ISSN 2454 - 5538
Vol. 5 No. 1
January - June 2019

FISHTECH REPORTER

भा कृ अनु प - केंद्रीय मात्स्यिकी प्रौद्योगिकी संस्थान
ICAR - CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY
सिफ्ट जंक्शन, विल्लिंगडन आइलैंड, मत्स्यपुरी पी.ओ., कोचिन . 682029ए केरल, भारत
Willingdon Island, Matsyapuri P.O., Cochin - 682029, Kerala, India

FISHTECH REPORTER

EDITORIAL BOARD

Cover designed by
Mrs. Razia Mohamed

Printed by
PrintExpress, Kochi

PUBLISHED BY

The Director
ICAR-CIFT

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Contents

From the Editorial Board.....

In the January-June issue of fish tech reporter, we are proud to introduce the latest research achievements of ICAR-Central Institute of Fisheries Technology. The current issue covers 12 articles in the areas of fishing technology, post harvesting, quality assurance, and microbiology.

For the first time in the country, ICAR-CIFT has initiated focused research efforts on ghost fishing; and the salient findings are reported in this issue. The unconventional fishery resource, Myctophids has been gaining attention as a source of protein for human consumption. This issue features an article describing the midwater trawling operations carried out by ICAR-CIFT exclusively targeting myctophid resources during the past few years.

For promoting the live mud crab trade, ICAR-CIFT has developed a prototype for live mud crab transportation, facilitating optimum storage conditions. The current issue also brings to you the innovations in fish processing such as application of electron beam irradiation for enhancing the shelf life of fish, high pressure processing of fish mince, air frying technique for fish cutlet etc. Articles featuring the nutritional composition of Jelly fish and development of protein concentrate from squilla highlight ICAR-CIFT's efforts to utilize the unconventional fishery resources.

The article detailing the status and prospects of e-marketing of seafood in Kerala may be of special interest to consumers who prefer buying good quality fish. Isolation of Tyrosinase producing bacteria from shrimp and assessment of stake holder's feasibility towards fish based entrepreneurship are the few other research achievements highlighted in this issue.

The fisheries sector of the country is expected to revitalize with the constitution of a new department separately for fisheries, animal husbandry and dairying. We hope that the highlights of current issue of fish tech reporter can help the readers in planning their future endeavors in the harvest and post harvest sector.

Mesopelagics: A promising fishery resource for future

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There is a growing concern about the production of enough nutritious food to feed the global human population. Environmental conflicts, disease outbreak and limited freshwater supply constrain further developments in the aquaculture sector. Since the production from the capture fisheries sector is plateauing, it is high time to explore unconventional resources as this has to play a more prominent role in supplying human food directly or indirectly. Mesopelagic resource in general and myctophid resource in particular could be one among them. It can be a source of fish protein for human consumption, fish meal, which have great demand in aquaculture/animal feed, fish oil, nutraceutical and cosmetic industry.

Acoustic data based recent estimation suggested the presence of mesopelagic fishes between 11,000 and 15,000 million metric tons in the world oceans, of which 365 million metric tons is in the Indian Ocean (Irigoien et al., 2014). Despite large potential of mesopelagics as a sustainable resource, a little information is available on the appropriate commercial harvesting methods. About 75% of total global catch of mesopelagic fishes is accounted by myctophids. Globally, average annual landing of myctophids was 10,640 tons between 1970 and 2015 with a peak production of 74,751 tonnes in 1990 (FAO 2001). Another acoustic data revealed that the biomass of lantern fish to be around 2 million metric tons in Oman sea during 1989-90 (Valinassab, 1998). In 1990 about 4 million metric tons of lantern fish biomass was estimated (Johannesson,1991). According to a survey during 1975-83 resource estimation was in the range of 8 to 20 million metric tons in Gulf of Oman (FAO, 2001). Mesopelagic fishes in the world ocean have been estimated at about 1000 million tonnes by Lam & Pauly (2005). At present partial operation at Gulf of Oman, the sub-Antarctic and off South Africa constitute the commercial fishery of mesopelagic (Hulley, 1996). Myctophids are the most abundant group of mesopelagic fishes in the Indian Ocean. About 137 species of myctophids were reported in the Indian Ocean (Boopendranath et al., 2012; Vipin et al., 2012). Eight species belonging to three genus; Myctophum (*Myctophum obtusirostre* and *M. spinosum*) Benthosema (*Benthosema fibulatum)* and Diaphus *(Diaphus watasei, D. dumerilli, D. hudsoni, D. luetkeni,* and *D. effulgens*) were identified by Boopendranath et al (2012) from deep sea shrimp trawl bycatch off southwest coast of India. During 2009-2010 the total bycatch in deep sea trawlers was 11,488 tons, out of that 32% (3,676 t) was contributed by myctophids (Boopendranath et al. 2012).

Despite large resource potential, only a little information on the commercial harvesting is available for mesopelagic fishery. This fishery at commercial level is mainly confined to one or two countries like Oman and South Africa. Vertical migration of the mesopelagics shoal during dusk and dawn at a considerable speed is the key factor to be taken into consideration during fishing operations. The movement of shoal is probably for feeding zooplanktons which are also undertaking vertical migration. Smaller the size, ugly appearance, presence of wax/esters in tissue, uncertainty in shoal identification and deep sea fishing are some of the possible reasons hindering the commercial exploitation of this fishery. Myctophids emits light sense and react according to the movement of fishing gear. The presence

of lateral line system helps them to detect low frequency vibrations & pressure waves (Glass and Wardle, 1989; Wardle, 1993). It has been proven that success of myctophid harvesting is mainly depends upon mouth opening of trawl and appropriate mesh size of the netting (Shilat and Valinassab, 1998). Aimed midwater trawling and pair trawling with appropriate trawl designs have been considered suitable for harvesting mesopelagic resources.

ICAR-CIFT attempted aimed midwater trawling from FORV Sagar Sampada (L_{OA} 72.5 m, 2285 hp) using 45 m midwater trawl and 49.5 m krill trawl in the Arabian sea during 2013. Trials were also carried out on board ICAR-CIFT research vessel RV Matsyakumari (L_{OA} 17.7 m, 325 hp at 1800 rpm, 66 GRT) during Aug-Nov 2018, off Kollam, in 300-500 m depth using 23.5 m four seam trawl (Fig.1). Speed of trawling was between 2.3 and 2.8 kn with plateena rope as warp. Hondex (HE 881) echo sounder was used to detect Deep Scattering Layer (DSL). Samples from commercial deep sea shrimp trawlers were also collected for the study.

Diaphus watasei with length range of 40-75 mm dominated the catch followed by pelagic shrimps, *Oplophorus typus* (30-65 mm), *Acanthephyra purpurea* (40-50 mm) and *Heterocarpus* sp. (65-70 mm). *Parapenaeus stylifera*, *Charibdis ferriata* and *Loligo* species were the other major components. Catch composition analysis of commercial fishing vessels off Kollam revealed occurrence of 22 species (Fig.2 and 3). *Diaphus watasei* of size range 70-180 mm represented the myctophid family in the catch of commercial trawlers followed by deep sea shrimp (Fig.4).

Maximum CPUE obtained in the 49.5 m trawl during the aimed midwater trawling onboard FORV Sagar Sampada was 60 kg. Since there is a demand for sources of protien for fish meal and poultry, mesopelagics can be considered as an alternative resource.

Fig.1. Shooting of mesopelagic trawl on board RV Matsyakumari-II

Fig.2. Catch of on board FORV Sagar Sampada

Fig.3. Sorted deep sea catch on board trawl on board RV Matsyakumari-IIV

Fig.4. Mesopelagic shrimps landed in midwater trawl

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Association of the jellyfish Rhopilema hispidum with ophiuroid brittle star *Ophiocnemis marmorata*

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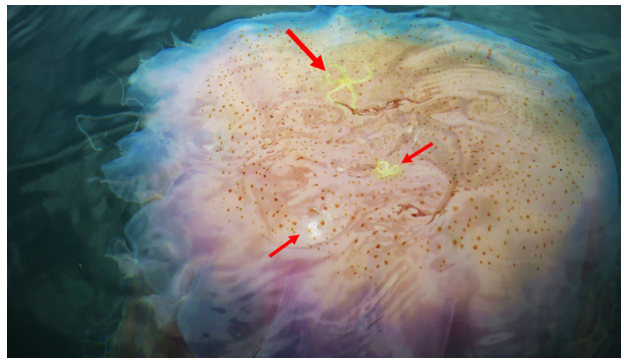
Jellyfishes are gelatinous zooplankton that drift through water column of the seas around the world. They are ancient animals, recent studies suggest that they evolved at least 500

million years ago (Cartwright et al., 2007). Jellyfishes belong to the phylum: Cnidaria with more than 10000 species reported globally. The phylum Cnidaria is divided into four groups namely, Scyphozoa, Hydrozoa, Cubozoa and Staurozoa. Scyphozoa are the most common jellyfish and are sometimes called "true jellyfish". Scyphozoa spend most of their lives in the medusa body form, and there are at least 220 valid species recorded world over, of which 35 species from Indian waters have been reported so far (Ramakrishna and Sarkar, 2003). These jellyfishes are predatory in nature, supported by network of nerve cells, however, some crustaceans, ophiuroids and fishes reported association with these scyphomedusae ranging from parasitoidism to mutualism (Boco and Metillo, 2018; Ingram et al., 2017).

During the routine underwater observation of experimental cages (treated with nano CuO2) deployed in the Vizhin jam coastal waters, a single specimen of rhizostome medusa (approximate bell diameter 500 mm) was photographed by snorkelling on 09 October 2018. Very interestingly, a few number of bright yellow coloured, black banded brittle stars were also seen over the umbrella margin of the jellyfish (Fig.1). The jellyfish was identified as *Rhopilema hispidum* using taxonomic key characters provided by Kitamura and Omori (2010) and the associated ophiuroid was recognised as *Ophiocnemis marmorata*. The incidence of the ophiuroid *O. marmorata* associated with the rhizostome medusa *R. hispidum* is reported for the third time in India. The other two observations were, Gulf of Mannar and Vellar estuary from south east coast of India (Panikkar and Prasad, 1952; Kanagaraj et al., 2008). Apart from this, Fujita and Namikawa, (2006) found this ophiuroid attached to jellyfish *Rhopilema esculentum* in the Philippines and Japan waters. A recent tropic relationship study using stable isotope by Ingram et al (2017), indicated kleptoparasitic relationship between ophiuroids and jellyfish.

R. hispidum is a common species in coastal waters of India and this species has been recorded in the East Pacific and Indian Oceans. With the advantage of the presence of long tentacles and oral arms, and drifting in the pelagic ecosystem, jellyfish act as fish aggregating device for many invertebrates and fishes, which make them an integral part of the marine ecosystem. Furthermore, studies to understand the relationship and interaction with other animals would throw more light on the ecological impacts and trophic interactions of both species.

Figure.1 The photograph showing the brittle stars present in the exumbrellar margin of jellyfish *Rhopilema hispidum* (indicated by an arrow).



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Ghost gear retrieval attempts from Enayam coast of Tamil Nadu

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Accidental loss of fishing gear during fishing operations is not a new phenomenon. As per FAO (Macfaden et al., 2009) 10% of all fishing gear operated around the world is lost in the sea. It has become a problem of severe concern as it adversely affects the ecosystem. The menace has assumed gigantic proportions in recent times due to a change in the material used for fabrication of gear since 1950s and the unusual increase in the volume of gear used per unit vessel. Replacement of natural fibers by synthetic fibers paved way for the lost gear becoming a threat to biodiversity.

Besides the accidental loss, forced abandonment and purposeful discarding of gear add to the - quantum of lost gear in water bodies. The low quality of netting material used for fabrication of gears result in easy breakage of nets at sea with irresponsible handling of gear by fishers adding to the gravity of the problem. The lost gears are collectively termed as ' ALDFG', viz., the abandoned, lost or otherwise discarded fishing gear.

ALDFG being plastic in origin, initially float on the sea surface drifting along with waves and ghost-fish until the fishing power of the netting is intact. Besides, ALFDG entangle non target

organisms including endangered animals such as turtles, cetaceans, birds etc. The problem of ALDFG and ghost fishing was first brought to the notice of the world during the 1970's (High, 1976; Pecci et al.,1978). Of late, it has become a serious problem, gaining much international attention. Retrieval of lost gear from the sea bottom; locating lost gear through under water survey using side-scan scanner and scuba divers; assessing the rate of gear loss by interviewing fishers; assessing the catch rate of lost gear and mitigation measures are areas where research is currently being carried out in different parts of the world.

India has 174 000 units of fishing gear in operation, of which 154 008 are gillnets / drift nets and 7 285 are traps (CMFRI, 2012). Gill nets and traps once lost, will continue to ghost-fish effectively for a substantial period of time. Research in the area of ALDFG and ghost fishing from Indian waters is in its infancy. Focused research on ghost fishing was initiated by ICAR-CIFT, Kochi in 2018 for the first time in the country. These research efforts have led to gear retrieval attempts at Enayam coast of Tamil Nadu during March 2019. About 33 kg of ghost gear were retrieved by scanning an area of 700 m^2 sea bottom (8^0 12.886'N ,77^0 10.874'E, depth 12-18 m) with the help of scuba divers from locations identified through information collected from local fishers. Seven types of lost gears were retrieved with gillnet being the most common of them. The lost gears recovered were polyamide (PA) monofilament gillnet panels (Fig. 1) (47.5 m^2), pieces of trawl codends (2.8 m^2), PA monofilament long line (15.6 m), polypropylene rope (8.3 m), damaged traps (Fish and lobster trap) (Fig. 2), and squid jigs (3nos).

The condition of the retrieved gear showed that the gear had been lost in the sea for more than a year as evident from the growth of algae, mussels and other sedentary organisms attached on the surface.In none of the retrieved gear remnants of fish or shell fish were observed. The extent of lost gear retrieved from the area surveyed showed that the problem of ALDFG in Indian waters is grave. Therefore, focused studies are required to assess the severity of the problem and to develop mitigation measures.

Fig.1 Retrieved gillnet panel from the sea at Enayam, Tamil Nadu

Fig.2 Retrieved lost trap form the sea at Enayam, Tamil Nadu

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Jelly fish- A problem to possibility

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Jellyfish is a marine invertebrate belonging to the class Scyphozoa under phylum Cnidaria. An adult jellyfish is having a bell shaped body, enclosed by a jelly like matter where its internal structures are encompassed. The manubrium (tentacles) are hanging from this mass. Some jellyfish tentacles are present with stinging cells that have poisonous substance which kills or stuns other animals whereby they capture the prey or protect themselves from enemies.

Jellyfish catch increasing tremendously in the marine environment and is said to create nuisance to the fishermen and to the marine environment. The swarms of jellyfish are a constant threat to fisheries and marine food chain. Some jellyfishes are reported to have toxin which makes it an inedible product. However, some species of jellyfish are identified as edible and are widely consumed in Asian countries like China, Japan, Malaysia, Taiwan, Singapore and Korea (Hsieh et al. 2001). Reports are there suggesting the utilization of jellyfish not only for consumption but also for generating high value products.

Jelly fish swarms are reported to cover vast area in the ocean, which causes destruction to the vessels, boats and fishing gear. In India, especially in South Indian coast, it was noticed that jellyfishes are available during the post monsoon season. Inspite of the huge production, a little is known about the composition and utilisation of jelly fishes. Hence, an attempt was made in analysing the nutritional composition so as to enable the utilization of jellyfish that are available from Indian coast.

In this study, Jellyfish (Fig. 1) was collected from Cochin waters and bought to the laboratory in chilled condition. As soon as it reached the laboratory, a thorough washing was given in ice cold potable water. The cleaned sample was cut into small pieces and then subjected to nutritional analysis of the meat (umbrella and manubrium) and fluid separately. Moisture, protein, fat, ash and carbohydrates were analysed according to AOAC method (AOAC, 2016).

The proximate composition of jelly fish (meat and fluid) is given in table 1. The protein content of meat portion was higher than the jelly fish fluid analysed. The protein content of meat studied is similar to *Aurelia aurita* with 2.1% protein (Spitz et al., 2010) and is higher than cannonball jelly fish with 1.07% (Huang et al. 1988). The lower amounts of carbohydrate and fat content creates its potential for low caloric food. It has also been accepted as a prime delicacy in many parts of the world. The presence of collagen and mineral content along with low calorie value make jellyfish a candidate species for developing nutraceuticals, functional food and nutricosmetics. Further studies are required in processing and product development aspects so as to enable the development of high quality products from the jelly fish studied.

Table 1. VNutritional composition

Sample	Moisture (%)	Protein (%)	Ash (%)	Fat (%)	Carbohydrate (%)
Meat	95.754	2.189	2.103	0.021	0.0
Body fluid	96.452	1.048	2.432	0.019	0.0

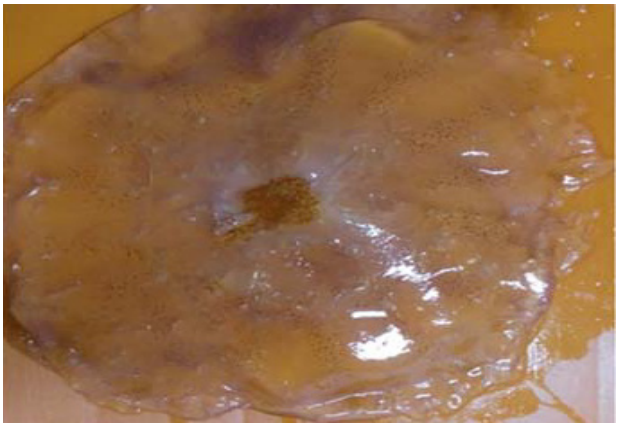

Figure 1. Jellyfish

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Electron Beam Irradiated Tilapia Fish Chunk: Quality and Shelf Life under Chilled Storage

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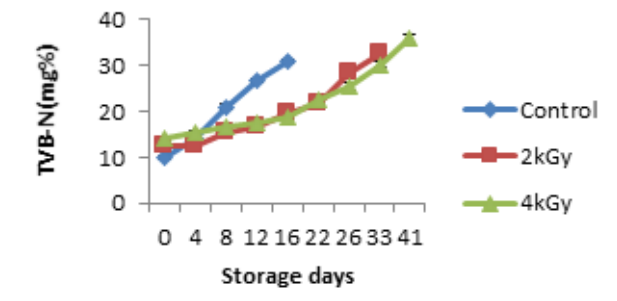
Fish is a highly perishable product, and the freshness of fish is an important factor that determines its commercial value and potential for export.Nowadays, consumers look for high quality and convenient food products with natural flavor, fresh appearance and nutrient's richness which stimulate a major research issue to develop and implement alternative technology such as minimal processing. Hence, a minimal processing involving heat and ionizing radiations has gained attention as an ideal technique to improve the shelf-life and preserve the food's nutrient value. Electron Beam Irradiation (EBI) is a non thermal processing technique, recently gaining much attention by food processor.The advan-

tage is that the electronbeam irradiation can be applied in a bidirectional manner in which the irradiation can come into contact with the food product from both top and bottom of the sample which results in reduction of microorganisms on food product. Further, the time required for the EBI treatment is very short.

Freshwater aquaculture sector has been found to have are markable growth in the past few years with more and more emerging freshwater species. Among the freshwater fishes, tilapia (*Oreochromis niloticus*) is one of the most traded food fishes in the domestic as well as export market. In the present study, the effects of electron beam irradiation on the quality of tilapia fish chunk were studied. Fresh tilapia (*Oreochromis niloticus*) were purchased from retail fish market at Vashi, Navi Mumbai and brought to laboratory in iced condition. Fish were cleaned with potable water, chunks (3-4cm thickness) were made and vacuum packed. Samples were divided for 3 treatments viz, first as control, second and third lot was given treatment of 2.0 kGy, 4.0 kGy dose of electron beam irradiation, respectively. Electron beam irradiation of fish chunks were done by a linear EB RF accelerator (Energy 5 MeV, beam power 40kW, EB tech., BRIT, Mumbai). All the samples were kept in chiller (2°C) for further studies

Biochemical parameters including proximate composition, pH, total volatile base nitrogen (TVB-N), peroxide value (PV) and thiobarbituric acid (TBA) value were analyzed. Results showed an increasing trend in pH, TVB-N, PV, TBA values during storage. TBARS values were within the acceptable limit in all the samples during storage. Peroxide value of control was within limit during storage. However, PV has crossed the acceptable limit on 26th day for 2.0 kGy and 4.0 kGy irradiated fish chunks. It was observed that TVB-N value was lower in irradiated fish chunk than control. TVB-N value of control had 30.8 mg% on 16th day of storage. However, 2.0 kGy and, 4.0 kGy irradiated sample reached the maximum acceptability level on 30th day (32.50 mg%) and, 41st day (35.8 mg%), respectively (Fig.1). Total plate count was lower in irradiated sample than control (Fig.2). There is a significant ($p<0.05$) reduction in pseudomonas and *Brochothrix thermosphacta* count in the irradiated sample. Based on the microbial and sensory analysis, control had a shelf life up to 16thday. However, electron beam irradiated fish chunks had an extended shelf life of 33-41days with respect to dose level .



TEXTURAL AND FUNCTIONAL MODIFICATION OF FISH MINCE USING HIGH PRESSURE PROCESSING

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Changing life style and the awareness about the nutritious and healthy diet has led to the necessity of bringing more fresh and natural ready to eat foods in the market. The demand for

convenient foods with superior quality and nutritionally healthier have led to the introduction of "minimal preservation and processing technologies".Conventional processing operations are designed to focus on the vital thermal treatments, which assure the consumer's required safety and shelf life of the product. But, the volumetric generation of heat energy inside the food during thermal processing had direct implication on the freshness and quality of the food. So the advent of non-thermal technologies like high pressure processing for microbial inactivation has been extended towards the development of new/ improved products with more natural freshness and taste through textural and functional modification.

The effect of high pressure processing on textural and functional modification was studied on pink perch mince against the conventional heat treatment. The fish mince was taken, packed in casings and subjected to high pressures of 200, 400 and 600 MPa for 10 min and compared against cooked and uncooked mince.

Plate 1: Treated mince in casings

The treated mince was then subjected to different textural and functional quality analysis like gel strength, TPA and viscosity, free and reactive SH groups, hydrophobicity, FTIR and microbial analysis.

The pressure treated mince was analyzed for gel strength before and after heating against the cooked mince.

Gel strength increased with increase in pressure, however reheating reversed the effect on gel strength. On reheating cooked and 200MPa treated gels also exhibited similar gel strength. So the high pressure up to 200 MPa pressures on fish mince did not affect the gel strength and the mince can be utilized for further modification during product development without losing its functionality. HPP prior to heating considerably enhanced the thermal gelation capacity of proteins in a comminuted meat.

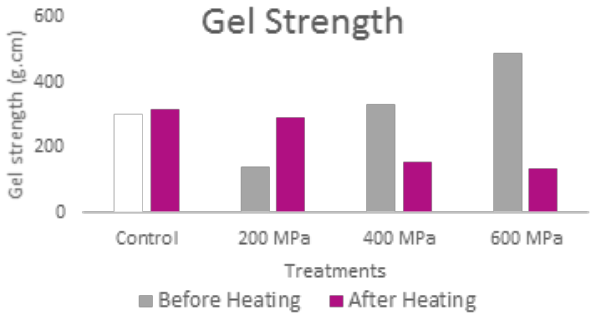

Fig 1. Changes in gel strength values of treated mince before and after heating

Textural properties of the treated mince before and after heating were analyzed using texture profile analysis. Hardness increased with increase in pressure. The 400 MPa treated samples had similar hardness as that of cooked mince and a higher hardness value was noticed at 600 MPa. The 200 MPa treated mince showed the lowest hardness value.

The study can be concluded as the pressure below 400 MPa on fish mince, most changes were reversible and loss in functionality of protein was least observed, but above 400 MPa, pressure had similar effect as that of cooking. Changes in protein conformation were minimum at 200 MPa. Above 400 MPa pressure can bring out significant alteration in textural and functional properties and pressure above 600 MPa leads to complete denaturation and loss of functionality.

Air frying – An Alternative method to develop healthy fried food product

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Frying is a popular food processing method in which a series of phenomena such as heat and moisture transfer takes place between the food products and heating medium simultaneously. Deep fat frying is a conventional frying method where food items are fried by immersing in hot oil at high temperature ranging between 120-180 ^{0}C *(*Mellema*, 2003)*. In deep fat frying, heat transfers from oil to food surface through convection and into the core of the product by conduction. Mass transfer phenomena in frying involve the outflow of moisture and intrusion of fat caused by transfer of heat energy to the product. Thus, the fat content of deep fried product will be increased and makes one of the draw back to accept the deep fried product. Other drawbacks of deep frying are repeated use of oil or frying medium, difficulty in cleaning utensils and unwanted smells in the frying environment. The reactions in deep-fat frying also depend on factors such as frying temperature, quality of frying oil and food materials etc.

As an alternative healthier approach to fry food products could be Air-frying technique, where no oil or fat used to fry the product. In air frying, the cooking of the food item happens through the circulation of heated air by rapid air technology. Hot gas is circulated by the blower motor assembly into the air fryer cavity where the hot air is directed in a manner wherein a conflicting, colliding turbulent gas flow is directed at a food product kept for the accelerated cooking. The food item placed inside the chamber is cooked effectively by the heat radiated from the heating element with lesser energy. The air fryer is designed to circulate extremely hot air at high speed in a fashion that mimics the movement and flow of heat currents in a pot of boiling oil, to crisp up the outside of food while cooking it inside (Anonymous, 2016). In hot air frying, the flow of air inside the frying equipment is different from hot air drying or convective drying. The air fried food product will be healthier than any other fried food product as it would be having less fat content, no repeated use of oil as medium, easy to clean the utensils and no unwanted smell in the frying environment.

As a case study, fish cutlet - a popular fish snack was developed using air-frying technique. Fish cutlet samples were prepared using Pink Perch *(Nemipterus japonicas)* mince and other standard ingredients. The prepared cutlets samples were dipped in batter mix and then coated with bread crumbs. The cutlet samples were fried using air and deep frying methods for comparative evaluation. Different levels of temperature varying from 160 to 180 ^{0}C and time varying from 5 to 15 minutes were tried for air-frying method along with deep fried sample as a control. The proximate, sensory, texture and colour analysis of air and deep fried cutlet samples were carried out.

It was observed from the analysis that air fried cutlets were having less fat content (almost 50 % less) compared to deep fried samples. The protein content of air fried samples was higher than deep fried samples. The mineral and moisture contents were in the same range for both air and deep fried samples. Based on the sensory evaluation on a 9 point hedonic scale, it was found that cutlets fried at 180 ^{0}C and 10 minutes time got

highest overall acceptability score (OAS – 7.94) compared to other time-temperature combinations of air-frying method. This was not significantly different from the OAS (8.01) of control sample. The textural and colour parameters at 180 ^{0}C and 10 minutes time were equally comparable with deep fried cutlet samples. Priya *et al*. (2017) reported that air fried fish fingers were having good acceptability and economic viability compared to deep fried fish fingers. Mohan *et al*. (2017) also reported that air fried tilapia steaks found to have better fatty acid profile compared to deep oil fried tilapia steaks. To conclude, the combination at 180 ^{0}C and 10 minutes time was found to be best combination for the development of healthy fish cutlet using air-frying technique.

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Study of e-commerce fish marketplace in Kerala

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Seafood is considered as an important part of a healthy and balanced diet by most consumers. It's been estimated that around 60 per cent of the Indian population consumes fish and the consumption pattern varies widely and across the different social fabric (Shyam, et al. 2013). The annual per capita consumption of fish for the entire Indian population is estimated at 5-6 kg whereas for the fish eating population it is found to be 8-9 kg. Average annual per capita fish consumption is highest in Kerala state at 30 kg which is very high compared to that of other states of India (Shyam, et al. 2015).

Consumers in Kerala and elsewhere are forced to buy fish from unhygienic markets and vendors. In general, parties in the fish supply chain don't necessarily conform to scientific food safety norms. Without a proper cold chain, bacterial contamination typically starts within 30 minutes. Poor quality ice and preservatives like sodium benzoate and formalin are reportedly used to keep the fish from deteriorating, which are potentially harmful and carcinogenic for humans. In recent times, the wide scale media highlight on fish adulteration has created an increased health concern and consciousness about safety and quality standards among consumers (Sajeev, 2018a).

In this context, online fish marketing has emerged in a big way and is assumed to disrupt traditional fish vending business (Sajeev, et al. 2018b). Online fish marketing claims to provide fresh and chemical/pesticide free fishes, which gives them an edge over other fish retail sources. There is a

steady rise of e-commerce fish marketplace that has gained momentum with the rise of e-grocery and advent of new cost-effective freezing technology (Vishal, 2015). Online sale of fish sounds crazy in India where vendors have a virtual monopoly over door sales of both marine and inland fish. Moreover, fish being a highly perishable product, the idea was found too difficult to implement unlike other consumables where online marketing rules the roost. However, things changed drastically over the last couple of years particularly in urban areas.

With an increased knowledge, attitude and better perception about health, quality and safety issues related to fish consumption, customers are fast switching to online fish markets. Orders are just a touch away on android mobile apps, websites, Facebook page, Whatsapp message, an SMS or a call. More than a dozen e-commerce sites are into business and are expanding their market base day by day (Cynthia, 2016). These fish E-commerce sites offer a rich array, mostly the variety available at local coast. Pre-ordered fresh fish reaches consumers' doorstep in curry cut, steak, fully cleaned or even as whole fish at prices affordable to the discerning homemaker. More than price, the focus in e-marketing of fish is on quality and safety (Sajeev, 2018b). Some online sites levy delivery charges while others do it for free.

Fish being a highly perishable commodity, adhering to quality standards makes its sales, marketing and promotion a risky affair. Sustenance of online fish marketing depends on providing fresh and affordable fish to the consumers on time. This distinguishing factor makes online fish marketing an interesting topic of study. Fifteen online fish vendors operating in Kerala were studied with respect to their products menu, price range, quality and safety guarantees, delivery systems and consumer accessibility over online, mobile and social media platforms. The portals studied were: www.freshtohome.com, www.dailyfish.in, www.mathafreshfish.com, www.healthyfishonline.com, www.suvichar.in, www.onedaycart.com, www.freshandhealthy.in, www.wildfish.in, www.biggro.com, www.cheenavala.com, www.onlinekochi.com, www.nallameen.com, www.bigbasket.com, www.matsya.in and www.pooi.in

Products menu/options:

The analysis revealed that wide range of options provided by online portals was the major attraction for consumers with 3 to 40 fish varieties made available on online platform. The choice included marine, fresh water and farmed fish and other products like shrimps, squids, crabs and mussels. The portals focused on convenience and easy availability of variety of products/dressing options (2-8) like whole, whole cleaned, steaks, curry cut, fillets, skinless cubes, marinated, tail-on, peeled, peeled deveined and peeled un-deveined which was hardly possible in case of traditional fish vendors and markets.

Price of fish:

It was found that fish prices ranged from Rs 49 to 1000/kg on dressed fish and on all the online portals the prices were always higher than local vendors. On an average it was 20-25% higher than that of local vendors. It can be understood that online fish marketing focuses on quality and convenience rather than price advantage (Sajeev, 2018b).

Quality and safety:

Quality and safety guarantees were given by 100% of online vendors studied. 'Fresh Not Frozen', 'As good as live', 'Always the catch of the day' were some of the tag lines used. While consumers perceive better safety and quality for fish with online sellers, the claims are yet to be ascertained through lab tests.

Delivery systems:

Unlike traditional vending, online vendors have 2-3 time slots for delivery in a day thus providing

great convenience to consumers. Besides, portals charged an additional amount between Rs. 29-50 for delivery depending on size of the order. Home delivery and 'Cash on Delivery'/Card payment/Net banking facilities were provided by all vendors. They covered almost all the pin codes in the cities and 2-3 time slots for delivery covering early morning to evening hours. Advance booking facility was available in nearly 70 per cent of the portals studied with some portals providing bookings up to 4 days in advance.

Consumer accessibility over online, mobile and social media platforms

Study on consumer accessibility over online, mobile and social media platforms revealed unique facts about online fish marketing. All 15 vendors had option of taking orders through phone call and messages. The study indicated that nearly half (7 out of 15) of the online vendors developed their own mobile apps which instantly notifies about stock and offers thus providing maximum consumer reach. All 15 vendors had their own websites that provided complete information on a day's stock and products available. With regard to hybrid media marketing done by all the online vendors, it was observed that 'e-mail+website' was the most popular mode adopted closely followed by 'Facebook+Mobile' mode. Nearly half of the vendors (7 out of 15) made 24x7 consumer engagements through dedicated Facebook pages providing latest update about stock position and immediate responses to consumers. Online marketing through Twitter, Instagram and YouTube was found to be in infancy stage with only one, three and two portals utilizing the above mentioned media, respectively.

Online marketing is a dynamic kind of marketing that is at a nascent stage in India and is constantly evolving and changing. It is gaining momentum with focus on quality and convenience rather than price advantage (Sajeev, 2018b). With unmatched consumer accessibility through web, mobile and social media platforms and options for wide range of products and quick home delivery systems, online fish vending portals have potential to disrupt traditional fish vending in urban Kerala. Online fish marketing is in a nascent stage in Kerala and conclusive studies need to be taken up to prove their sustainability in the long run.

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Exopolysaccharide producing bacteria associated with brown seaweed- *Sargassum wightii*

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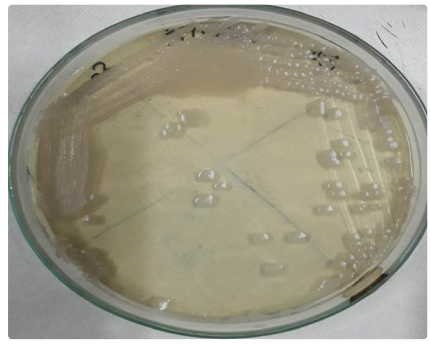
Biopolymers are the polymers obtained from various biological organisms containing covalently bonded monomers and are classified into polysaccharides, polypeptides and polynucleotides. The main source of biopolymers from marine environment includes macro algae, micro algae, bacteria, and fungi. Among the microorganisms, bacteria are widely accepted as the source of exopolysaccharide with different functional properties and can be exploited for novel industrial and biotechnological applications. Exopolysacchrides (EPS) are high molecular weight polymers secreted by bacteria, consisting of different functional groups such as acetyl, succinyl or pyruvyl, sulfate etc. Biodegradation ability of EPS from bacterial origin can replace the traditional polysaccharide sources from various fields such as biomedicals, food and textile industries in larger extent. However, the high cost of production and low yield from bacterial sources may limit the use in industry scale.

In the present study, an attempt was made to screen brown seaweeds viz, *Sargassum wightii*, *Padina gymnocephalus*, and *Turbinaria connoides* for EPS producing bacteria. Bacterial isolation was carried out by homogenizing the dried seaweed samples (25 g) in 225 ml 1X phosphate buffer saline and plated on trypticase soya agar (TSA) with 2% NaCl. A total of five distinct morphological isolates were selected based on their slimy mucoid appearance on the TSA plate. EPS was extracted according to the method by Berekaa and Ezzeldin (2018). Initial screening for EPS production by the bacterial isolates was carried out on the basis of EPS yield after 10 days of incubation in a shaker incubator with 180 rpm at 37 ^{o}C in trypticase soya broth (TSB). The EPS production in these isolates varied from nil to 0.62 mg ml^{-1} .Out of five isolates, one isolate from *Sargassum wightii* showed maximum production and was further inoculated into Luria bertani (LB), and Brain Heart Infusion (BHI) broth and the dry weight was measured. The dry weight of EPS was recorded maximum in BHI (1.27 mg ml^{-1}) followed by LB broth (1.12 mg ml $^{-1}$). The EPS production is often accompanied with the aging of the culture and exhaustion of available nutrients in the media. During chemical analysis, it was found that EPS from BHI broth contained 59.9% carbohydrate, 8.1% protein, 3.2% total uronic content and 1.5% sulphate content. The isolate was identified as *Bacillus cereus* by 16S rRNA sequencing.

Structural analysis of EPS by FT-IR analysis (Fig. 2) which showed a characteristic N-H and OH stretch at around 3292.93 cm^{-1} and a C-H stretching vibration at around 2925 cm^{-1} (Deepika et al., 2016). The absorption peaks within 1650-1540 cm^{-1} attributed to vibrations of a C O, NH and CN bending of protein and peptides. The absorption peaks within 1200-1000 cm^{-1} attributed to vibrations of a broad stretch of C O and C O C

glycosidic bands, which revealed the presence of carbohydrates (Zhang et al., 2013) that, would be sugar monomers in the EPS. The absorption peak at 600 cm^{-1} and 492 cm^{-1} could be attributed to the S-S stretch. The absorption observed at 1500-1600 cm^{-1} could be attributed to the stretching vibration of C=C and C–N groups. Peaks at 884 cm^{-1} ascertain the presence of glycosidic linkage bonds. The composition and components of exopolymeric substance of bacteria have large implications in their bioactive properties. Further research may be carried out to exploit the unique properties of exopolysaccharide from *Bacillus cereus* to find the practical applications in various fields such as textiles, pharmaceuticals and food industry.



A

B

Figure 1: A) *Bacillus cereus* producing exopolysaccharide on trypticase soya agar; B) crude extract of exopolysaccharide produced by *Bacillus cereus* in Luria Bertani (LB) and Brain Heart Infusion (BHI) broth

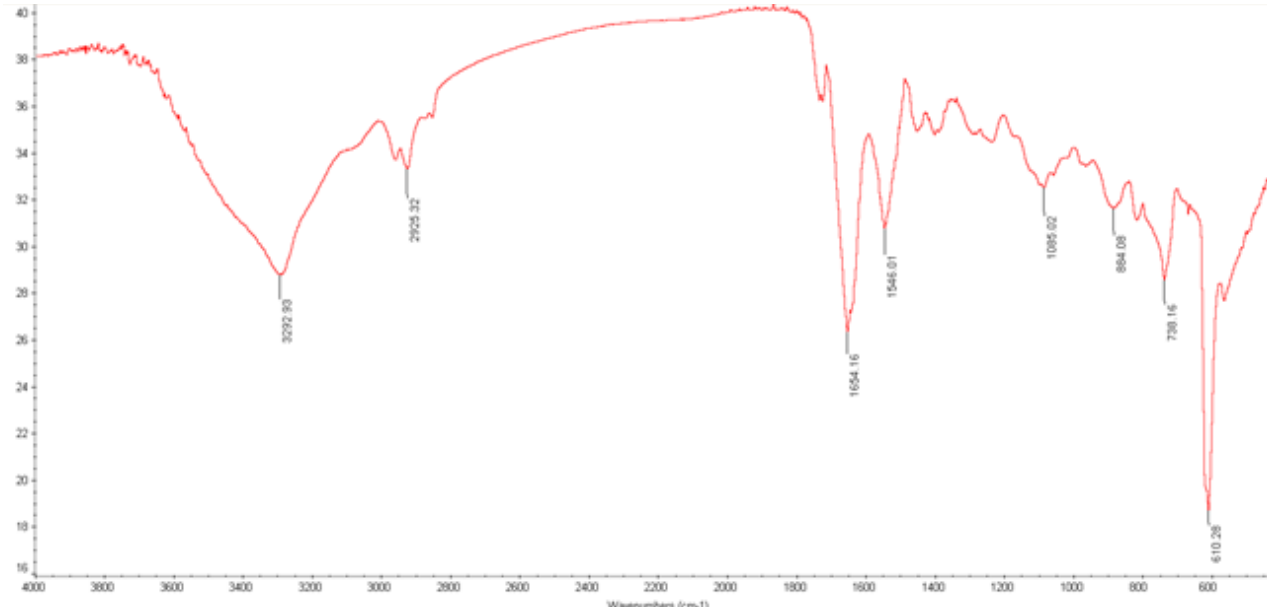


Figure 2: FT-IR Spectrum of crude EPS from Bacillus cereus

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Microbiological changes of Pangasius hypophthalmus fillets with Moringa oleifera (Lam) leaves in chilled storage condition

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Worldwide fishery products consumption is on the rise as it is a rich source of high-quality protein, essential vitamins, polyunsaturated fatty acids *etc* (Verbeke et al., 2005). But the unique biological composition along with high water content of fishery products make them susceptible to rapid enzymatic and microbial spoilage. Therefore, their shelf life is limited and several synthetic chemical additives are being used indiscriminately as preservatives. But continuous usage of such chemicals including antibiotics results in cancer, other foodborne illness, and development of multidrug resistance (MDR) in bacterial strains (Thomas et al., 2015).

To address such issues, bio-preservation has emerged as a novel technology which extends the shelf-life and safety of food products by the use of natural products like essential oils, phytoextracts, animal enzymes, microbial bacteriocins, organic acids, naturally occurring polymers *etc (*Pilar et al., 2010). *Moringa Oleifera (Lam)* belongs to family *Moringaceae* is often called as 'Miracle tree' or 'Tree of life' because of its wide range of medicinal uses with high nutritive value. *Moringa* leaf is well known for its potential antibacterial as well as antioxidant activity and is being used as a natural preservative for shelf life extension of various food products. There are limited reports on the use of *Moringa* leaf juice as a natural source of antimicrobial substance in fish processing and this study evaluates the antibacterial and antioxidant potential of *Moringa* leaf juice for extension of shelf life in vacuum packed pangasius fillets during chilled storage at 4 ± 1 °C.

About 5.5 kg of *Pangasius hypophthalmus* were procured in fresh condition from the local market, Mysore, Karnataka and immediately brought to the laboratory in the chilled condition. The fish were cut into pieces of equal size approximately weighing 30 gm and used for analysis and storage studies. Fresh *Moringa* leaves were collected and juice was extracted based on Rahman *et al*. (2009). The yield of juice is 29% and this

was used further for the preparation of 5% (v/v) and 10% (v/v) solution in distilled water at 4ºC. Water at 4ºC was used as a control.

The control (untreated) and treated groups of fillets with 5% (v/v) and 10% (v/v) *Moringa* leaf juice (MOL) were examined periodically at 0, 3, 6, 9, 12, 15, 18 days during chilled storage until rejection by sensory, physicochemical and microbiological methods

This study revealed that the *Moringa* juice is a good source of phenolic compounds with significant antioxidant potential and total phenolic content was found to be 183.75mg GAE /100g. The pH and TBA-RS values showed an increasing trend during the storage time and were significantly higher ($p < 0.05$) in control group than treated and 10% treatment showed the lowest value. *Moringa* leaf juice was also found to have strong antimicrobial and antioxidant potential and can retain the quality attributes during the storage time. The initial TPC was found to be 4.2 log, which showed a significant reduction ($p<0.05$) on the third day of storage and thereafter increased continuously and reached about 6 log on 9th and 15th day for control and treated sample, respectively. The dip treatment for 15 minutes with MOL improved the shelf life by 6 days in vacuum packed condition. Hardness 1 and 2 were found to decrease in control as well as treated samples during storage. Lightness value (L*) was initially high for 10% MOL treated sample compared to untreated and 5% treated sample, but decreased significantly during storage. A decrease in quality of fish samples was noticed by the panelists on storage on the 6th day while the 5% and 10 % *MOL treated* fillets was found acceptable till 9th day of storage.

Treatment of *Moringa oleifera* juice can thus be effectively used as a safe bio-preservative to extend the shelf life of vacuum packed pangasius fillets under refrigerated condition without any adverse effect on the sensory acceptance.

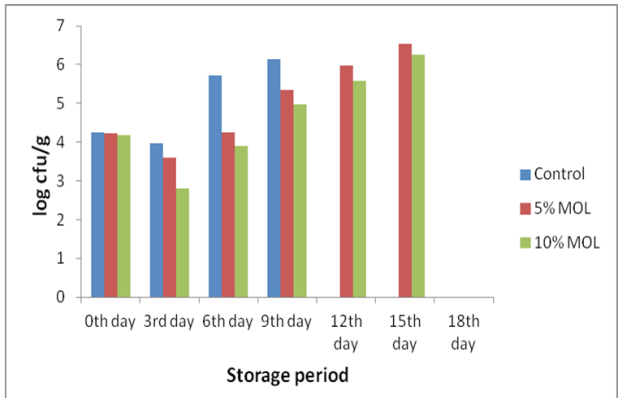

Figure 1. Changes in mean values of total plate count (TPC) during storage period

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Identifying melanosis producing bacteria from shrimp with utilization perspective.

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Melanosis, which is also called as black spot, the enzymatic browning of phenolic compounds in shrimp is considered as a challenge in processing industry. The melanosis happens either due to the innate immune response (Prophenoloxidase system) or due to the tyrosinase producing bacteria in the system (Nirmal *et al.*, 2009). The tyrosinase producing bacteria convert the phenolic compounds into melanin with the help of phenol oxidase enzymes. The final product melanin and the intermediate products such as L-dopa (L-3,4-dihydroxyphenylalanine), dopaquinone and dopamine are commercially important. Tyrosinases are the key enzymes to form the biopolymer melanin which have inherent properties like absorption of UV radiation, metals, sound and also have anti-oxidant and semi-conductor properties are used in the production of complex biopolymers (EMPA., 2010) These bacteria has the potential to be used for tyrosinase enzyme production, biocompost production from fishery products, phenolic waste treatment and also for melanin production (Amonette *et al.*, 2004;., Kafilzadeh et al., 2010;., Cédric *et al.*, 2016.)

In this study, *Penaeus vannamei* was procured from market of Ukkadam, Coimbatore with melanosis. Tyrosin enriched nutrient agar media was used for isolation of colonies. Three isolates i.e TMA7, TMA9, TMA10 showing maximum tyrosinase production were selected for further studies.

Potential tyrosinase producing isolates TMA 7, TMA9 and TMA10 were selected for identification using 16 S rDNA sequencing. Crude DNA was extracted from the young cultures from tyrosinated broth the phenol chloroform method. The forward and reverse primer used are 27F AGAGTTTGATCCTGGCTCAG and 1492R ACGGYTACCTTGTTACGACTT. Amplified product of 1500 bp was sequenced by sanger sequencing. Blast analysis of the Isolates TMA7,TMA9 ,TMA10 shown similarity for *Bacillus sp, Acinetobacter Sp,* and *Bacillus megaterium* respectively. Phylogenetic tree constructed revealed the distances and similarity of these bacteria. The study has provided the evidence *Bacillus sp* could be a potential source of tyrosinase enzyme for application in the shrimp waste industry.

Tyrosinases from microbes are being exploited for a variety of biotechnological and environmen-

tal applications and thus have attracted various groups actively engaged in molecular characterization and bioengineering studies. Melanosis which considered as a poor quality indicator in post mortem shrimp maintenance can be effectively utilized for bacterial isolation with multifunctional utilities

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Stakeholders feasibility analysis: A tool for successful entrepreneurship in fisheries

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Stakeholders interest and attitude determines the success and failure of any enterprise. Hence, it is often treated predominant to examine the feasibility of stakeholders' during early stages of enterprise development. Stakeholders' feasibility analysis is the process of collecting and analyzing data prior to the new business start-up, and then using knowledge thus gained to formulate the business plan itself (Castrogiovanni, 1996). At the pre start-up phase, usually attempt is made to identify the potential stakeholders, which produce often unsatisfactory results due to lack of systematic approach while identifying the stakeholders.

An attempt was made using systematic method to assess the stakeholder feasibility towards establishing fish based enterprise at Kadamakkudy village, Ernakulam, Kerala with emphasis on identification and determination of stakeholders. The stakeholders' viz., end users and service providers were contacted for the study. The determination of stakeholders (service providers) was looked into as per Salience model using three attributes viz., power, legitimacy and urgency (Currie et al., 2009). A customized overall stakeholders feasibility index (OSFI) was developed for assessing the level of stakeholders' feasibility (end users).

Stakeholders' determination matrix

The criteria used for classifying the stakeholders were based on the possession of three attributes viz., power, legitimacy and urgency. Power is the 'extent of which one can gain access through coercive and normative means'; Legitimacy is that 'action is desirable within the prevailing social system'; urgency extents 'the degree of which the stakeholders require attention'. According to the Salience model, non-stakeholders are those who are not holding any attribute at the particular point of time. The stakeholders holding any one of the attributes are determined as dormant (power only), discretionary (legitimacy only) and demanding (urgency only). There were classified as latent stakeholders. Similarly, stakeholders holding any two of the attributes were classified as dominant (power and legitimacy), dangerous (power and urgency) and dependent (legitimacy and urgency). These three stakeholders were categorized into broad category called expectant stakeholders. The stakeholders who are holding all the three attributes and influence the business start up are classified as definitive stakeholders. Those who are not holding any attributes are known as disinterested stakeholders. The stakeholders' determination matrix shows the degree of interest of stakeholders and their capacity to support the fish based enterprise at the selected locality in the long run (Table 1).

	POWER	LEGITIMACY	URGENCY	TYPOLOGY
Latent Stakeholders		■		Discretionary stakeholder
			■	Demanding stakeholder
			■	Demanding stakeholder
Expectant Stakeholders	■	■		Dominant stakeholder
	■		■	Dangerous stakeholder
		■	■	Dependent stakeholder
Definitive Stakeholders	■	■	■	Definitive stakeholder
	■	■	■	Definitive stakeholder
	■	■	■	Definitive stakeholder
	■	■	■	Definitive stakeholder

Table 1.Determination of stakeholders using Salience model of feasibility analysis

The service providers in the study village revealed that there is variation in determining stakeholders using the attributes. For establishing fish based enterprise, end-users (EU) and Self Help Groups (SHGs) were classified as demanding stakeholders. End users, Self Help Groups (SHGs), were the latent stakeholders. While local self government (village panchayat), activist groups and Co-operative Societies were classified as expectant stakeholders. Four stakeholders viz., Village Higher Secondary School (VHSS), Parents Teachers Association (PTA), Society for Assistance to Fisherwomen (SAF) and Indian Council of Agricultural Research (ICAR) research institute are the definitive stakeholders because of their predominant role in starting and executing the fish based enterprises starting from pre-start up to till implementation and follow-up.

Estimation of stakeholders feasibility index

Other than service providers, the end users stakeholders feasibility was estimated using five dimensions viz., resource availability, technol-

ogy support, financial assistance, information source and extension network. Likert scale was followed to measure the attitude or opinions of different stakeholders in a 5-point continuum. The customised index for overall stakeholder feasibility index (OSFI) showed that the overall stakeholders feasibility index was satisfactory for establishing fish based enterprises. Among other dimensions, technology support, extension network and information source valued high but only two dimensions, technology support and extension network were found significant in estimating stakeholders feasibility.

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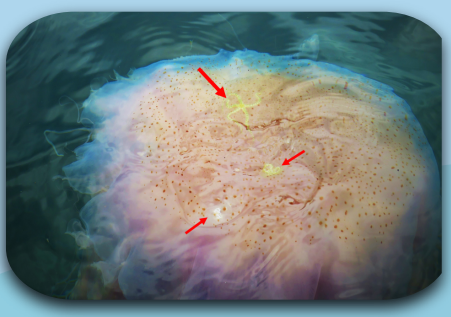

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