reactive substances (TBARs) value was observed to be in range of 0.36-0.39 mg malondialdehyde (MDA)/Kg (Fig 1). The meat bar having an L* 39.35, a* 7.83 and b* 21.07 initially, showed a slight increase in the colour attributes after 16 weeks with L* 43.49, a* 6.68 and b* 19.69 in MPE and L*42.17, a*6.91 and b*21.62 in PPE stored samples. Microbiologically, bars packed in MPE and PPE were safe throughout the storage period under chilled conditions. So, the products were acceptable up to 16 weeks under chilled storage conditions.

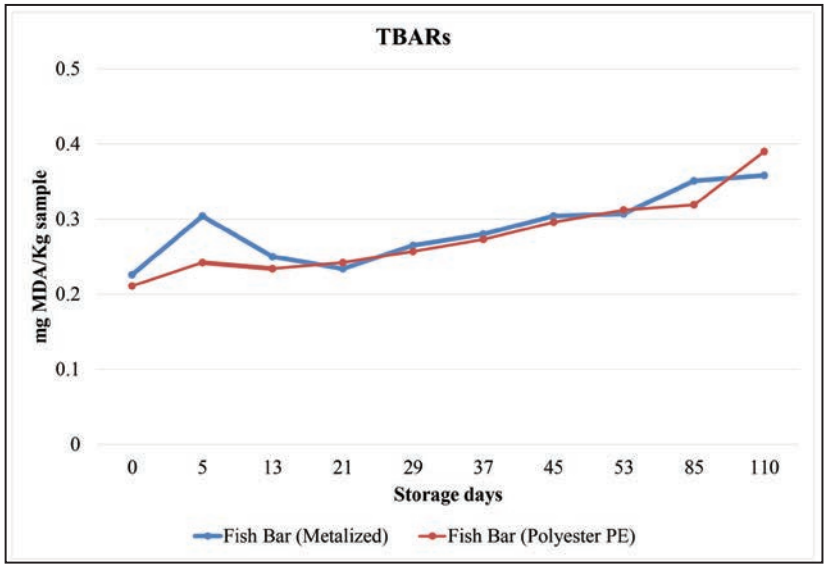

Fig 1 Changes in the TBARs value of fish bars during chilled storage

Consequently, fish bars stored under frozen conditions were analysed for a period of 12 months. During the frozen storage, all the physico chemical parameters were within acceptable range. A slight change in pH was observed from an initial pH of 5.96 which increased to 6.07 in MPE and 6.18 in PPE packed bars after 12 months. On storage, maximum TVB-N and TMA values observed were 18.2 and 9.8 mg N2/100g and 19.6 and 9.8 mg N2/100g in MPE and PPE respectively. Similarly, the oxidative indices were also found to be within the limit. After 12 months of storage PV, FFA and TBA values were observed to be in the range of 9.5 meq/ Kg fat, 7.15 % and 1.3 mg MDA/ Kg in MPE packs and 3.3 meq/ Kg, 2.78% and 1.24 m MDA/kg in PPE stored samples. Even though a slight flavour and colour loss was observed, microbiologically bars were acceptable throughout the frozen storage. So, the fish bars under frozen condition had a good shelf life of one year and no significant variations were observed bet-ween samples stored in selected packaging materials.

Seaweed: An excellent agent of bioremediation in aquatic environment

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Globalization and population growth in urban area, along with wild expansion of agricultural and industrial activities had led to the increase in the generation of waste water which ultimately reaches the aquatic environment and thereby impacting the entire food chain of the system (Akpor *et al*., 2014). The untreated waste water which is released to the natural water bodies accounts to around 60% of that produced, which is highly alarming.

The bioremediation practices were started very early by Romans employing microorganisms for

Fig:1 Ulva lactuca

removing contaminants from water bodies. They employed various organisms under controlled conditions to deteriorate, negate, and/or eliminate hazardous contaminants from polluted waterbodies. Research is being carried out even today using microorganisms especially bacteria and macroalgae to mitigate the contaminants present in aquaculture effluents, oil spills and coastal waters and sediments.

Bioremediation is described as the treatment that uses naturally occurring organisms to break down hazardous substances into less toxic or nontoxic substances and uses naturally occurring entity (*biostimulation*) or added indigenous or exogenous organisms (*bio augmentation*) to breakdown or absorb various pollutants. It is also an economically viable technique which can be employed *in situ* or *ex situ* with much public recognition. The success of bioremediation depends on the metabolic activity of the organisms selected for the purpose and the conditions for the organism to thrive well. The targeted organisms acting as agents for bioremediation are usually locally available which use these contaminants as their limiting food source for example, macronutrients such as nitrogen (N), phosphorus (P) etc.

Ulva is a seaweed known to be grown in fish culture ponds as a propitious species because of its affinity towards ammonium uptake from the ponds which is then employed for its metabolic activities (Neori *et al*., 1996; Lehnberg & Schramm 1984). Yamasaki *et al*. (1997) studied on the kuruma prawn, *Penaeus japonicus* larvae cum seaweed *Ulva lactuca*, together exhibited better growth and survival rate of prawn larvae in seaweed. Bat *et al.* (2001) stated that *Ulva* has an excellent bio-indicators potential in the water column as it exhibits excellent property to accumulate the surrounding nutrients rapidly.

There are reports indicating the use of green seaweed *Ulva lactuca* as fish biofilters with minimum maintenance (Vandermeulen and Gordin, 1990; Cohen and Neori, 1991; Neori *et al*., 1991). The nutrients released from the fish pond is reported to support the yield of *U. lactuca*-78-kg m^2 $year^1$and efficient 80% ammonia filtration. The donor acceptor interactions and hydrophobicity has induced the bio-sorption capability of phenolic compounds. It is reported that brown algae, Sargassum had shown high efficiency in eliminating the heavy metals from the water bodies (Sheng *et al*., 2004; Vijayaraghavan *et al*., 2005). The adsorption of dyes by seaweed, is achieved due to the presence of active functional groups, such as hydroxyl, carboxyl, carbonyl, amine, and sulfate. Kinetic reaction studies revealed that the chemisorption phenomenon had led in the removal of dyes from contaminated water bodies.

Application of seaweed for the removal of pesticide from contaminated water

In a preliminary experiment conducted at ICAR-CIFT Cochin, seaweed *Ulva lactuca* was treated with water contaminated with pesticides for 35 days and the treated water was periodically tested for residual pesticide. o,p- Dichlorodiphenyl trichloro ethane (o,p-DDT) and Heptachlor isomer-Epoxide were completely removed from the water by the seaweed by 4^{th} week of treatment. It was observed that the concentration of pesticide significantly reduced and become below detectable limit by the end

Standard	Initial conc. (ppm)	7th day (ppm)	14th day (ppm)	21st day (ppm)	28th day (ppm)	35th day (ppm)
α-BHC	0.3560	0.0126	0.0046	0.0076	0.0031	0.0000
Hepta Epox.	0.4492	0.0046	0.0039	0.0024	0.0000	0.0000
o,p-DDT	0.3421	0.0000	0.0000	0.0000	0.0000	0.0000

of treatment period. Thus, seaweeds have the potential to remove contaminants from polluted seawater, through bioremediation process.

Fig 2: Seaweed based bioremediation unit

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