p.

Asha, K.K., Kumari, K.R.R., Kumar, K.A., Chatterjee, N.S., Anandan, R., and Mathew S. (2016) Sequence determination of an antioxidant peptide obtained by enzymatic hydrolysis of oyster, Crassostrea madrasensis (Preston). *International Journal of Peptide Research & Therapeutics* 22(3), 421-433.

Binsi, P.K., Visnuvinayagam, S., Viji, P., Zynudheen, A.A. and Chakrabarty, R. (2013) - Fish scale: A biomaterial with versatile applications. *INFOFISH Intl* 3: 41-43.

Binsi, P.K., Zynudheen, A.A., George Ninan., Mohan, C.O. and Ashok Kumar, K. (2015) - Proceedings of National Seminar on 'Chitin in Agriculture, Medicine and Allied Fields, SOFTI, India. ISBN: 978-81-930245-5-3.

Binsi, P.K., Viji, P., Zynudheen, AA., Ravishankar, C.N. and Srinivasa Gopal, T.K. (2014) - Fish Collagen Peptide. Central Institute of Fisheries Technology, Cochin

Binsi, P.K., Nayak, N., Sarkar, P.C., Joshy, C.G., Ninan, G. and Ravishankar, C.N. (2017) - Gelation and thermal characteristics of microwave extracted fish gelatin–natural gum composite gels. *J. Food Sci. & Technol.*, 54(2): 518-530.

Gopakumar, K (2002) - Fishery byproducts, In: Textbook of Fish Processing Technology (Gopakumar, K., Ed.) Indian Council of Agricultural Research. New Delhi

Hall, G.M and Reid, C.L. (1994) - Scale up of lactic acid fermentation process for the recovery of chitin from prawn waste. In: Zakaria, M.B., Wan Muda, W.M. and

Abdulla, M.P. (Eds.) Chitin and Chitosan. The versatile environmentally friendly modern materialsm. National University of Malaysia. Kualalumpur, pp 48-51.

Madhavan, P. and Nair, K.G.R. (1974) - Utilization of prawn waste - Isolation of chitin and conversion to chitosan. *Fish. Technol.* 11: 50-53.

Madhavan, P. and Nair, K.G.R. (1978) - Metal binding property of chitosan from prawn waste, In: Proc. First International Conference on Chitin and Chitosan, Muzzarelli, R.A.A. and Parisier, E.R. (Eds.), Massachusetts Institute, Cambridge

Mathew P.T. (2003) - Non-conventional fishery byproducts, In: Winter School Manual on Product Development and Seafood Safety, Joseph, J., Mathew, P.T, Joseph, A.C. and Muraleedharan, V. (Eds.), Central Institute of Fisheries Technology, Cochin, p. 161-168.

Mathew, P.T. and Nair, K.G.R. (1978) - Hypocholesterolemic effect of chitin and its hydrolysed products on albino rats. *Fish. Technol.* 35: 46-49.

Mukundan, M.K., Stephen, J. and Devadasan, K. (1989) - Collagen fibres from fish gut, In: Resent Trends in Processing Low Cost Fish, Balachandran, K.K, Peregreen, P.A., Madhavan, P. and Surendran, P.K. (Eds.), Society of Fisheries Technologists, Cochin, pp 187-191.

Muraleedharan, V. (2003) - Surimi and surimi based products and byproducts In: Winter School Manual on Product Development and Seafood Safety, Joseph, J., Mathew, P.T, Joseph, A.C. and Muraleedharan, V. (Eds.), Central Institute of Fisheries Technology, Cochin, pp133-138.

Nair, K.G.R., Mathew, P.T., Joseph, A., Xavier, M. and Krishna, A. (2004) - Live stock feed from cephalopods processing waste, In: Report of National Agricultural Technology Project on Development of Value added Products and Byproducts from Low Cost Fish and Processing Waste from Fish and Shellfish, Central Institute of Fisheries Technology, Cochin pp. 1-11.

Nair, K.G.R., Mathew, P.T., Madhavan, P. and Prabhu, P.V. (1987) - Chitin as a feed additive for broiler chicken, *Indian J. Poultry Sci.* 22: 40-44.

Nair, K.G.R, Mathew, P.T, Madhavan, P. and Prabhu, P.V. (1993) - Effect of feeding chitin on poultry, *Fish. Technol.* 30: 24-27.

Ninan, G., Joseph, J., Zynudheen, A.A., Mathew, P.T. and Geethalakshmi, V. (2009) - Optimization of gelatin extraction from the skin of freshwater carps by response surface methodology, *Fish. Technol.* 46(2): 123-138.

Raghunath, M.R. (2002) - Fish silage, In: Text book of Fish Processing Technology, Gopakumar, K. (Ed.), Indian Council of Agricultural Research, New Delhi, p. 263-268.

Rajalakshmi, M. and Mathew, P.T. (2007) - Colour and textural parameters of thread bream surimi during frozen storage as affected by cryoprotectants and chitos *Fish. Technol.* 44: 55-64.

Santhosh, S. (2006) - Studies on the Anti-ulcerogenic and Anti-hepatotoxic Potent of Chitosan and Glucosamine in Experimental Rats. Ph.D. Thesis, Coch University of Science and Technology, Cochin.

Santhosh, S. and Mathew, P.T. (2008) - Preparation and properties of glucosamine a carboxy methyl chitin from shrimp shell, *J. Appl. Poly. Sci.* 107: 280-285.

Santhosh, S., Anandan, R., Simi, T.K., Mathew, P.T. and Thankappan, T.K (2005) Biochemical studies on the anti-ulcer effect of glucosamine defense status experimentally induced peptic ulcer in rats, *J. Clin. Biochem & Nutr.* 37: 61-6

Sini T.K. (2005) - Application of fermentation techniques in the utilization of praw shell waste, Ph.D. Thesis, Cochin University of Science and Technology, Cochi

Sini T.K., Santhosh S. and Mathew P.T. (2005) - Study of the influence of processin parameters on the production of carboxymethyl chitin, *Polymer* 46: 3128-313

Thankamma, R. (2003) - Speciality products from fish, In: Winter School Manual o Product Development and Seafood Safety, Joseph, J., Mathew, P.T, Joseph, A.C and Muraleedharan, V. (Eds.), Central Institute of Fisheries Technology, Cochi p. 139-148,

Thankamma, R., Gopakumar, K., Nair, L., Shenoy, A.V. and James, M.A. (1979) Preparation of hydrolysate from miscellaneous fish, *Fish. Technol.* 35: 71-75.

Venugopal, V., Alur, M.D. and Nerker, D.P. (1989) - Solubilisation of fish protein using immobilized microbial cells, *Biotechnol. Bioeng.* 33: 1098-1103.

Zynudheen, A.A., Elavarasan, K. and Bins,i P.K. (2016) – Fishaceutias - A detaile Investigation, In: Advances in Marine Natural Products and Neutraceutica Research, (Eds). Suseela Mathew, Anandan, R, Asha, K.K., Niladri Sekha Chattergee, Tejpal, C.S., Lekshmi, R.G. Kumar, and Menon, A.R.S., pp 69-84.