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भा कृ अनु प - केंद्रीय मात्स्यिकी प्रौद्योगिकी संस्थान
ICAR - CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY
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It is universally accepted that fishery is an initiative to raise or harvest fish and aquatic life through wild fisheries and aquaculture. It is estimated that over 500 million people worldwide are economically dependent on fisheries. The global fisheries production is nearing 180 million tonnes and sustainable fisheries management is the slogan to make it a sustainable venture without compromising the issues of aquatic lives and environmental concerns. Keeping that in the forefront, ICAR CIFT is addressing the issues in the harvest and post-harvest sector within the frame work of global requirements for the sake of the stakeholders. Some of the important of information from the major finding are drafted as articles for the purpose of easy understanding and brought out in 'FishTech Reporter', a half yearly scientific publication from ICAR CIFT.

This issue of FishTech Reporter contains twelve articles in the areas of harvest, post-harvest and social sciences. The articles in the harvest sector include emerging fouling concern of culture cages by *Mytella strigata*, use of river stones as sinkers by fishers of Saurashtra coast, indigenous live feed used for fish capture in North East hill regions, reports on the incidence of fresh water turtles in gillnets operated in the reservoirs and the possible mitigation measures and an interesting report on the reduction in the carbon emission by fishing operations during the Covid-19 pandemic time.

In the post-harvest, application of a fish peptide based foliar spray for the growth of microgreens, characteristics of microwave assisted production of tuna chunks, characteristics of a *Moringa oleifera* incorporated edible alginate films for packaging purposes, quality of ice used for fish preservation in Gujarat and an article discussing the application of a silica and alginate based chitosan beads for removal of lead from water. There is also an article discussing the validation of a method for phylogrouping of *E.coli* and another one discussing the dynamics of cured fish import to India during the past decade.

The articles would provide insight in to the peripheral areas of research taking place in CIFT and also exposes the reader to the traditional practices happening in the sector for the information.

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CONTENTS

Peptides from anchovy waste for foliar spray application in microgreens

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Bioactive peptides have gained prominence in agricultural applications on account of their potential to increase the germination, productivity and quality of a wide range of horticultural and agronomic crops (Colla et al., 2015). Peptides derived from industrial discards are promising options for effectively upgrading waste to valuable commodities besides addressing environmental pollution issues.

Presently, consumers are questing for novel, fresh, healthy products having culinary attributes. The specialty crop growers and researchers are updating with the possibilities to tap niche products. A recent high demanded specialty crops are Microgreens, also called 'vegetable confetti'. They are defined as tender immature greens produced from the seeds of vegetables, herbs, or grains (Kyriacou et al., 2016). They have delicate textures, characteristic flavors and are loaded with health promoting nutrients than their mature counterparts. Microgreens are generally harvested upon appearance of the first pair of true leaves, generally within 7-21 days from seed germination depending on the species and growing conditions. Foliar spraying is generally adopted in microgreens as it offers specific advantages over soilapplied fertilizers, with the nutrients applied being directly taken-up by their target organs, providing specific and rapid response.

The present study focused on the optimized extraction of peptides from anchovy head waste collected from processing industry for its application as a crop stimulant in microgreens from green grams. Response Surface Methodology was employed for deriving optimized peptides using enzyme papain. The effect of hydrolytic conditions viz.,enzyme substrate ratio (1.0 - 5.0 %) and hydrolysis time (2 - 24 hours) under optimized temperature (60°C) and pH (6.5), on the protein recovery, and yield were considered. An enzyme-substrate ratio (E/S) of 5% and 23.48 hours of hydrolysis time with a desirability of 0.942 was found to be the optimized protocol for deriving peptides with maximum yield (8.26%) and protein recovery (73.63%).

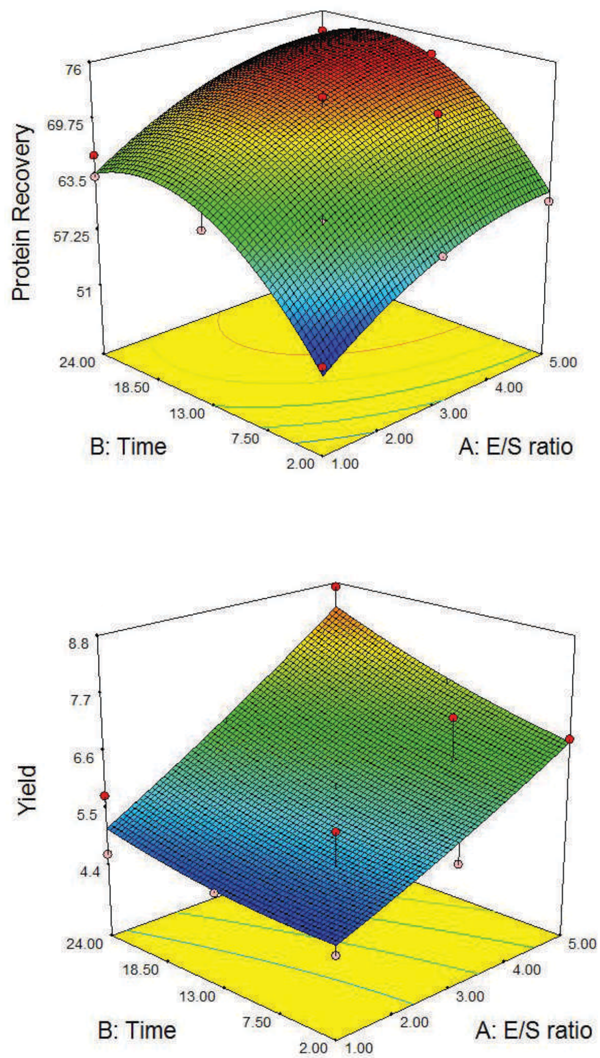

Fig. 1 *Variations in protein recovery (%) and yield a. in response to enzyme-substrate ratio and hydrolysis time*

The optimized peptides indicated a degree of hydrolysis (formol method) of 25.2% and proteolytic activity of 1.316 µmoles tyrosine liberated/mg protein. The peptides were applied as foliar spray periodically for a duration of one week in green gram microgreens, at concentrations of 0.5% (**$P_{0.5}$**) and 1.0% (**$P_{1.0}$**), keeping a control (C) for comparison. The germination rate as well as biomass was comparatively higher for microgreens subjected to 0.5% peptide foliar application (**$P_{0.5}$**) (Table 1). Chlorophyll index also indicated superiority for **$P_{0.5}$** and it was observed that higher treatment of 1.0 % negatively impacted the chlorophyll content of the samples. Water retention in the microgreens were comparatively higher in treated samples. Overall acceptability of the sample indicated a higher sensorial preference for untreated samples (control) than treated ones. The acceptability of microgreens treated with 1.0 % (**$P_{1.0}$**) peptides was affected, as the higher peptide concentration influenced the flavour, colour and taste of the microgreens.

The study suggested selection of optimized hydrolytic conditions for deriving specific hydrolysates for foliar spray formulation to incorporate into plants for encouraging their growth. A peptide application of 0.5% from anchovy waste was found optimum for microgreens from green gram. Further studies are recommended to completely explore the beneficial properties and mechanisms of these peptides as well as to determine different product formulations and application methods under a range of agro-ecological conditions.

Table 1. *Quality characteristics of microgreens from green gram*

Parameters	**Control**	**$P_{0.5}$**	**$P_{1.0}$**
Germination rate (%)	78.7	87.3	69.3
Biomass (g)			
Leaf	3.82	4.72	5.16
Root	2.61	3.37	3.14
Shoot	4.42	6.15	4.52
Chlorophyll a (µg/ml)	25.44	26.17	19.42
Chlorophyll b	9.15	10.17	6.11
Carotene	7.06	6.96	6.08
Water retention capacity (%)	63.64	68.38	70.9
Sensory attributes	9.0	8.0	5.0

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Time Series Evaluation of Import of Cured Fish Products to India

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The fish production in India has witnessed a positive growth over the decades, even then the import of fish and fishery products catch the momentum. India imports cured fish products under the code HS – 0305 in different forms such as dried, salted or in brine, smoked fish, whether or not cooked before or during the smoking process, fish meal fit for human consumption. The compositional structure of import of cured fish products to India changed over the decades. The sub-classifications of HS – 0305 under which cured fish and fishery products imported to India are given in Table 1.In this article, secondary data on different HS codeswere collected from the database https://comtrade.un.org/data/ and analyzed descriptively the dynamics of compositional structure of import of cured fish products to India.

HS Codes	Description of HS codes
0305	Fish; dried, salted or in brine, smoked fish, whether or not cooked before or during the smoking process, fish meal fit for human consumption
030510	Fish; flours, meals and pellets, fit for human consumption
030520	Fish; livers, roes and milt of fish, dried, smoked, salted or in brine
030530	Fish; fillets, dried, salted or in brine, but not smoked
030539	Fish fillets; dried, salted or in brine, but not smoked, n.e.c. in item no. 0305.3
030541	Fish; smoked, whether or not cooked before or during smoking, salmon, Pacific (*Oncorhynchus nerka, gorbuscha, keta, tschawytscha, kisutch, masou, rhodurus*), Atlantic (*Salmo salar*) and Danube (*Hucho hucho*), includes fillets, but excludes edible fish offal
030542	Fish; smoked, whether or not cooked before or during smoking, herrings (*Clupeaharengus, Clupeapallasii*), includes fillets, but excludes edible fish offal
030549	Fish; smoked, whether or not cooked before or during smoking, n.e.c. in item no. 0305.4, includes fillets, but excludes edible fish offal
030551	Fish; dried, whether or not salted but not smoked, other than edible fish offal, cod (*Gadus morhua, Gadusogac, Gadusmacrocephalus*)
030559	Fish; dried, whether or not salted but not smoked, other than edible fish offal, other than cod (*Gadusmorhua, Gadus ogac, Gadus macrocephalus*)
030562	Fish; salted or in brine, not dried or smoked, other than edible fish offal, cod (*Gadus morhua, Gadus ogac, Gadus macrocephalus*)
030563	Fish; salted or in brine, not dried or smoked, other than edible fish offal, anchovies (*Engrails spp.)*
030569	Fish; salted or in brine, not dried or smoked, other than edible fish offal, n.e.c. in item no. 0305.6
030572	Fish; edible offal, fish heads, tails and maws
030579	Fish; edible offal, other than shark fins, fish heads, tails and maws

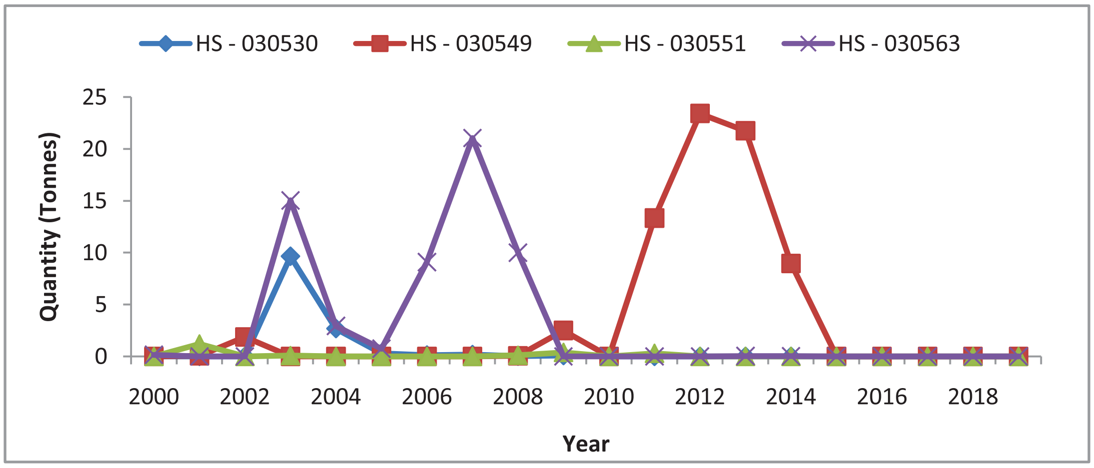
**n.e.c indicates that not elsewhere considered*

India had imported 8.28tonnes of cured fish and fish products in 2000, which increased to 805tonnes worth 1.23 million US $ in 2010 and reached to a maximum quantity of 2780 tonnes worth 4.5 million US $ in 2014, before starting to declining the import quantity in the following years. The import, however, decreased in quantity to 1896, 1472, 1376 and 993 tonnes in 2016, 2017, 2018 and 2019, respectively. Bangladesh was the major country exporting cured fish products to India under the head HS – 0305 accounting for about 90 % of total import throughout the period 2000-2019.

India also imported 0.01 tonnes of fish - flours, meals and pellets fit for human consumption from Thailand in 2007 under the head HS – 030510;0.06 tonnes of fish- livers, roes and milt of fish, dried, smoked, salted or in brine from Republic of Korea in 2003 under the head HS -030520 and 6.39 tonnes of fish fillets- dried, salted or in brine, but not smoked, not elsewhere considered in item no. 0305.3 from Republic of Korea in 2013 under the head HS – 030539. The import of fish - fillets, dried, salted or in brine, but not smoked to India under the head HS – 030530 mainly from Italy, Netherland and Denmark during 2003-2008 but completely stopped due to unknown reasons.

India imported only 0.04 and 0.02 tonnes of fish-(cooked or not cooked before or during smoking), herrings *(Clupea harengus, Clupea pallasii)*, includes fillets, but excludes edible fish offal under the head HS – 030542 from United Kingdom in 2005 and Norway in 2013, respectively. Also, India imported fish –(cooked or not cooked before or during smoking salmon, Pacific *(Oncorhynchus nerka, O.gorbuscha, O.keta, O.tschawytscha, O.kisutch, O.masou, O.rhodurus)*, Atlantic *(Salmo salar)* and Danube *(Hucho hucho)*, includes fillets, but excludes edible fish under the head HS-030541up to 2014 from Norway and United Kingdom but import stoppedsince then under this head. The import of products under the HS code. 0305.4, includes fillets, but excludes edible fish offal under the head HS - 030549 discreetly during 2000 - 2014 but subsequently stopped import of smoked items under this category.

India had just imported 0.10 tonnes of fish- salted or in brine, not dried or smoked, other than edible fish offal, cod *(Gadus morhua, Gadus ogac, Gadus macrocephalus)* under the head - 030562 from Portugal only in 2003. India mainly imported fish - salted or in brine, not dried or smoked, other than edible fish offal, anchovies *(Engrails spp.)* under the head HS - 030563 from Republic of Korea in 2004 and 2005; and from Thailand in 2006, 2007 and 2008. But, later imported only from Italy a mere quantity 0.04 and 0.02 tonnes in 2013 and 2014, respectively. The import source of fish- salted or in brine, not dried or smoked, other than edible fish offal, not elsewhere considered in item no. 0305.6 to India under the head HS – 030569 varied during the period 2000-2019. The major countries importing the items under the head HS – 030569 were Bangladesh, Republic of Korea, United Arab Emirates and United Kingdom; also China, Singapore and Thailand contributed at times. India had only once imported 22 tonnes of fish - edible offal, fish heads, tails and maws worth 0.50 million US $ from United Kingdom in 2019. India imported 0.40 and 0.001 tonnes of fish- edible offal, other than shark fins, fish heads, tails and maws from Republic of Korea in 2016 and from Norway in 2019, respectively.



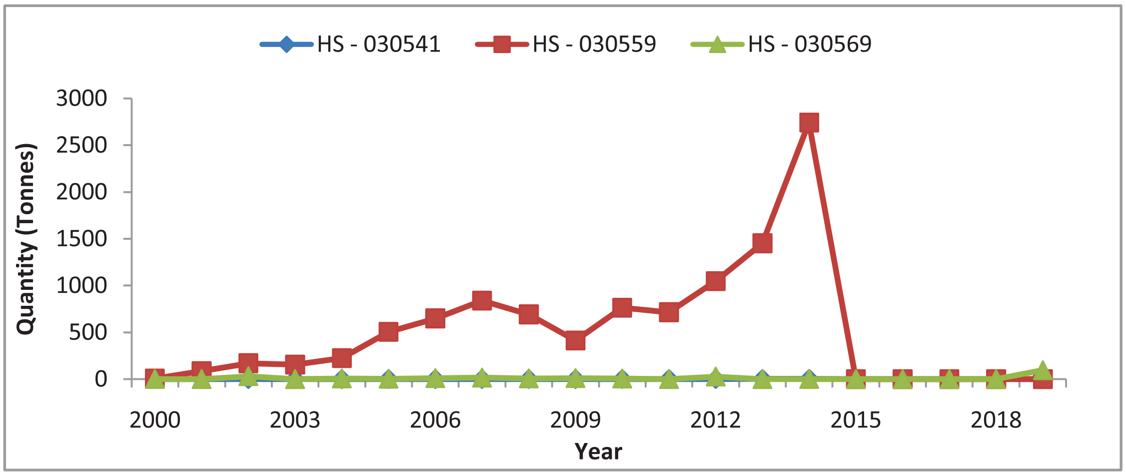


Fig. 1. *The Import of major cured fish products to India*

The quantity wise import dynamics of cured fish products is depicted in Figure 1 a & b. It could be inferred that the import of smoked fish products to India increased from 2000, but later completely stopped the import since 2015. India still continues the import of dried fish products, salted or in brine but not dried or smoke fish products during the period 2000-2019 from Bangladesh, which accounted nearly 90 % of total import of cured fish products to India. The import of cured fish products to India is considered as a free trade. The firms in India can import cured fish products after paying basic import duty, applicable taxes and surcharges; and fulfilling compulsory compliance reports.

Mytella strigata: Emerging biofouling concern for coastal cage farmers along Kerala coast

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The fishery sector in India provides livelihood support to14.49 million people participating in main or subsidiary activity (DADF, 2014). The marine capture fishery in the country is at plateau for the last two decades. Aquaculture is considered as a viable and rapidly growing fishery sector in India with an annual growth rate of over 7% which augments fish production as well as ensures livelihood. The increased demand for high value fish has led to large scale cage culture sponsored by government agencies in the coastal waters. The cage culture technology has been adopted at several locations along the Indian coast for all promising species, which helped to advance the design and feasibility of the cages (Aswathy & Imelda, 2020). In aquaculture cages, structure and stability play a critical role and in India high-density polyethylene (HDPE) is the commonly used netting material for cages. The netting keeps the fish in a closed structure and the mesh size of the cage guarantees the water movement. Proper water flow in cages enhances the water quality, reduces stress, improves feed conversion and reduces the mortality of cultured fish.

Cage culture in India still faces some issues during operation like unavailability of good quality seed & feed, high risk of disease within cage reared fish, accumulation of unconsumed feed, faecal wastes and excreta which cause leaching of nutrients to the surrounding waters. Besides, the nets are highly susceptible to biofouling which is a global issue in cage aquaculture (Kumari et al., 2020). Biofouling refers to the growth of unwanted organisms on the surface of any immersed structure in the sea. Biofouling of cages can cause clogging of the webbing/mesh which ultimately reduce the water circulation and creates anoxic condition resulting in reduced growth rate and mortality of fishes. In India, thousands of species belonging to divergent groups are recognized as biofouling organisms which includes bryozoans, algae, barnacles, bivalves, polychaetes, gastropods, isopods, amphipods, crabs, etc. (Kripa et al., 2012; Chinnadurai et al., 2018).

Among the foulers, American brackish water mussel *Mytella strigata*, which has emerged recently in backwaters of Cochin, has become a menace and great concern to the aquaculture farmers in Kerala. The presence of *M. strigata* was reported by Jayachandran et al., (2019) from the Vembanad Lake of Kerala, India. The invasion of this species into the coastal waters of India may be through ballast water or from fouling on ships hulls (Jayachandran et al., 2019). There is no sufficient data regarding their first settlement, but local fishermen from Kerala claim that the widespread distribution of this invasive mussel species was observed after the period around cyclone Ockhi, that struck the Kerala coast in 2017 (Biju et al., 2019). As the invasive species settle and occupy the natural environment in huge densities and dominate over the other native benthic biomass (Joshi, 2006; Sanpanich & Wells, 2019). In certain locations, *Mytella strigata* has replaced the green mussel *(Perna viridis)* and other indigenous clams (Biju et al., 2019). The major foulers from Kerala coast were bryozoans *(Electra spp., Victorella spp.)*, bivalves *(Perna spp., Mytilus spp., Ostrea spp.)* and crustaceans (amphipods, isopods, tanaids, decapods).

Mytella strigata is a euryhaline species that can tolerate salinity ranging from 2 to 40 ppt (Yuan et al., 2010) and water temperatures between 6 and 31°C (Brodsky et al., 2009). Besides, they also have a high egg-laying capacity, short lifespan and good dispersal ability (Willan et al., 2000; Boudreaux and Walters, 2006; Lim et al., 2018). Studies showed that *Mytella strigata* matures at a length of 1.25 cm and grows up to a length of 5.9 cm. They also can change sex (female to male) under starved conditions (Stenyakina, et al., 2010). The young specimens of *Mytella strigata* were found throughout the year indicating the possibility of multiple recruitments in Cochin estuary (Jayachandran et al., 2019). The maximum density of *Mytella strigata* in Cochin backwater was found to be 1451 ind./m² during 2018 (Biju et al., 2019) and the study conducted by ICAR-CIFT, Cochin in 2020 found that the density of this mussel ranged between

6000 - 25000 ind./m² with the highest density during post-monsoon period. *M. strigata* has the capacity to encrust in all structures like concrete, wood, plastics including webbings.

The coastal aquaculture activities including cage culture in Kerala begins after monsoon and at the same time spat of *M. strigata* gets colonized over the polyethylene webbings, which gradually increases the weight of the cage thereby causing a significant change in the structure of the webbing which reduces the water flow, resulting in low dissolved oxygen and high ammonia within the cages (Kumari et al., 2020). Increased weight of the cage brings about risk of structural failure and damage, which also make them more difficult for lifting and cleaning. Studies conducted by ICAR-CIFT estimated a fouling biomass of general foulers in polyethylene webbings was between 65-200 g/100 cm² while for *Mytella*, it was around 500-850 g/100 cm² which depended upon the seasons.

It is estimated that the management of biofouling requires about 25% of the total production cost (Braithwaite et al., 2007) which may bring economic losses to the fishers and also may hinder cage culture operations. Ashraf et al., (2020) developed strategies based on nanotechnology (nano copperoxide and polyaniline) to prevent the common biofoulers in the polyethylene nettings used in cage aquaculture. During field evaluation, nano coated net exhibited increased attack of *Mytella strigata.* The presence of high density of *Mytella strigata* and its attachment on cages could not be controlled by this composite having low concentration of nano copperoxide. Utilisation of high concentration nano materials are not recommended for aquaculture activities in coastal water bodies due to the leaching of metals which may lead to the problems like bioaccumulation. Hence proper management measures need to be taken up during the culture operations like changing of outer cagenet after the spat fall, standardizing feeding strategies to limit the excess nutrient flow to the water body, development and usage of ecofriendly antifouling composites to prevent settling of invasive mussel *Mytella strigata* in aquaculture cages; or else, it can become a severe menace to the emerging cage aquaculture industry in India.

Biofouling of Mytella strigata over aquaculture cages

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River stone sinkers of Saurashtra coast: A report after quarter century

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Cost of the fishing gears plays an important role to make fishing activity economic. Fishermen throughout the world, understandably unwilling to wait for the slow process of science to provide a solution, have 'taken matters into their own hands', experimenting on their own with various techniques (Jefferson and Curry, 1996, Prajith et al., 2014). Use of river stones as gillnet sinkers is a traditional approach by the fishermen of Saurashtra coast of Gujarat, India, to reduce the gear fabrication cost. This small-scale business is mainly pertaining to Gir Somnath district of the state, especially in Veraval and nearby locations. From this region, use of river stones as gillnet sinkers was first reported by Manoharadoss et al in 1996. This investigation reports the changes happened to this small-scale sector in the past 25 years.

Collection and transportation of stones

By employing daily workers, stones are directly collected from the nearby rivers. The collection is mainly done form Megal, Saraswathi, Gadu, Sapri and Hiran rivers, near to Veraval and Somnath city. Nearly 2000-2500 stones are collected per day. The daily wage for collecting stone is 350 INR. After collection,stones are transported to the workplace with the help of local transportation systems *Chakkada* (Rickshaw) with a transportation cost of Rs. 600/- per trip. Some family have their own vehicle for transportation.

Sorting and categorization of stone

Once the stones reach in the workplace, they are sorted into various categories according to the size and weight (Table.1). Large stones are usually used in the bottom set gillnet, whereas comparatively small size stones are used in other nets. Besides gillnet, these stones are also used in the artisanal long line fishery, locally known as *Vaaga*.

After sorting a 10 mm holes ismade to the side of the stone with the help of electric drilling machine. The cost of the drilling machine is around 5000-6000 INR. The major maintenance required for the machine is periodical replacement of needle and the motor belt (once in six month). Both cost 100-150 INR.

Close view of drilled river stones sinkers of various size

Table : 1 *Details of stones used in various gillnets*

SL No	Name of the net	Speciestargeted	Approximate weight of the stone
1	Bottom set gillnet	Lobster, shrimp	1-2kg
2	Large mesh gill net *(Jada jaal)*	Tuna, seer fish, Shark	750g
3	Pomfret gillnet Dhakara	Pomfret	100-250g
4	Small mesh gillnet	Small pelagics	100g

River stone sinker moulding unit of Bhidia, Veraval, Gujarat

Twenty five years ago, fishermen from the nearby villages were only procuring these stones from Kajli village (Manoharadoss et al., 1996). Presently this small scale business spread to other parts of GirSomnath district (Bhidia, Kindarva, Kanek) and fishermen from Jakhau to Bhavnagar are using these stones in their nets. To reduce the transportation cost, stones are transported with the help of fishing boat and also by vehicle returning to the respective locations. Fishing net shops of the respective locations keeps their contacts with the river stone collection units, and supplies them to the required fishermen. The price of a single stone is in the range of 1-1.3 INR irrespective of the size. The daily income for a person engaged in this work is 300 INR. Comparative details of expenditure and earning are given in Table.2. In Bhidia, near Veraval, a family belongs to *Vankar* (traditionally engaged in hand loom weaving) community is engaged in this work. They do this business from August-April and in the rest of the months engaged in other business.

Cement sinkers used in other part of Gujarat

Besides rivers stones, the use of several other materials like metals (lead), natural stones, cement disc etc as sinker have been observed. At Rupen Bandar, Dwarka, a group of nomadic family engaged in fabrication of cement sinkers used in gillnets. Long back, the family is migrated from nearby Maharashtra state and settled in Rupen Bandar. Cement sinkers of various size and weight are fabricated for all type of gillnets. Small sinkers are used in the drifting/surface set gillnets. whereas bigger once are used in large meshed or bottom set gillnet. On bag of cement is mixed with 15 mortar pan (cement mixing vessel) of sand and nearly 400-500 sinkers are fabricated per day. PVC pipes cut into suitable size are used as mould. Sinkers are sold for 2-3 INR/piece based on the size and weight.

Table: 2 *Comparison of expenditure and earning of 1996 and 2021*

Sl. No.	Item	*Cost (INR) 1996	Cost (INR) 2021
1	Transportation charges of stones from river to village	60-70	600
2	Cost of electric drilling machine	3000	5000-6000
3	Selling price of 100 stones (All size group)	20	100
4	Average income per day	30-50/family	300/person

(*Manoharadoss et al., 1996)

Various stages of fabrication of cement sinkers

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Determination of phylogroup in extended spectrum beta lactamase (ESBL)-*E. coli* from fishes by Clermont's rapid phylotyping method

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Escherichia coli is a normal intestinal inhabitant in majority of the animals including humans. It is a versatile commensal but capable of causing both intestinal and extraintestinal diseases such as diarrhoea, septicaemia, urinary tract infections and neonatal meningitis (Orskov and Orskov, 1992). The strains of *E. coli* are diverse with its genome plasticity and the population structure of this organism remains mostly clonal (Touchon et al., 2009). Despite this, *E. coli* can be delineated into six prominent phylogenetic groups-A, B1, B2, D, E and F. Determining the phylogroup of *E. coli* help to understand the path-ogenicity and also give an insight of how these pathogenic strains acquire virulence genes. Tech-niques like multi locus enzyme electrophoresis and ribotyping are capable of assigning phylogroups, but these are time consuming, complex and need a collection of typed strains (Clermont et al., 2000). In 2000, Clermont et al., (2000) developed a PCR based method to characterize the phylogroup based on three candidate markers –*chuA, yjaA* and *TSPE4.C2*. The primers designed were such that strains could be classified into four groups A, B1, B2 and D. Extensive multi locus sequence data and genome data of *E. coli* lead the Clermont group to further improvise the method and in 2013, characterization of eight phylogroups (A, B1, B2, C, D, E, F and *E. coli* cryptic clade I) of *E. coli* were made possible.

The recent study documented 50 extended spectrum beta lactamase (ESBL) *E. coli* isolated and characterized from fishes collected from Guwahati, Assam through quadraplex PCR phylotyping method of Clermont et al., (2013) (Sivaraman et al., 2020). *arpA* gene was used as an internal control for DNA quality and the *E. coli* and Escherichia clade I strains were expected to give a positive amplicon. Other than the primers used in the quadraplex, two other primers *viz., trpAgpC* and *ArpAgpE* (Lescat et al., 2012) were also used to classify phylogroups C and E, respectively. trp *BA* was used to provide an internal control. The primer sequences and the PCR conditions are listed in Table 1.

***Table1:** Primer sequence, reaction conditions and amplicon size of the gene targets*

Target	Primer Name	Sequence (5'-3')	Length (bases)	Primer concentration (µM)	Annealing temp. (°C)	Amplicon size (bp)
chuA	*chuA.1b* *chuA.2*	ATGGTACCGGACGAACCAAC TGCCGCCAGTACCAAAGACA	20 20	1.0 1.0	59	288
yjaA	*yjaA.1b* *yjaA.2b*	CAAACGTGAAGTGTCAGGAG AATGCGTTCCTCAACCTGTG	20 20	1.0 1.0		211
TspE4.C2	*TspE.C2.1b* *TspE4C2.2b*	CACTATTCGTAAGGTCATCC AGTTTATCGCTGCGGGTCGC	20 20	1.0 1.0		152

arpA	*AceK.f* *ArpA1.r*	AACGCTATTCGCCAGCTTGC TCTCCCCATACCGTACGCTA	20 20	2.0 2.0		400
arpA – *Group E*	*ArpAgpE.f* *ArpAgpE.r*	GATTCCATCTTGTCAAAATATGCC GAAAAGAAAAAGAATTCCCAAGAG	24 24	1.0 1.0	57	301
trpA- Group *C*	*trpAgpC.1* *trpAgpC.2*	AGTTTTATGCCCAGTGCGAG TCTGCGCCGGTCACGCCC	20 18	1.0 1.0	59	219
trpA-Internal *control*	*trpBA.f* *trpBA.r*	CGGCGATAAAGACATCTTCAC GCAACGCGGCCTGGCGGAAG	21 20	0.6 0.6	57/59	489

The results showed that forty percent (n=20) of the *E. coli* strains were grouped into phylogroup B1 and 30% (n=15) to group A.Other prominent phylogroups amongst the strains were E (12%, 6) and D (8%, 4). Two strains belonged to group F and one to Group C. One isolate could not be typed based on Clermont phylogrouping and was termed 'Unknown' as the PCR results were negative for *arpA/chuA/yjaA/TspE4.C2*. This isolate was positive when screened for *E. coli* specific *uidA* gene. The Fig 1 shows the amplification results of few strains studied. Literature points to the fact that virulent extra-intestinal strains of *E. coli* mainly belong to phylogroup B2 and to a smaller extent to Group D. Most of the commensal strains belong to phylogroup A. Phylogroup E was earlier unassigned to which one of the most important serotype O157:H7 belongs and group F is a sister group of phylogroup B2. Group C is closely related to but distinct from phylogroup B1. These findings emphasizes the phylogenetic diversity of *E. coli* strains isolated from fish source and their ability to disseminate infection. In humans and animals, intra-intestinal infections are caused mostly by phylogroup A/B1 or E and extra-intestinal infections are caused mainly by strains belonging to B2 (Clermont et al., 2011). The findings are in concordance with the reports that *E. coli* strains from animals usually belong to phylogroup B1 with 34-50% incidence. None of the studied strains belonged to pathogenic B2 phylogroup. About 8% of the *E. coli* strains belonged to phylogroup D which is known to be present in extra-intestinal pathogenic strains and calls for greater alert.The study validates Clermont's phylotyping method as a simple, rapid, robust and inexpensive tool for phyogrouping of *E. coli.*

Funding

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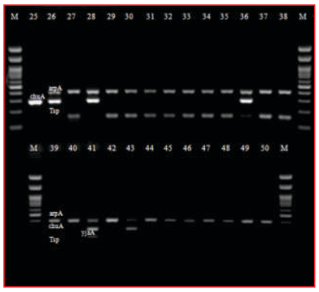

Fig1 : *Quadraplex PCR with the primer combination -arpA/chuA/yjaA/TspE4.C2.*

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Microbial quality of ice used for preservation of seafood in Veraval, Gujarat

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Ice preserves freshness of fish and fishery products, which otherwise deteriorates rapidly during distribution, storage and marketing. Ice acts as a preservative agent by reducing the temperature of fish and thereby retarding the growth of microorganisms. However, ice can act as both source of contamination and a medium for bacterial cross contamination. Microbial contamina-tion of ice is associated with many factors including the use of contaminated water used for its production, storage conditions, unsanitary ice handling, production and transportation procedures and type of use and production equipment (Teixeira et al., 2019). If quality of source water used for manufacturing ice is not good, there is a chance of carryover contamination of pathogenic microorganisms which cannot be destroyed completely during freezing of water. In fact, many microor-ganisms can survive in ice but their numbers decrease gradually with time. When ice is thawed, the remain-ing microorganisms may get injured, but they tend to recover their viability when the ice melts into the fish. This means that if pathogenic microorganisms are present in the source water used to make ice, they remain viable in the ice and are capable of causing contamination to fish (FEHD, 2005). Ice-making machines may also contribute to contamination of ice by seeding from the mains supply, defective plumbing that allows backflow from drains and inconsistent cleaning of the machines and containers (Burnett et al. 1994). The improper handling of ice by dragging on floor or storing on contaminated floors before being transported to fishing boats, or poor hygienic practices during transportation and inadequate knowledge of workers in handling and washing of contact surfaces can also increase the chance of microbial contamination in ice.

Ice can act as an important vehicle for trans mission of pathogenic bacteria and viruses to fish leading to food borne illness such as gastroenteritis in humans (Gerokomou et al., 2011). Indicator micro-organisms are used to assess the hygienic status of ice and possible presence of pathogens. The coliforms, *E.coli* and the total count of heterotrophic micro-organisms indicate the sanitary quality of ice (Smoot and Pierson, 1997). According to the World Health Organization (WHO 1997), the ice which is to be consumed or which is in direct contact with food should be of same quality and safety as that of drinking water. The Indian standard (IS 10500) recommends that the ice should be devoid of total coliforms, fecal coliforms and *E. coli* and should meet the requirements of drinking water standards. There-fore, the present study was undertaken to evaluate the microbial quality and contamination sources of ice used for fish preservation in Veraval.

Seventy five samples including water from ice plant used for production of ice, ice from ice plant, ice before crushing (after unloading from transportation vehicle), ice after crushing and ice from fish hold (after fishing) were collected (Fig.1). Microbial parameters such as Heterotrophic plate count (HPC), Total coliforms (TC), Faecal coliforms (FC) and E.coli were determined as per APHA, 2017 and results are shown in Table 1. The microbial count of water used for ice production, ice from ice plant, ice before crushing, ice after crushing and ice from fish hold were found in the range of 2 - 6.65 log cfu/ml. Significant increase in the microbial count was observed from ice plant to fish hold which indicate inadequate hygienic and sanitary measures during handling and transportation of ice from ice plant to fishing vessel. The heterotrophic count of water (@37°C) used for ice production were above the values (20 cfu/g) stipulated by EU directive 98/83/EC, (Table.1). Total coliforms (TC) and faecal coliforms (FC) showed a steep increase in the distribution chain of ice. Average TC of water, ice from ice plant, ice before crushing and ice ranged from 83.15- 752 MPN/100ml and average FC value were 1.39 -71.65 MPN/100ml for the different points. The remarkable increase in TC and FC may be due to the unhygienic and improper handling practices during transportation and also there is a general practice of keeping ice on the floors in the landing centre before crushing. Average TC and FC of ice collected from fish hold were 3834.3±744 and 1198.14±400 MPN/100ml respectively, indicating improper cleaning of fish hold and lack of sanitary practices and cleaning schedule at the end of each fishing trips.

E.coli was detected in all the stages from water from ice plant to fish hold with an average count of 1.86±0.62 to 25.57±6.6 MPN/100ml respectively. The presence of *E.coli* in water and ice in the ice plant indicated the poor quality water used for making ice and the lack of hygienic practices. Environmental contamination and contamination from transportation vehicles, utensils, ice crushing machines etc. also might have played a significant role in the high levels of coliforms and *E.coli*. The presence of faecal coliforms and *E.coli* in ice is an indication of fecal contamination (Falcao et al., 1993). The high load of *E.coli* in ice from fish hold is of concern since the ice from the fish hold was used for icing and re-icing of fish after landing and distributed to far off places. The crew of the fishing vessels and personnel involved in the production of ice are not trained on maintenance of personnel hygiene and hygienic handling of ice.

Overall the study revealed that out of seventy five samples collected from different stages of ice distribution chain, 94.66, 89.33 and 60% of samples had TC, FC and *E.coli* above acceptable limit as per IS 10500:2012 (Fig.2).

In conclusion, the study highlighted important sanitary issues in the distribution chain of ice used for fish preservation in Veraval. The ice used for refrigeration of fish can be a source of bacterial (pathogen) contamination. Only potable water shall be used for preparation of ice. Extreme care has to be taken in handling of ice during transportation and practices such as dragging of ice on contaminated floors should be avoided. Training on hygienic handling of ice shall be ensured for all the personnel involved in every stage of handling ice. There is need for strict monitoring by competent authorities for the improvement of quality of ice used for seafood preservation in Veraval, Gujarat.

Fig: 1 *Sampling points: water from iceplant, ice from ice plant, ice before crushing (after transportation), ice after crushing, ice from fish hold.*

Table.1 *Microbial quality of ice collected from various stages of distribution*

Test	Water Sample	Ice from Ice plant	Ice before crushing	Ice after crushing	Fish hold
Heterotrophic plate count (log cfu/ml)	3.31±0.18 † (2.95–4.95) ‡	2.95±0.15 † (2.0-3.96) ‡	4.57±0.15 † (3.58-5.37) ‡	4.76±0.18 † (3.68-5.91) ‡	5.95±0.13 † (5.9-6.65) ‡
Total coliforms (MPN/100ml)	83.15±51.6 † (0-790) ‡	11.41±4.8 † (0-49) ‡	675.82±271.7 † (16-3300) ‡	752±336 † (16-4900) ‡	3834.3±744 † (70-11000) ‡
Faecal coliforms (MPN/100ml)	6.19±2.5 † (0-33) ‡	1.39±0.38 † (0-4.5) ‡	63.32±27.3 † (0-350) ‡	71.65±28 † (0-350) ‡	1198.14±400 † (9.2-4900) ‡
E.coli (MPN/100ml)	1.86±0.62 † (0-23) ‡	0.35±0.03 † (0-4.5) ‡	5.08±1.6 † (0-70) ‡	5.87±2.2 † (0-79) ‡	25.57±6.6 † (0-170) ‡

† Average values
‡Range

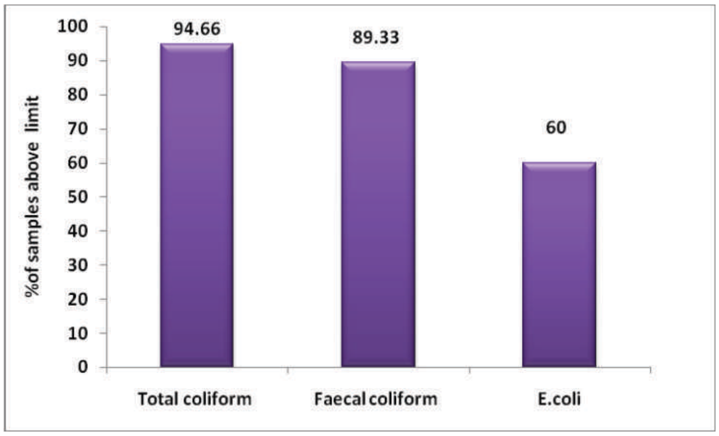

Fig:2 *Percentage of various microorganisms exceeded the limit in collected samples*

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Silica and alginate-based chitosan beads for removal of lead from water

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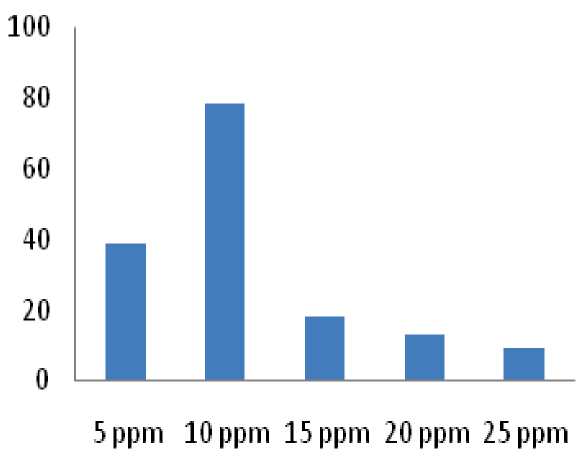
Large volumes of industrial discharges contaminate the water resources which often contains harmful organic and inorganic pollutants including heavy metals. The heavy metals get accumulated in the living organisms and finally reach humans. Removal of such contaminants is being addressed from different sources with limited success. Lead is one of the most conspicuous toxic heavy metals having dangerous environmental impacts as per toxicological criteria (Volesky and Holan 1995) which can affect multiple body systems especially in children. Exposure to lead can also results anaemia, hypertension, renal impairment, immunotoxicity and toxicity to the reproductive organs. Biopolymer based adsorbents such as chitosan can be used effectively to remove heavy metals from waste waters. Adsorption based techniques for removal of heavy metals are of high efficiency and economically feasible. Chitosan, a partially N-deacetylated product of chitin carrying positive charges, is an important natural biopolymer due to its biocompatibility and biodegradability.

Two types of chitosan beads were prepared in combination with silica (Bead I) and sodium alginate (Bead II) along with glutaraldehyde cross linking. The characteristics of beads viz., swelling behavior, amine content and pH buffering capacity were evaluated besides FTIR and SEM analysis. Batch adsorption studies of bead I and II were carried out for evaluating the lead (Pb) removal efficiency. Effect of pH (pH 3, 5, 7 & 9), dosage (0.25, 0.5, 1 & 2%) and initial lead concentration (5, 10, 15, 20 & 25 ppm) on the lead removal were also evaluated. The content of lead in water was analysed using Inductively Coupled Plasma photometer (ICP ICAD6300 Duo view, Thermo fisher, USA).

Both the bead types exhibited higher swelling behavior at acidic pH. Bead I exhibited a 326 % swelling at pH of 1.46, while bead II exhibited a 159% swelling at the same pH . Amine content of adsorbent was more in case of bead II (3.27 m mol/g) compared to bead I (0.21 m mol/g). The final pH was ranging from 3.32 to 7.41 during pH equilibration with 1mM



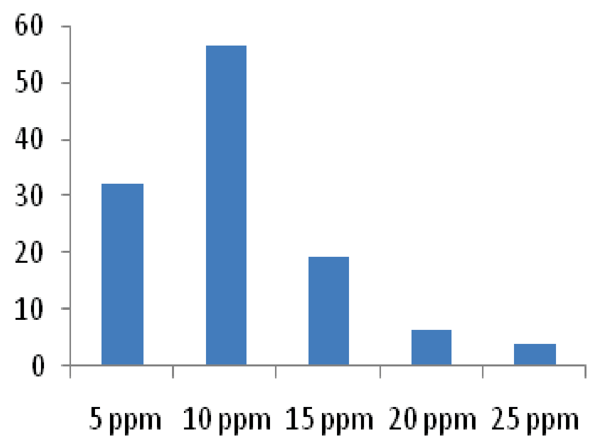


***Fig 2.** Effect of initial Pb concentration (Bead I) and (Bead II)*

to 0.1 mM HCl respectively for 180 minutes in case of bead I and in case of bead II, the final pH was ranging from 3.91 to 7.49 during pH equilibration under identical conditions. Pb removal efficiency was found maximum at pH 5 (95.5%), followed by pH 7 (87%) by bead I. While in bead II, maximum Pb removal efficiency was found at pH 7 (32.2%) followed by pH 9 (19.3%). Both the beads I and II showed maximum lead removal efficiency at dosage of 0.5%. Bead I showed maximum lead removal efficiency of 78.8% at initial concentration of 10 ppm, while bead II showed removal efficiency of 56.9% (Fig 2). Chitosan bead in combination with silica cross linked with glutaral - dehyde is efficient in removal of lead content from water in comparison to alginate-based beads.

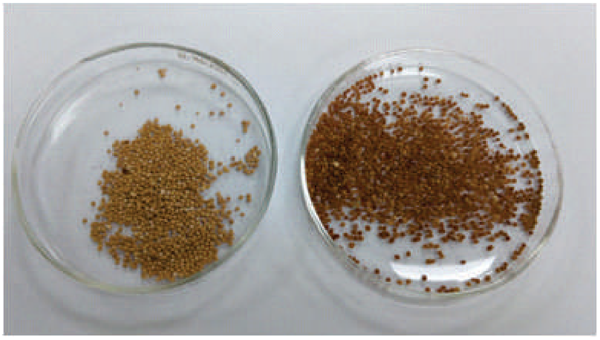


Fig 1. *Chitosan silica bead (Bead 1) and chitosan alginate bead (Bead 2)*

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A Report on the Indigenous Fishing Baits of North-Eastern States of India

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North-Eastern states of India has been known for bountiful resources of freshwater in the forms of rivers, streams, dams, lakes, wetland and cold water etc. and ranked 6 among the top 25 biodiversity hot spot in the world. It has diversified fish fauna and flora. Common fishing methods being widely practiced are cast net, lift net, hooks and line, barricade, encircling gear, entangling gear, impaling gear, scooping gear, groping, impoundment, indigenous traps/pots etc. Though destructive fishing is banned, it is prevailing in many parts of India including North-Eastern states. Some of the indigenous fishing baits commonly used from the above regions are given below.

Types of Baits

Earth worm: Earth worms are mainly used in hooks as traditional fishing method in rivers, lakes, dams, ponds and wetland. It is mainly used targeting common carp, catfishes, eels and murrels.

Grass shopper: Grass shopper is commonly used as seasonal bait in monsoon and post monsoon during in May-November targeting carnivorous and omnivorous species of fishes in ponds, lakes, reservoirs, wetland and dams. Grass shopper is inserted into the hook after wing, leg and head are removed.

Frogs: Frogs are traditionally used as bait targeting mainly catfishes and murrels in wetlands, dams, ponds and rivers. The frog skin is removed and the frog leg is inserted into hook. A frog is one of the commonly used indigenous fishing bait in hooks in rural areas of Manipur, Mizoram and Assam.

Termite nest: Termite nest is commonly used as feed as well as baits in rivers, streams and ponds to catch omnivorous and carnivorous species such as catfishes, murrel and tilapia. It is also used in cold water streams to catch Mahseer and Polynemus species using cast net and gill net.

Wood worm: It is collected from the certain tree fibres from jungle. The head part is removed and inserted into hooks. It is used mainly to catch murrel, catfishes and tilapia in rivers, dams, wetland and lakes.

Mole cricket: It is seasonal bait used during monsoon. It is collected from paddy field during ploughing. The head, leg and wings are removed and inserted into J type hook to targeting catfishes and murrels.

Fermented rice with rice husk: Fermented cooked rice with rice husk are commonly used to catch omnivorous species such as common carp, mrigal, silver carp and puntius in pond, lakes, and dams. Fermented rice is mixed with rice husk and make into dough and put inside the traps.

Freshwater prawn *(M.manipurense)*: It is rarely used as a bait in hook after rostrum, chelepeds, chelate, uropod, pleopods, carapace, telson, pleura and attennae are removed and insert into hook. It is used targeting omnivorous and carnivorous fish species such as *Clarius batracus, C. gariepinu, C.straitus, C.marulius and Oreochromis niloticus.*

Smaller fishes: Puntius and zebra fishes are commonly used as baits to catch catfishes and murrels in the ponds, lakes, wetlands, rivers and dams. The head part of the fish is removed and inserted into the hooks.

Chicken viscera: It is commonly used in hook and traps targeting carnivorous species in ponds, lakes, rivers and dams. It is mainly targeting murrel, catfishes and freshwater crabs.

Jackfruits: The latex and rag parts of ripened jackfruits are commonly used as bait in rural area of Manipur, Mizoram and Arunachal Pradesh targeting freshwater crabs in streams and rivers. The crabs are catch by handpicked or using scoop net.

In North-eastern States of India, different types of natural baits such as organism, vegetable and lives forms are commonly used in domestic and recreation scale of fishing. However, there is scanty of documentation and information on different types of baits used in different gears.

Physicochemical properties of microwave assisted dehydrated tuna chunks

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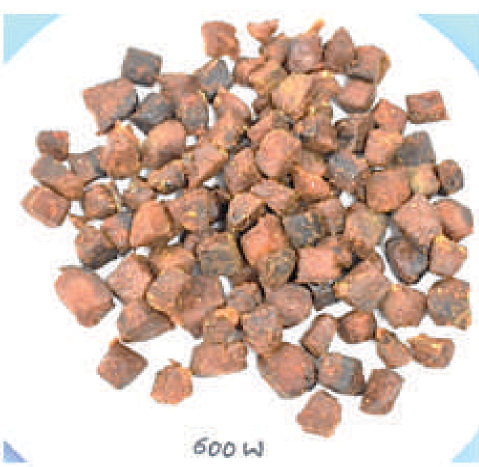
Microwave heating is a dielectric processing in which heat is produced by molecular friction caused during the shifting of polar molecules from their equilibrium positions under an electromagnetic field. It is therefore a volumetric heating and is considered as an effective heating method to produce high quality foods. In the electromagnetic spectrum, microwave frequency lays between 300 MHz and 300 GHz and the frequencies of 915 MHz-2.45 GHz are utilized for scientific, industrial and medical applications (Hoogenboom et al., 2009). Microwave processing is gaining much interest in food industry as it has potential applications in pasteurisation, baking, blanching, disinfestation, cooking, drying, extraction, defrosting etc. Microwave drying has several advantages over conventional drying methods such as hot air or sun drying because of their deep penetrable nature and ability to generate homogenous heating at a faster rate inside the product. Many studies have shown that microwave drying is a shorter process of high efficiency resulting in high product quality without case hardening (Fu et al., 2015; Monteiro et al., 2018). Vacuum assisted microwave drying is a latest innovation in the field of drying technology which uses high rate of heat transfer by microwave at a controlled temperature under vacuum. Microwave vacuum drying has the potential to produce value added dried fish product and in this context, the present study was aimed to develop value added dried tuna chunks as a function of microwave power and to study the physicochemical properties of the dried products.

A low value tuna belonging to the genes Euthynnus was selected for the study. Boneless chunks of 2x2 cm were cut from the fillet and it was marinated with spices and salt. The marinated chunks were dried in batches in a microwave vacuum dryer at different radiation (power) levels (600 W (T1), 650 W(T2) and 700 W(T3) for 2 h., maintaining a vacuum of 700 mmHg in the drying chamber. The samples after dehydration were cooled and its physicochemical properties such as moisture content, a_w, rehydration, microstructure and lipid oxidation indices were evaluated.

The result of the experiment indicated that microwave power had significantly influenced the moisture content and a_w of the products. Moisture content of the chunks dried at 600, 650 and 700 W after 2 h was 44.69, 39.26 and 26.4%, respectively. Accordingly, a_w of the samples also differed significantly among the samples in a reverse trend with highest value in T1 (0.89) followed by T2 (0.85) and the lowest was in T3 (0.77). The result shows that



only T3 sample confirmed to quality standards of dried fish samples for a_w established (<0.78) by food safety and standards authority of India (FSSAI, 2016). Most spoilage bacteria and spoilage yeast require a water activity of 0.91 and 0.88, respectively but the spoilage mould can survive up to 0.8 a_w (Sen, 2005). In microwave drying, drying rate is determined by the ratio of microwave power to the amount of moisture to be removed (Scaman et al., 2015). The results of the study are in agreement with other studies reported previously for other food products (Doymaz et al., 2015; Chahbani et al., 2018).

Lightness (L*) and redness (b*) value of tuna chunks didn't vary significantly with microwave power because of similar exposure time in all experiments. Rehydration properties is an important quality parameter of dried products. Microwave vacuum drying process develops a porous structure inside the product which facilitate rehydration during soaking (Scaman et al., 2015). As given in Fig. 2, rehydration rate of tuna chunks increased with increase in microwave power. These findings can be explained with the help of SEM image which indicate a tight microstructure of T1 sample (Fig. 3a) dried at 600 W compared to a loosened microstructure of T3 sample (Fig 3b) dried at 700 W. A tight muscle structure and higher amount of moisture in T1 sample might have hindered the absorption of water during rehydration process resulting in lower rehydration rate. Microstructure of tuna muscle was influenced by the rate of water vapour evaporation during microwave heating. At higher power levels, the rate of evaporation is faster under vacuum and creates a more porous and loose structure.

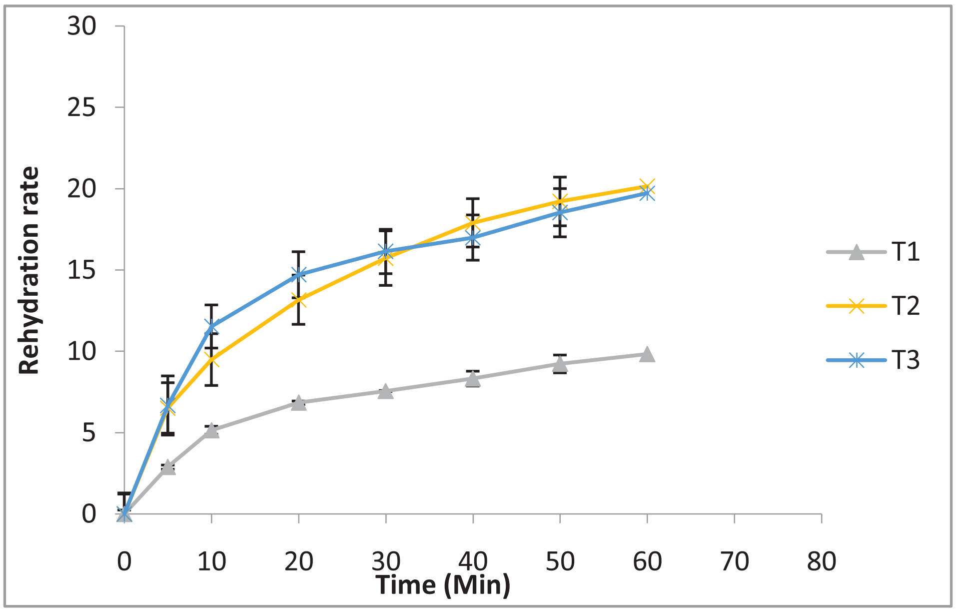


Fig. 2. *Rehydration rate of Tuna chunks dried at different microwave power*

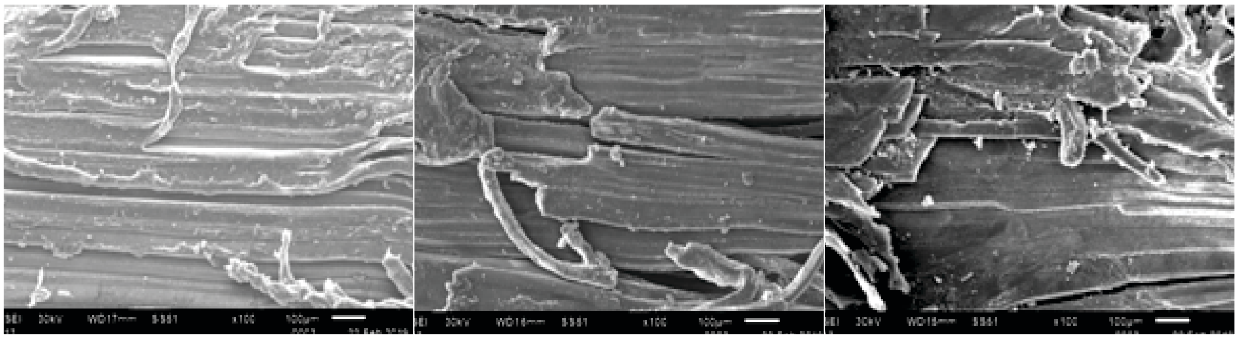


Fig.3 *Scanning electron microscope image of Tuna chunks dried in microwave vacuum dryer at a) 600 W, b) 650 W and b) 700 W*

Lipid oxidation is an inevitable chemical process caused by the oxidation fatty acids during drying process.In the present study, oxidation of lipids significantly increased with increase in microwave power. Peroxide values, the primary lipid oxidation index were 9.72, 10.17 and 16.94 mEQ O2/kg oil for T1, T2 and T3 samples, respectively. The mean value of TBARs, an index of secondary lipid oxidation was 0.65, 0.72 and 0.94 mg MDA/kg sample, respectively for T1, T2 and T3 samples. Under electromagnetic waves, fats and oils get extracted out of muscle fibre, making it susceptible to oxidation. Fatty acids of lipids are strong polar molecules and they exhibit strong dielectric properties depending on the composition of fatty acids which makes lipids more sensitive to oxidation and degradation under microwave. Abbas et al (2016) also noticed higher degree of oxidation in corn oil when the microwave power was raised from medium to high in a domestic microwave oven.

The results of the present study revealed that microwave power had significant influence on the physicochemical properties of fish product. Moisture removal was faster with increased powers indicating that microwaves of 650 W and above can be used to produce value added dried fish product. However, lipid oxidation is a constraint of drying at higher microwave power which needs to be controlled using heat stable antioxidants.

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Antioxidant and physiochemical properties of edible sodium alginate films incorporated with moringa leaves

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There is a growing interest in the development of biodegradable packaging materials from the emerging natural biopolymers such as protein and polysaccharides in the food industry due to their biodegradability and raising environmental concern related to plastic packaging (Farhan and Hani, 2017). Biodegradable packaging films with additional properties such as antioxidant and antimicrobial properties are set to replace the existing plastic packaging. Sodium alginate, a polysaccharide extracted from seaweeds, has been widely used to develop active packaging films and also as a coating material for protection of quality of food. Degradation of food are generally, triggered by the growth of aerobic microorganisms, lipid oxidation and enzymatic browning etc. Incorporation of antioxidants either directly into food matrices or into food packaging materials controls the negative oxidative effect caused by native oxygen (Bonilla et al., 2012). In this regard, natural antioxidant compounds are preferred over the deleterious chemical antioxidants. Moringa (*Moringa oleifera*; drumstick) is a tropical plant widely available in India and its antioxidant properties has been reported by several authors (Qwele et al., 2013; Vongsak et al., 2013). The Present study was conducted to evaluate the antioxidant properties of sodium alginate films incorporated with moringa leaf powder and moringa leaf extract for possible application as food grade applications.

Edible sodium alginate films incorporated with 0.25% (w/w) dried moringa leaf powder and 0.5% (v/w) moringa leaf extract (hot water extraction) were prepared according to the tray casting method (Fig. 1). Antioxidant activities, physicochemical properties such as water activity, pH, colour and heat-sealing property of the edible films were characterized. The sodium alginate films incorporated with moringa leaf powder and moringa leaf extract had pH 6.98 and 7.02 and lower aw 0.41 and 0.56, respectively. The sodium alginate films incorporated with moringa leaf extract had higher aw as compared to the film added with moringa leaf powderand were relatively sticky in nature and showed poor sealing characteristics as the films werevery thin and soft. However, sealing was possible for the moringa leaf powder incorporated sodium alginate film. Regarding the colorimetric parameters, there was significant difference ($p>0.05$) in lightness (L*) and redness (a*), between the edible films incorporated with moringa leaf powder and moringa leaf extract. Edible sodium alginate films with moringa leaf powder have lower L* (20.48) and a* (-2.51) values compared with the film incorporated with moringa leaf extract (L* 41.59 and a* -0.33). This is possibly explained by the presence of higher chlorophyll content in the moringa leaves which changed the colour of the edible sodium alginate films.

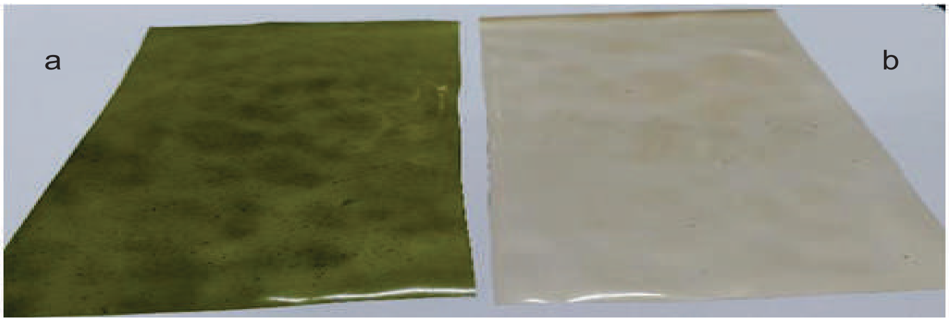

Fig. 1. *Edible sodium alginate films incorporated with a) 0.25% moringa leaves powder and b) 0.5% moringa leaves water extract*

DPPH radical scavenging activity of edible sodium alginate film incorporated with dried moringa leaf powder and moringa leafextract were 70.04±0.34% and 55.44±0.22%, respectively at 2.5% concentration. Accordingly, sodium alginate film incorporated with moringa leaf powder showed stronger ABTS scavenging activity and had significantly higher reducing power than the films incorporated with moringa leaf extract (Fig. 2). Contrary to present results, Rodríguez et al. (2020) reported lower antioxidant activity of papaya edible films incorporated with 6% moringa leaf powder. The differences in antioxidant activity of moringa leavescouldbe influenced by many factors such as location and season (Iqbal and Bhanger, 2006).

Finally, the incorporation of moringa increased the antioxidant properties of the sodium alginate films and moringa can be used as an antioxidant compound to develop active food packaging to prevent the lipid oxidation in food.

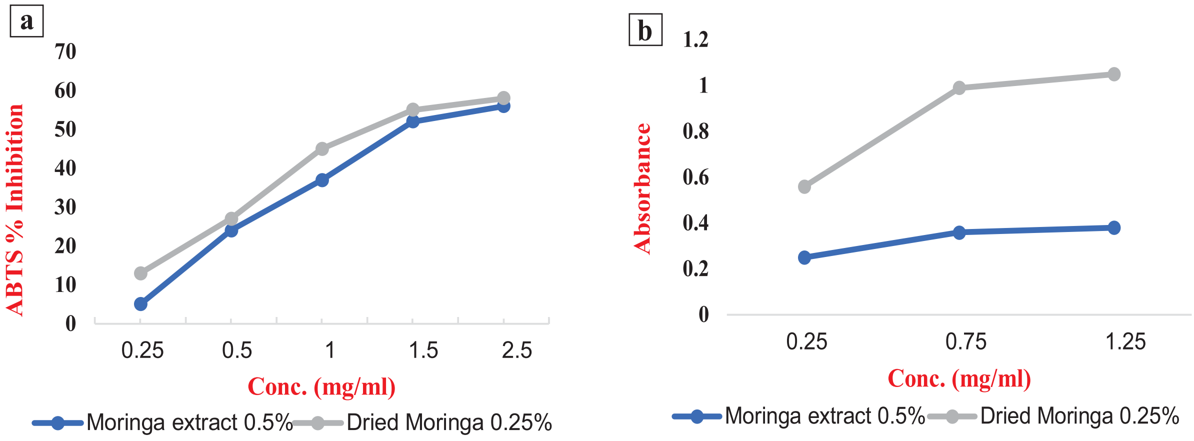

Fig. 2. *Antioxidant activity a) ABTS scavenging activity and b) reducing power of sodium alginate films incorporated with moringa leafpowder and moringa leaf extract.*

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Report on incidental catch of freshwater turtle, *Melanochelys trijuga* in gillnet from a reservoir in Kerala, India

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The term incidental catch or bycatch is widely used to refer to the part of the catch that is unintentionally caught during fishing operations other than the target species. Nowadays, bycatch is considered as an important international issue and has attracted the attention of global community as some of the bycatch includes marine mammals, sea birds, sea turtles, elasmobranchs and fin fishes etc. which are susceptible to over exploitation and population declines. However, freshwater bycatch concern has received less public attention. Knowledge of bycatch in the freshwater systems is important as many of the world's threatened species live in freshwaters. The few studies to date on freshwater bycatch have identified serious conservation issues (Collins et al., 1996, Koed and Dieperink 1999). Many reports point out that the use of different types of fishing gears, especially gillnets has led to a decrease in several types of aquatic marine life due to incidence of bycatches (Poonian, 2009; Lopez-Barrera et al., 2012).Though gillnets are the most size selective gear, incidental catch of non-targeted organisms in gillnet fishery is a growing concern and an important management issue.The incidental catches from gillnets in inland waters are rarely reported and studied (Anirudh et al., 2017; Santos et al., 2020).

During a study undertaken at Meenkara reservoir (10º 38' N and longitude 76º 48' E, area 2.59 km^2), in Palakkad district, Kerala, India during June 2019 to February 2020, incidental catch of fresh water turtle, *Melanochelys trijuga* (Indian black turtle) was observed in gillnets (Fig. 1).The gillnets operated in the reservoir were of 25 m length and 4 m height and made of nylon multifilament (210 x1x3) and 120 mm mesh size. Nets generally operated as set net, are deployed by around 5 pm and hauled the succeeding day around 6 am. During one such operation in November 2019, two turtles got entangled in these gillnets. It was caught during night as this species shows crepuscular to nocturnal life style. The turtles,having a carapace length of 170 mm and 180 mm and weighed 350 g and 500 g respectively, were caught alive and were released back to reservoir by the fishermen.To the 'best of our knowledge, this is the first report of incidental catch of turtle in gillnets from a reservoir in India'. The exploitation of Indian black turtle, *Melanochelys trijuga* from Vembanad lake and associated wetlands in Punnamada, Kerala using encircling nets, gill nets (as bycatch), hand nets and hook and line have been reported by Kumar et al.(2009).

Melanochelys trijuga known as Indian black turtle is one of the most common freshwater turtles of India and is recorded as the most abundant species in South India including Western Ghats (Das and Bhupathy, 2009). This species has been exploited for food by the people of North-eastern India and the tribes of Western Ghats (Das and Bhupathy, 2009). The IUCN status shows the species as 'Least concern'as well as the current population shows a declining trend (Ahmed et al., 2020) indicating such incidental catches may be a problem in the near future.

Turtles are usually caught in the nets by their front or rear legs or their heads. Thus, they cannot emerge to breathe and drown (Santos et al., 2020). Incidental catch of freshwater turtles in gillnet is rarely studied and there is a need for additional data to advance the development of bycatch mitigation measures in the inland gillnet fishery. Moreover,turtles require special conservation strategy as its life history includes low reproductive output, late maturity, and habitat requirements of both aquatic and terrestrial environments. Measures employed in ocean fisheries can probably be applied to freshwater fisheries for reducing such incidental catches of turtles. Modifying the spatio-temporal distribution of fishing effort to reduce encounters with non-target species, discarding incidentally caught turtles alive, monitoring of such incidences to ascertain their population status, making fishermen aware about the need of conservation of turtles and involvement of fishermen themselves in conservation activities would help to reduce bycatches in gillnets in reservoirs. Further, the possibility of using visual deterrents like illumination of nets using LED lights which are successful in marine gillnets can be explored in the fresh water sytem to reduce turtle bycatch. General management measures and mechanism to record such incidental catches on a long-termbasis would be required for sustainable inland fishing.


Fig. 1. *Entangled Indian black turtle (Melanochelys trijuga) in gillnet*

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Reduction in carbon emission by small scale fishing boats off Alappuzha coast, Kerala during COVID-19 pandemic

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Small scale fisheries involve a range of practices but are typically traditional activities require less capital investment and energy for operation, comparatively simple gear and small fishing vessels which makes short fishing trips close to shore (Ben-Yami and Anderson, 1985). There are 1,99,141 fishing vessels operates in marine fisheries sector of India, in which 36.9% comes under motorised which accounts for 23% of total landed catch (CMFRI, 2012; 2015). Since recent past the price of fuel and other energy sources had considerably increased. In 2001, fuel was estimated to account for 21% of revenue from landed fish catch, whereas in 2008 this increased to about 50%. Profitability and livelihoods are potentially highly sensitive to energy costs (FAO, 2015).

With this background a study was conducted to estimate reduction in fuel consumption and carbon emission by small-scale fishing boats during nationwide lockdown due to COVID 19 pandemic. Three landing centres of Alappuzha district namely; Punnapra, Paravur and Thottapally were selected for the data collection. More than 30 respondents who were using kerosene/petrol operated outboard engine of 9.9 hp,were contacted around fishing villages over telephone during the period, for gathering continuous data about fuel consumption before and during pandemic period for comparison. The details of the fishing systems are given in Table 1. The information was collected about voyage during the four different phases of nationwide lockdown period of 68 days (25 March 2020 to 31May 2020). Due to strict measures to curb the transmission of disease, hardly 10-15% of total fishing vessels were allowed to operate from landing centres during the period which resulted in drastic reduction of fuel consumption. Earlier in order to find out daily fuel consumption by fishing boats of similar L_{OA} and engine power, systematic data of 72 fishing operationswere recorded from small scale fishing vessel engines of same horsepower through personal interview method, and later it was validated with present study.

Data collected analysed statistically and it was found that the fuel consumption of out-board motor was 2.38±0.3 litres of kerosene/hour (for propulsion) and 1.1±0.3 litres of petrol/trip (for ignition). Fuel consumption for cruising (reaching to fishing ground and back to shore) and towing were different, but in the analysis two were combined and average was taken for analysis since fishing trips were single day type. Assuming 5 h of operation per day, the Kerosene consumption would be 2.38*5=11.9 litres/day and petrol consumption would be 1.1*1=1.1 litres/trip which will be equal to 13.0 litres of total fuel/day/vessel. There are about 7000 motorized boats operating off Punnapra, Paravoor and Thottapilly, but during pandemic 700-1000 (10-15% of total) were in operation. Assuming 7000 vessels in operation fuel consumption would be 7000* 13.0=91000 litres/day (consumption before lockdown), but operating only at 10-15% (750-1000 number of boat) fuel consumption will be 700-1000*13.0=9100-13000 litres/day (consumption during lockdown period). So, there is a reduction in fuel consumption by motorized fishing vessel to about 78000-81900 litres/day which is equal to 18,72,000-19,65,600 litres/month (assuming 24 days of active fishing in a month). So as a whole there is reduction of fuel consumption by motorized vessels of Alappuzha coast was about 37.4 to 39.0 lakh litres/month during the period. This corresponds to 89.76 to 93.6 lakh kg of CO_2 emission due to burning of the same quantity of fuel (assuming one litre fuel combustion results 2.4 kg of carbon di-oxide emission). This indicates the enormous reduction in carbon emission during COVID-19 pandemic time by motorised fishing vessels from selected landing centres only. This reduction in carbon emission would have positive impact on environment, resources and human health. Generally, fuel consumption and carbon emission are on rising trend over the period of time, mainly due to overcapacity. In Indian marine fisheries, the boosted fishing effort and efficiency in the last five decades has led to in considerable increase in fuel consumption, which is equivalent to CO_2 emission of 0.30 million metric tonns (MMT) in the year 1961 to 3.60 MMT in 2010. The CO_2 emission has increased from 0.50 to 1.02 t for every tonne of fish caught during the period. In 2010, fishing boats with outboard motor emitted 0.59 t CO_2/t of fish caught. Emission of CO_2 equivalent is a measure to compare the emissions from various greenhouse gases on the basis of their global warming potential (Jha and Edwin, 2019).

Fuel consumption in small scale fisheries have been subjected to notable interest as it started to explore implications of fishing intensification. The significance of energy use in the small-scale fisheries sector along with their probable future trends and optimisation is needed to be reviewed. The detailed database along with its technical and economic comparison as well as optimisation of fuel consumption/energy use by out-board motors would lead to policy guidelines and better management for small scale fisheries.

Table 1. *Description offishing system*

Item	Description
Engine type	Outboard motor
Power	9.9 hp
Fuel	Kerosene (for propulsion) and petrol (for ignition)
L_{OA}	8-13 m
Boat material	FRP/wooden
No. of crew	3-7
Gear used	Hand trawl/seine/gillnet/trammel net/line
Fishing area	Off Alappuzha/Kollam/Ernakulam
Fishing season	Round the year
Depth of operation	9-10 m
Cruising speed	6-7.5 Kn
Towing speed (in case of hand trawl)	2-3 Kn
Target catch	Shrimp
Net hauling method	Manual
Otter board dimension (in case of hand trawl)	81x43 cm

NB: *The result showed here based on analysis of data which were purely base upon personal interview method and as reported by boat operators.*

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