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Contents

From the Editorial Board.....

The current status of aquaculture in Asia, and the activities being demonstrated around the globe suggest that farming of high value fishes, especially in cages and pens, has a bright future. Efforts have been initiated by the policy makers and research organizations for developing indigenous breeding and rearing technologies and promotion of farming activities in captivities. This in turn demands viable handling, processing, value addition and live transportation protocols for channelizing the harvested resources to the domestic and international markets. The current issue of 'FishTech Reporter' covers 16 articles, a few being focused on this background theme. The antibiotic resistance pattern of cultured resources, another major area of concern, is also been discussed. A statistical summarization of the country's fish import data is another highlight of the current issue. Articles on fish bone oil and gelatin hydrolysate deliberates the viable opportunities for generating additional income from process discards. The current issue also addresses the safety issues prevalent in seafood sector, insisting the need for protocol harmonization for pathogenic strains. Considering the vast potential of coastal farming of seaweed resources, an article on organochlorine pesticide residues in seaweeds from one of the major seaweed bed Mandapam, is also included in the current issue.

The editorial team of 'FishTech Reporter' invites more industry-oriented articles highlighting applied research findings in harvest and post harvest aspect, with emphasis on green technologies, emerging preservation and processing technologies, value addition opportunities, commercialization challenges, secondary raw material utilization and on-field rapid monitoring techniques and devices for ensuring safe fish consumption, for the benefit of general public.

Occurrence of deformity in genetically improved farmed tilapia

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Abnormality in farmed fishes can drastically reduce market demand. (Afonso *et al.*, 2000; Castro *et al.*, 2008). In culture-based fisheries the occurrence of deformity in fishes is often seen. The food availability in farmed condition is optimum unlike natural condition, where deformed fishes are vulnerable to predation, because food is a limiting factor in natural condition. Abnormal individuals that would be vulnerable to predation in the wild can survive at farm condition. There are several reasons which cause deformity in fishes. Generally it is presumed that all deformities are related to genetic reasons, but most are non-heritable and caused by disease (Tave, 1993); injury (Gunter and Ward, 1961); environmental disturbances etc. (Grady *et al.*, 1992). Generally fish stocks/ population contains deformed fish(s) and could be revealed after detailed examination. A hatchery population of *Sparus aurata* (gilthead seabream) had 39 deformities out of 11,640 nos. of species. (Afonso *et al.*, 2000). Similarly Verhaegen *et al.* (2007) recorded that 80% of *S. aurata* which were intensively cultured were deformed. Some of the surveys on tilapia have also indicated deformity in population. Out of 5459 individuals of *Oreochromis niloticus*, 2621 showed fin deformity (Guilherme, 1992). Eissa *et al.* (2009) reported 2.7% and 1.6% deformity in *O. Niloticus* at two Egyptian farms.

The present study was conducted at M/s Green Aqua Farm, Njarakal, Kerala. A total 30 fishes (average length - 22.05 cm; average weight - 231 g) were caught. Out of 30 fishes, one fish was found deformed. The deformity was found at caudal fin near caudal peduncle. The upper margin of first six caudal fin rays from dorsal end were partially fused together showing ventral curvature (Fig.1). Morphometric measurement and meristic count of both deformed and normal fishes (Fig. 2) are recorded separately and details are presented in Table 1. Percentage of deformation calculated on the standard length of deformed fish was 32% for the1st dorsal fin,18.8% for the 2nd dorsal fin, 32.8% for pre-dorsal fin length, 34.5% for pre-pectoral fin length, 39.7% for pre pelvic fin, 29% for pelvic fin length, 36.2% for pectoral fin length, 36.6% for max body depth, 33.7% for head length and 5.2% for eye diameter. The details of morphometric comparison of (Percentage of standard length in cm) of deformed genetically improved farmed tilapia with normal genetically improved farmed tilapia is given in Table 2. It was generally found that sub-optimal farming conditions, pollution, inbreeding depression, nutritional deficiency, genetic mutation or combination of all these may be the causing factor(s). However, further study is required to define the exact cause of the deformity. Tilapia is a sturdy fish which is tolerant to adverse condition and showing morphological deformities in culture practices. Though these deformities

Fig. 1. Deformitiy near caudal peduncle

Fig. 2. Normal fish

Table 1. Comparative morphometric and meristic characters of deformed genetically improved farmed tilapia and normal genetically improved farmed tilapia

Morphometric measurements (cm)/Meristic counts (Nos.)	Deformed fish	Normal fish
Total length	20.83	30.55
Standard length	17.82	24.86
First dorsal fin length	5.89	7.96
Second dorsal fin length	3.12	4.68
Pre-dorsal fin length	5.59	8.16
Pre-pectoral fin length	5.49	8.58
Pre-pelvic fin length	6.49	9.87
Pelvic fin length	4.6	7.23
Pectoral fin length	6.75	9.01
First dorsal fin rays	13	15
Second dorsal fin rays	11	11
Pectoral fin rays	9	9
Pelvic fin rays	16	16
Anal fin rays	12	12
Lateral line scales	30	30
Caudal fin rays	16	16
Maximum body depth	7.29	9.10
Head length (cm)	5.43	8.38
Eye diameter (cm)	1.44	1.3
Weight (g)	160	360

may not have effect on nutritional quality, it may affect consumer preference due to aesthetic concern. It was seen that there is no significant variation in morphometric measurements and meristic counts between deformed and normal fish. Hence, probably deformity has no role in growth of fish as revealed in the present study.

Table 2. Morphometric comparison of (Percentage age of standard length in cm) of deformed genetically improved farmed tilapia with normal genetically improved farmed tilapia

Morphometric characters (cm)	Deformed fish	Normal fish
Standard length	-	-
First dorsal fin length	32.01	33.05
Second dorsal fin length	18.82	17.50
Pre-dorsal fin length	32.82	31.36
Pre-pectoral fin length	34.51	30.80
Pre-pelvic fin length	39.70	36.41
Pelvic fin length	29.08	25.81
Pectoral fin length	36.24	37.87
Maximum body depth	36.60	40.90
Head length	33.70	30.47
Eye diameter	5.22	8.08

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Fish bone oil: A recent addition to health food industry

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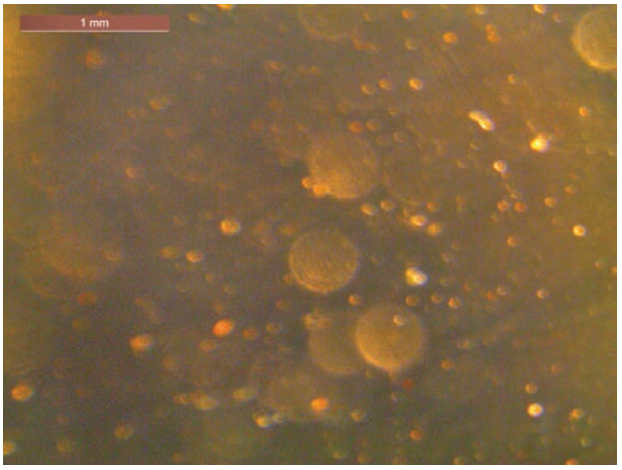
In marine fishes, lipid is stored in various body organs including muscle, liver, swim bladder, gonads, and bone. Many of the fast moving migratory fishes accumulate majority of lipid in spongy bones, which shows great variations depending on the stage of maturity and season. The content of oil in certain species may go as high as 52% (percent dry weight) in the skull, and 82% (percent dry weight) in the spine. Head and frame waste forms the major components of bulk waste generated in the filleting industry. One of the possible ways to use these solid wastes is the extraction of oil for human consumption. There are a numbers of protocols for the extraction of oil from spongiform tissues, *viz*. wet rendering, dry rendering, hydrolysis, and solvent extraction. The wet rendering process is the commonly employed method, which mainly include cooking, pressing and separating. In the present study, bone oil was extracted from the head and frame bones of fast moving marine fishes like tuna (*Thunnus albacares*), giant trevally (*Caranx ignobilis*) and dolphin fish (*Coryphaena hippurus*). Oil was extracted from head and frame bone at 60 ^{o}C under vacuum by three different protocols, *viz*. hot water extraction, enzymatic extraction, and solvent extraction method. The yield of oil from wet bone was 47-58%, 62-78%, and 58-64%, respectively by following the three different protocols. Among the three species, the highest oil recovery was observed for tuna, followed by dolphin fish and the least was noticed for giant trevally. The fatty acid profile of bone oil was only marginally affected by the extraction protocols attempted in the study, with comparatively higher degree of unsaturation for enzyme-assisted extraction protocol. The fatty acid composition of extracted oil was at par or even superior to fish liver oil, for the given sets of parameters studied, with predominance of DHA (6.82%), EPA



Microscopic image of bone oil encapsulates

(29.83%), arachidonic, oleic, stearic, palmitoleic and palmitic acid. The oxidation indices of extracted oil were well within the limit.

The oil extracted from Dolphinfish was further encapsulated using maltodextrin and chitosan and the quality characteristics were evaluated. The encapsulates were characterized based on encapsulation efficiency (EE), optical microscopy, DSC, viscosity and FTIR profile. The powder showed EE of 65.89% and solubility of 18.7%. The optical microscopic image of bone oil encapsulates indicated the formation of uniform spherical capsules of micro-dimension.

Further, oxidation parameters such as PV and TBA values were found to be within the range of 0.75 mEq/Kg and 0.29 mg malonaldehydes/kg, respectively. The results indicated that high quality bone oil can be extracted from head and frame wastes of fast moving migratory fishes.

Clam to cash: Clam paneer as a non-veg variant of milk paneer

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The black clam, *Villorita cyprinoides*, is the most important clam species landed in India. They are found in abundance in the backwaters, lakes and estuaries. Kerala is one among the leading producers of clam. In India *V. cyprinoides* accounts for nearly 70% of the total clam fishery. Proteins, lipids, glycogen and minerals together with minor components of hydrophilic and lipophilic nature, contribute to the organoleptic characteristics and nutritional value of clams. The presence of traces of sand affects the palatability of clams and is highly dependent on the method of harvesting. They are usually harvested by handpicking and baskets, while diving in waters. Although they are considered as a delicacy in many parts of India, a large quantity is being used as poultry feed. Thus value addition of black clam is necessary for the sustainable utilization and better value realization from the resource.

Paneer is an indigenous product prepared from coagulated milk by addition of organic acids at high temperatures. Clam paneer was developed by mixing clam meat and milk coagulum. The standardization of the product formula was done with different combinations and various ingredients. The standardized product consisted of milk coagulum: clam meat in the ratio 1:1. Potassium sorbate (0.1%) was added before chilled storage so as to study its preservative effect along with control sample. The samples were stored at 2 **ºC for analyzing the physico-chemical and microbial stability under different storage conditions.**

The clam paneer developed had 57.8% moisture, 1.5% ash, 22.7% protein and 13.03% fat (Table 1). Milk paneer has a fairly high level of fat (22-25%) and protein (16-18%) (Sunilkumar *et al*., 2014). Thus development of clam paneer reduces the fat content of milk paneer without compromising on the nutritive value in terms of protein. During chilled storage, sampling

Table 1. Proximate composition of clam paneer

Parameter	Paneer (Percentage)
Moisture	57.8±2.62
Ash	1.5±0.59
Protein	22.7±1.3
Fat	13.03±0.89

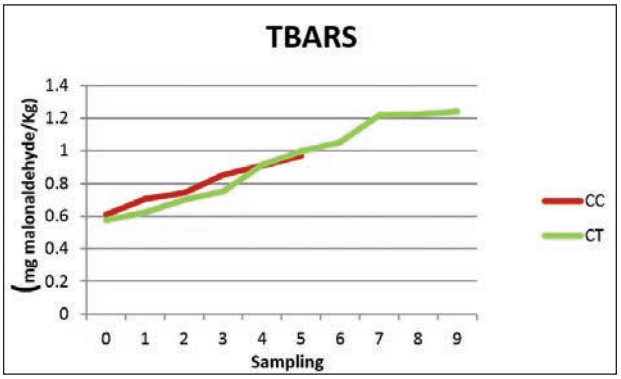

Fig. 1. TBARS value of clam paneer on chilled storage (CC - control, CT – treated)

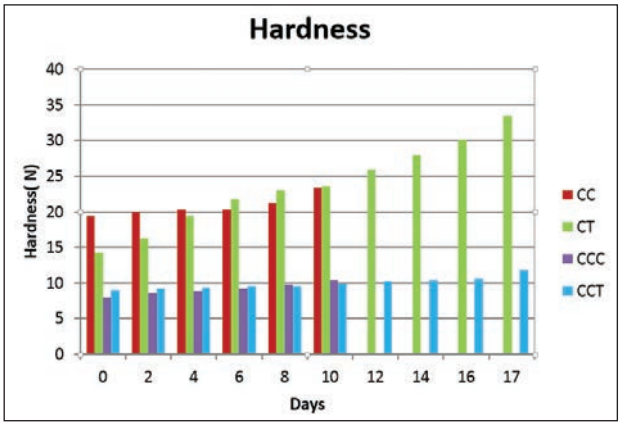

Fig. 2. Hardness of clam paneer on chilled storage (CC - control, CT - treated, CCC - cooked control, CCT - cooked treated)

was done on alternate days. Both the samples showed minimum indications of lipid oxidation and the values remained well within the limit during chilled storage. Control paneer was microbiologically acceptable till 10th day of storage where the treated samples had a shelf life of 17 days. The TBARS value (Fig. 1.) in both control and treated paneer increased with storage time. There was no significant changes in the hardness (Fig. 2.) of the control samples with storage time, whereas treated samples showed higher hardness values towards the fag end of storage period. As paneer is commonly consumed after cooking, the hardness of the samples were analyzed after cooking the paneer in boiling water for 10 minutes. Cooked paneer samples (both control and treated), had lower hardness values than the uncooked samples, indicating the soft texture of prepared paneer on consumption. Also increase in storage time did not affect the hardness of the cooked samples, significantly. Both the samples scored high sensory scores compared to conventional milk paneer till the end of storage study.

These observations, in general, put forth an attractive and novel option for product diversification and adding value of the under-utilized and abundant clam resource.

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Fish gelatin hydrolysate

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The global collagen/gelatin market is anticipated to reach USD 6.63 billion by the year 2025. Gelatin and hydrolyzed collagen/gelatin are the key product segments in this market. The market is growing due to increasing demand for collagen-based products in healthcare applications (wound healing, tissue engineering and bone reconstruction), food and beverages

and cosmetics industries. Collagen is the major structural protein and partial hydrolysis of collagen gives another soluble protein called gelatin. Commercially, the key sources for extraction of collagen include bovine, porcine and poultry. However, after the outbreaks of bovine spongiform encephalopathy, there are restrictions on collagen from these sources. Therefore, by-products from fish processing operations have been used in the industry for collagen and gelatin extraction. Thus, the objective of this article is to briefly describe the production process, protein profile and gel forming ability of gelatin hydrolysate.

Gelatin hydrolysate production process

Hydrolysate can be produced using two different processes. In the first process, hydrolysate could be made after gelatin extraction from the source by enzymatic hydrolysis. In the second process, the hydrolysates/enzyme-derived peptides can be prepared without prior extraction of gelatin. The second process could shorten the processing time and production costs by eliminating the gelatin extraction step. For the production of gelatin into gelatin hydrolysate, protease enzyme such as alcalase, pepsin, papain, trypsin, pancreatin, bromelain etc. are being used. Figure 1 shows the overall process for production of gelatin hydrolysate from Nile tilapia skin using thermal and enzymatic hydrolysis.

Molecular weight

Gelatin is a high molecular weight protein. The triple-helix of gelatin is approximately 300 nm in length. The γ chain had high molecular weight of approximately 200 kDa, while the ß and α chains had molecular weights below 200 kDa. During hydrolysis the peptide bonds are broken down producing low molecular weight peptides. The molecular weight of gelatin hydrolysate is generally in the range of 5.0-25 kDa. The SDS-PAGE profile of Nile tilapia skin gelatin and its hydrolysate indicated the presence of high molecular weight (HMW) polypeptides in gelatin whereas, no visible bands were found in the hydrolysate (Figure 2).

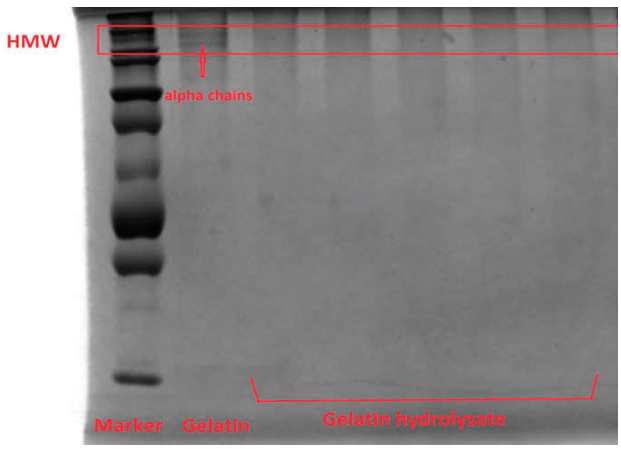

Fig. 2. SDS-PAGE profile of Nile tilapia skin gelatin hydrolysate

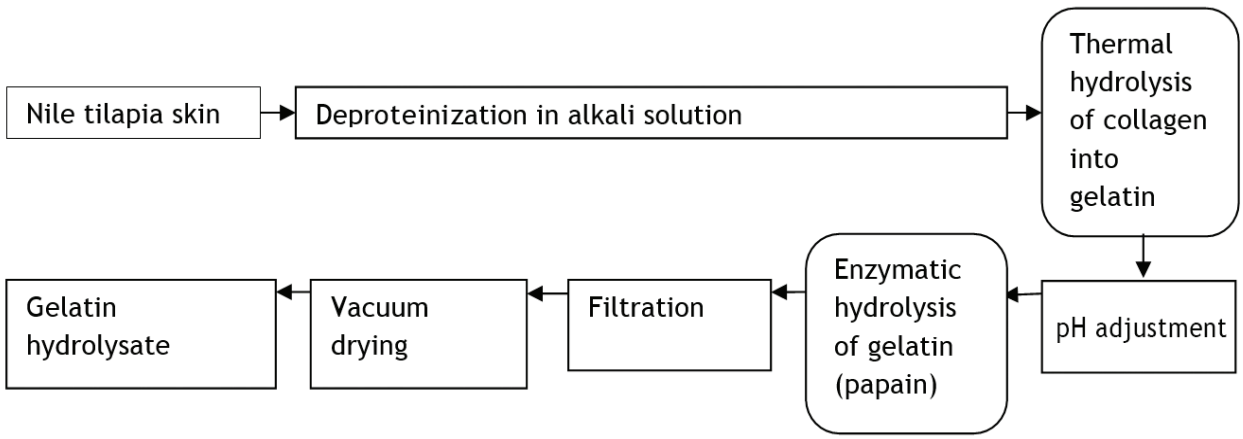

Fig. 1. Process layout for production of Nile tilapia skin gelatin hydrolysate

Solubility and gel forming ability

Gelatin is soluble in warm water while gelatin hydrolysate can be dissolved in cold water at room temperature. Gelatin forms a thermo-reversible gel at low temperature while gelatin hydrolysate does not form the gel. Figure 3 shows the formation of gel in gelatin solution while hydrolysate solutions were still in liquid state after incubation at low temperature.

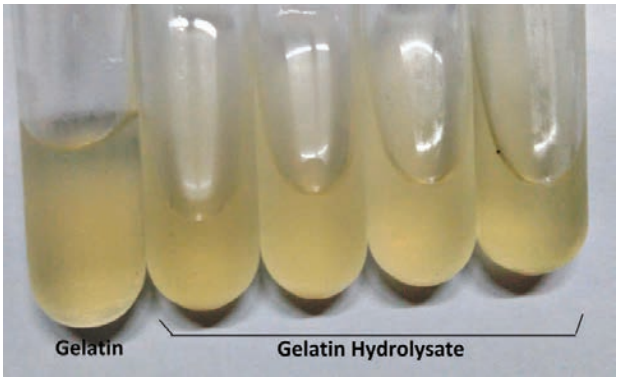

Fig. 3. Gel forming ability of Nile tilapia skin gelatin hydrolysate

Monitoring organochlorine pesticide residues in seaweeds from Mandapam coast, India

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Continuous and indiscriminate use of pesticides results in environmental pollution and several health implications in various aquatic and terrestrial organisms. Among the various environmental pollutants, organochlorine pesticides poses potential health hazards due to their extreme toxic nature. These compounds are stable, non-degradable and have high bio-accumulation power in the blood and fatty tissues of higher organisms due to its lipophilic characteristics. Since the synthesis of DDT in 1874, and subsequent finding of its insecticidal action by Paul Herman Mulle, (1929) organochlorine pesticides are being used indiscriminately in agriculture.

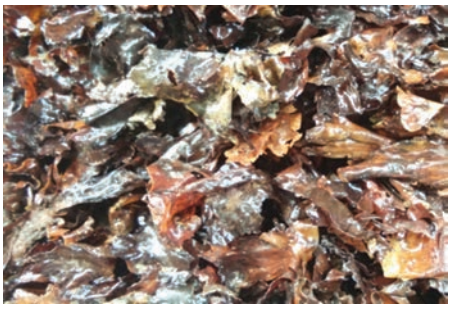
Seaweeds play a major role in food chains and are associated with prey-predator relationship with higher aquatic organisms such as fish and shellfishes, marine mammals which in turn are related to food chain of human beings. In recent years, seaweed farming has become a common practice in coastal states of India due to the awareness about the nutritional and biochemical applications of seaweeds. Although seaweed contains very less amount of lipids, the percentage of polyunsaturated fatty acid content in their total lipid is high. There might be chance of getting accumulation of pesticides in seaweed lipids and subsequent transfer to higher organisms through food chain. Considering these facts, a constant monitoring of the levels of pesticides residues in seaweed is essential.

With this view, seaweed originating in Gulf of Mannar, Mandapam coast, Tamil Nadu (India) *viz*. *Sargassum wighti*, *Turbinaria connoides*, *Padina gymnocephalus*, *Lobophora variegata*, *Stoechospermum marginatum* and *Ulva lactuca* were collected (Fig. 1) and analyzed for 13 organochlorine pesticides (OCPs) (α-BHC, ß-BHC, γ-BHC, Heptachlor, Aldrin, Heptachlor epoxide, *p,p′*-DDE Dieldrin, o,p′ DDD, Endrin, pp′ DDD, o,p′ DDT, p,p′ DDT). The QueChERS single step buffered acetonitrile method was employed for the extraction of organochlorine pesticides from the seaweed samples. The final extracts were analyzed by Varian CP-3800 gas chromatograph

Sargassum wighti

Turbinaria connoides

Padina gymnocephalus



Lobophora variegata

Ulva lactuca

Stoechospermum marginatum

Fig. 1. Seaweed samples collected for organochlorine pesticide residue analysis

Table 1. Results of pesticides residues detected in different seaweed samples

Organochlorine pesticides analyzed	*S. wightii* (ng/g)	*T. connoides* (ng/g)	*P. gymnospora* (ng/g)	*L. variegata* (ng/g)	*U. lactuca* (ng/g)	*S. marginatum* (ng/g)
α BHC	0.02	0.02	0.01	ND	ND	ND
ß-BHC	ND	0.02	0.05	ND	ND	ND
γ-BHC	0.02	0.02	ND	ND	ND	ND
Heptachlor	0.03	ND	ND	ND	ND	ND
Aldrin	0.01	ND	ND	ND	ND	ND
Heptachlor epoxide	0.05	ND	0.16	ND	ND	ND
p,p′ DDE	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND	ND
o,p′ DDD	ND	ND	ND	ND	ND	ND
Endrin	0.185	ND	ND	ND	ND	ND
p,p′ DDD	0.63	ND	ND	ND	ND	ND
o,p′ DDT	ND	0.12	0.03	ND	ND	ND
p,p′ DDT	ND	0.05	0.01	ND	ND	0.03

ND - Not detected

(Varian Association Inc., USA) equipped with auto sampler and electron capture detector. The pesticides residues level was determined quantitatively by comparing the retention time and peak areas of standards. The concentrations of organochlorine pesticide residues in various seaweed samples detected (ng/g dry weight) is presented in Table 1. The concentrations of pesticides residues in all the samples recorded were below the WHO guidelines limits for fish samples. Among the seaweed species studied, maximum number of pesticide residues was detected in *T. connoides* (α-BHC, ß-BHC, γ-BHC, o,p′ DDT and p,p′ DDT), *S. wightii* (α-BHC, γ-BHC, Heptachlor, Aldrin, Heptachlor epoxide, Endrin, and p,p′-DDE) and *P. gymnospora* (α-BHC, ß-BHC, γ-BHC o,p′ DDT, and p,p′ DDT). The concentration of total pesticides detected in the present study in the range of 'Not detected' to 0.63ng/g is comparable with those reported from the coastal parts of other countries such as Italy (5-56ng/g), China (8.4ng/g to 33.1ng/g) and Kenya (0.02ng/g to 0.5ng/g) (Barasa, 1998; Pavoni *et al*., 2003; Qiu *et al*., 2017). It was reported that the magnitudes of OCP is lower in seaweed samples than in phytoplankton indicating the higher uptake efficiency of persistent organic pollutants by phytoplankton due to its large surface area (Qiu *et al*., 2017). Concentrations of organochlorine pesticides in *L. variegata*, *U. lactuca* and *S. marginatum* were relatively Nil and they have shown only the presence of p,p′ DDT. Although the use of DDT and its metabolites, BHCs, Eldrin and heptachlor has been banned in India, their presence in the samples analyzed indicates its persistence in the aquatic environment. Hence appropriate scientific strategies have to be developed for the biodegradation of these pesticides for its complete elimination from the nature.

Acknowledgement

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Live fish transportation: A less explored value addition option by the domestic sector

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The major concern in domestic fish trade is the unscrupulous use of deadly chemicals to slow down the process of material spoilage during transportation and vending hours. The practice will continue to exist in the absence of alternative safer options and many more

chemicals are expected to enter in to the trade in the coming years, In this juncture, one of the most logical methods for preserving the quality of fish is to keep them alive till consumption. Live fish, an indication of most excellent quality, guarantees freshness to the consumer. Hence compared to chill stored fish, live fish has better price realization. At the same time there are a number of factors which need to be considered very critically for improving the survival of fish during transportation from the point of harvest to the table. These include the transportation system, species variation, temperature, dissolved oxygen, pH, metabolic rate, the biochemical changes and stress during transportation, post-mortem quality on consumption etc. Above all, a thorough knowledge on the conditions that each type/size of fish can tolerate is necessary for designing an efficient live transportation system.

During live transportation, sedation of the fish is generally considered desirable, as it reduces the rate of oxygen uptake, release of Carbon dioxide, formation of ammonia and control the excitability of fishes. A number of safe and food grade anaesthetics are in use for this purpose, which cause reversible loss of sensation. Similarly, lowering the temperature of water to the minimum possible level is suggested as an effective strategy to reduce the metabolic rate of fish during transportation. Hence a study was conducted with the objective of optimizing the conditions during the transportation of live tilapia with emphasis to enhance the survival rate during holding and transportation.

In the present study, live tilapia (*Oreochromis mossambicus*) having an average size of 250 g was used for the experiment (Fig. 1). The anaesthetics opted were MS 222, AQUI-S, and clove essential oil which are considered as safe for the use on food fish and is effective with short induction time and rapid recovery time. The results indicated that various sedatives *viz*., MS 222, AQUI-S and essential oil had differential effect on live tilapia, with distinctly diverse induction and recovery time as well rate of survival. Among the three anaesthetic used, highest dosage

Fig. 1. HDPE boxes with live tilapia at low stocking density and low temperature (20 °C)

was required for MS 222, moderate dosage for AQUI-S and lowest for essential oil for the same extent of sedation in live tilapia. Light sedation was characterized by slow movement without losing equilibrium with response to external stimuli, and deep sedation was characterized by gill movement with no body movement, loss of equilibrium and no response to external stimuli. In the case of clove oil, an average exposure time of 5 min. was required for deep sedation at ambient temperature whereas it was slightly lower for MS222 and higher for AQUI-S under different concentrations. The experiment was repeated with the optimized concentration of clove oil at a low temperature of 20 °C for different stocking densities.

The results indicated 100% survival in both anaesthetised and unanaesthetised fish, which were kept at 20 °C under aerated condition. However, mortality was observed in non-aerated boxes kept at both ambient and low temperature conditions. The direct implication of the observed results is that anaesthetisation had negligible effects on survival rate at lower stocking densities, rather temperature and aeration had a significant role. Further experiment with higher stocking density and without anaesthetisation indicated aeration as the major limiting factor for survival, as mortality was observed even at 20 °C under non-aerated conditions. Similar to low stocking density, at higher stocking density also, 100% survival rate was achieved when ambient temperature/ low temperature (20 °C) was coupled with aeration.

Development of extruded product using partially hydrolysed fish flour from Nile tilapia

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Recently, the utilization of farmed fish species for the preparation of various processed fishery products is gaining importance. As there is a trend of increase in the aquaculture production on account of the decline in capture fisheries, it has necessitated the development of novel technologies to utilize farmed fish varieties to its maximum potential. Simultaneously, there is also a huge demand for the development of functional snack products from low value fish species. The extruded products are of great demand under this category. Though ample studies have been carried out in this regard, most of the developed methods could not satisfy all the attributes required for an extruded product. By and large, the major drawbacks of these products are the development of fish odour during storage, grittiness and the inferior shelf life. At times there occurs some difficulty in incorporating various products developed from fish in various conventional food products. In the present study, extruded products were developed by incorporating partially hydrolysed fish flour from the meat of Nile tilapia (Fig. 1). The tilapia meat was collected, minced and washed several times in ice cold water. The washed meat was then drained well and subjected to hydrolysis. The hydrolysis was done with protease enzyme at various concentrations of 0.5%, 1%, 1.5% and 2% to obtain partially hydrolysed fish flour which was incorporated at various levels *viz*., 10%, 15% and 20% in the extruded product. Here the control sample for the extruded meat was the unwashed partial hydroysed meat which was then incorporated in the above concentrations.0.5% of the partially hydrolysed product was incorporated at various concentrations to obtain the extruded product. The hydrolysis process of tilapia meat was monitored through solubility values at different incubation periods (Table 1).

Table 1. Solubility values of the partially hydrolysed Nile tilapia meat

Concentration	Protein concentration (mg/ml)
Control	0.413
0.5%	0.454
1%	0.493
1.5%	0.571
2%	0.604

From the results it was noted that control samples showed lesser values of lightness (L*) than the fish flour added samples (Table 2). Also yellowness (b*) was higher for control samples in comparison to the others in the respective batches. From the above results it was evident that

Fig. 1. Extruded product incorporated with 10%, 15% and 20% partially hydrolysed fish flour

Table 2. The colour values of the extruded product

Sample	Lightness (L*)	Redness (a*)	Yellowness (b*)
Control (C1)	80.26	-0.23	17.39
10%, 30 min.	78.97	0.03	14.04
10%, 60 min.	81.54	-0.24	10.33
Control (C2)	75.60	1.18	14.15
15%, 30 min.	77.57	0.04	12.28
15%, 60 min.	79.26	-0.01	13.15
Control (C3)	72.65	-0.27	20.46
20%, 30 min.	73.03	0.35	15.1
20%, 60 min.	74.62	0.27	14.02

the treatment samples gave a better appearance to the extruded product and hence the product can be much more appealing on further giving a coating with masala. The extruded products were also subjected to texture profile analysis and it indicated variations among the samples. Among the samples analyzed, inclusion of the fish flour at 10% levels showed a better texture profile compared to other combinations. Same lot also exhibited better sensory scores supporting the texture properties. Hence it was concluded that inclusion of partially hydrolysed fish flour from Nile tilapia meat at 10% levels generated a better extruded product with desirable properties.

Effect of tragacanth gum-based coating containing lemon grass extract on the shelf life of chilled stored Wolf herring (*Chirocentrus dorab*)

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Due to the negative perception of consumers against synthetic chemical preservatives, many recent studies are focused on the use of natural extracts of plant origin for enhancing the storage life of perishable foods like fishes. *Cymbopogon citrates* (Fig. 1), commonly known as lemon grass, is widely used in tropical countries as folk medicine, due to its antimicrobial efficiency. For the present study, lemon grass leaves were purchased from local market in Veraval, Gujarat and dried in a hot air oven at 50 ^{o}C. The dried leaves were powdered and extracted with 40% ethanol in 1:10 ratio using Soxhlet extraction system for 5 h. Extract was filtered and the residue was re-extracted. The filtered extracts were combined and concentrated using a rotary evaporator. The final thick solution was dried at 50 ^{o}C in a vacuum drier and the extract was stored at 4 ^{o}C until further use. The amount of total phenolics in the lemon grass extract (LGE)

determined with Folin–Ciocalteu reagent was 130.02±0.03 mg GAE/g. Further, the antioxidant potential of LGE was assessed by DPPH free radical assay and ferric reducing antioxidant power assay (FRAP) and compared with synthetic antioxidant. The DPPH scavenging action of LGE was concentration-dependent and was lower than that of BHA. Antimicrobial activity of LGE on *Chirocentrus dorab* (Fig. 2) was analyzed by disc-diffusion method. Bacterial strains used were gram positive *Staphylococcus aureus* (ATCC 25923) and gram negative *Escherichia coli* (ATCC 25922). DMSO was used as negative control and Ampicillin was used as positive control. LGE showed activity against both the bacteria. Zones of inhibition were 22.10±0.2 mm and 10.00±0.1 mm, respectively against *S. aureus* and *E. coli*. The antimicrobial efficiency and antioxidant activity of plant extracts are generally linked to the presence of phenolic compounds in them (Wong and Kitts, 2006).

Natural biopolymer-based edible coatings can enhance the shelf life of food by reducing its quality loss by preventing the transfer of moisture, lipids, flavours or gases across the package. Tragacanth gum (TG) is a natural polymer, which is non-toxic and bio-compatible and hence is widely used as an emulsifier and thickener in the food and drug industries. It is a natural gum obtained from the dried sap of several species of Middle Eastern legumes of the genus *Astragalus*. TG contains water soluble fraction known as tragacanthin (30–40%) and non-water-soluble fraction called bassorin (60–70%). Due to its multiple advantages, there is an increased attention on preparation of antimicrobial and antioxidant edible coatings containing plant extracts and essential oil for food preservation, which are considered as eco-friendly active packaging. In the present work, effect of TG-based edible coating containing lemon grass extract (LGE) on the shelf life of chilled stored *Chirocentrus dorab* was studied. *C. dorab*, widely known as Wolf herring was purchased from Jaleshwar landing centre (Gujarat, India) and brought to the laboratory in thermocol boxes with ice. The beheaded and gutted fishes were cut into steaks of 2.5 cm width. A batch of steaks which were not given any coating was kept as control. The remaining steaks were further separated into two batches for treating with two different coating solutions. One group was coated with 5% TG solution and the other one was coated with TG containing 100 µg/mL LGE. The fishes were dipped in coating solutions for 15 min. and then allowed to drain for 2 min. Later, the fish steaks were packed in multilayer film of ethylene–vinyl alcohol (EVOH) (nylon, EVOH and polyethylene) and stored in ice. Fresh Wolf herring had a moisture content of 74.13%. Protein and fat contents of the fresh fish were 20.4 and 4.2%, respectively. During storage, there was a significant reduction in total volatile base nitrogen formation and fat oxidation in TG+LGE coated fish, compared to control. Total mesophilic count of the control exceeded the allowable limit of 7 log cfu/g, after 12th day of storage, indicating that the microbial shelf life of the control samples was almost 12 days (Fig. 3.). There are previous reports on the antimicrobial efficiency of edible coatings in combination

Fig. 1. Lemon grass leaves

Fig. 2. *Chirocentrus dorab* used for the study

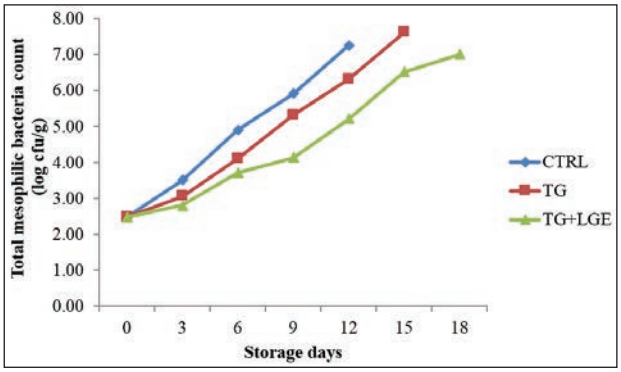

Fig. 3. Changes in the total mesophilic bacteria count of fish steaks during chilled storage

with natural plant extracts to maintain quality of fish flesh. Choulitoudi *et al*. (2016) have reported about the antimicrobial and antioxidant activity of *Satureja thymbra* (L.) extracts in edible carboxy methyl-cellulose coating and its potential to prolong the shelf life of gilthead seabream fillets. TG and TG+LGE coated samples were sensorily acceptable for 15 and 18 days, respectively in chilled condition compared to 12 days for uncoated control. It is clear from the results that TG-based edible coating containing LGE can retain the quality and improve the shelf life of fish steak during chilled storage (Table 1).

Table 1. DPPH scavenging action (%) of lemon grass extract

*DPPH scavenging ability (%)	Concentration (µg/mL)		
	25	50	100
LGE	68.42±0.42	74.11±0.60	89.66±0.68
BHA	74.23±0.24	84.22±0.50	98.33±0.14

* Values are expressed as mean ± standard deviation (n=3)

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Biochemical and microbial quality of mackerel available in different markets of Cochin

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Fish is highly perishable than other proteinacious animal food and its freshness is the most important criteria for judging the quality. Proper post harvest handling of fish is an important pre-requisite as quality is a major concern to food processors, consumers and public health authorities. Further, fish is more prone to contamination at various stages of handling, transport and storage. After catch, the fish undergoes deteriorative changes resulting in the gradual accumulation of volatile and carbonyl compounds due to the effect of various biochemical and microbial mechanisms. Fish quality is also affected by the contamination with pathogenic bacteria due to the use of uncleaned utensils, contaminated water and ice, inadequate amount of ice and unhygienic handling practices. Generally, fishes reach the domestic consumers through the landing centres, retail markets, local markets and supermarkets. Even though retail, local and

supermarkets sell fresh fishes, it takes quite a while for transportation from different landing centres to the far away markets. Hence, there is always risk of deterioration of quality due to poor or unhygienic handling, transportation and storage. Poor quality fishes or even contaminated with pathogenic organisms are also put up for sale in these markets. This can pose serious health hazards to the consumers. Several authors reported about the poor quality of fishes available in the domestic markets and are mostly contaminated with pathogenic microorganisms (Nambiar and Iyer, 1990).

Maintenance of adequate hygienein fish market is a pre-requisite for prevention of contamination. The quality of fish, particularly microbial quality, determines the safety of the fish and also predicts the risk factor about presence of various pathogenic organisms. The quality can be assessed by the routine biochemical and microbiological analysis such as pH, TMA, TVBN, aerobic plate count, identification of spoilage organisms and enumeration of different indicator bacteria like total Enterobacteriaceae, total Coliforms, *E. coli*, coagulase positive Staphylococci etc. (Sanjoy Das *et. al*., 2015). These quality analysis provides an outline of fish quality, hygienic status of samples and possible faecal contamination in the fish and its surrounding environment (Niemi and Taipalien, 1982).

In order to understand the quality of fish in the different nodal points, mackerel samples were collected from landing centre, retail market, supermarket and local market (n=3) of Cochin on the same day and analyzed for biochemical and microbiological quality. The results of biochemical analysis of the mackerel samples are presented in Figure 1. The average pH of the samples collected from different points were found in between 6.07-6.17. The average TVB-N of all the mackerel samples was below the rejection limits. The TVB-N of samples from landing centre and retail outlet was almost similar (14 and 13.3 mg/100g) and from supermarket and local market was 16.5 and 16.8 mg/100g respectively. The TMA values ranged from 0 to 1.4 mg/100g from all the points.

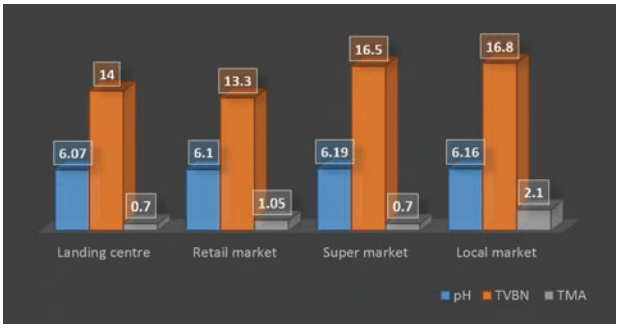

Fig. 1. Biochemical quality of mackerel from different nodal points

The results of the microbiological quality of mackerel samples is shown in the Table 1. In the present study, among the samples examined from different nodal points, highest APC value was reported inthe supermarket samples (5.61-6 $\log_{10}$ cfu g^{-1}) and least count was in landing

Table 1. Microbiological quality of mackerel from different nodal points (Bacterial count, $\log_{10}$ cfu g^{-1})

Microbial parameters	Landing centre	Retail market	Supermarket	Local market
APC	4.7-5.54	5.07-5.21	5.61-6	4.91-6
Total Coliforms	1.8-3.07	2.34-2.63	3.25-3.75	ND-2.44
E. coli	<1.00	<1.00	ND--2.78	ND-1.3
Enterobacteriaceae	1.3-3.57	1.8-3.17	3-3.8	2-3.83
Coagulase positive Staphylococci	ND-1	ND-1.47	1-2.3	1-1.3

*ND - Not detected

centre samples (4.7-5.54 log_{10}cfu g^{-1}). Coliforms were detected from all the points and highest value was recorded from the supermarket samples (3.25-3.75 log_{10} cfu g^{-1}). The samples collected from landing centre and retail market were devoid of *E.coli*, whereas, local market samples (<1-1.3 log_{10}cfu g^{-1}) and supermarket samples (<1--2.78 log_{10}cfu g^{-1}) showed positive results. Enterobacteriacea was detected in all the samples and maximum count was from the supermarket samples with a count of 3-3.81 log_{10}cfu g^{-1}. Though coagulase positive Staphylococci (CPS) were recorded from all the nodal points, its count was within the limit of acceptability (2 log_{10} cfu g^{-1}) except in case of supermarket samples (1-2.3log_{10}cfu g^{-1}).

The TMA and TVB-N values of the mackerel samples collected from the different nodal points were found to be within the acceptable limit (TVBN: 35-40 mg-N/100, TMA: 10-15 mg-N/100g) and hence considered as biochemically fresh. However, the APC values of all the samples were found to be above 5 log_{10} cfu/g^{-1}. The microbial load of the samples collected from landing centres and retail markets were found to be less than that of the super and local markets indicating that contamination might have occurred during transport of samples from the landing centres to those markets. Therefore, great care has to be taken to prevent contamination and cross contamination of samples from other food items and contact surfaces. Maintenance of proper hygienic condition should be ensured at every step of catching, landing, transportation and storage by following HACCP steps for good quality fish and fishery products.

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A Statistical summarization of fish import to India

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India is the third largest producer of capture fisheries and second largest producer of aquaculture fisheries in the world contributing 6.3% of global fish production. Fish production has increased from 41.57 lakh tonnes (24.47 lakh tonnes for marine and 17.10 lakh tonnes for inland fisheries) in 1991-92 to 107.90 lakh tonnes (35.8 lakh tonnes for marine and 72.10 lakh tonnes for inland fisheries) in 2015-16. The fisheries sector contributes to 1.1% of the GDP and 5.15% of the agricultural GDP. In 2015-16, India also has exported 945892 tonnes of fisheries products worth ₹ 30420.83 crore which is about 0.9% of the National Gross Domestic Products (GDP) and 5.17% to the agriculture GDP (Annual Report 2016-17, DAHDF, Govt. of India). At present, the aquaculture production has witnessed an increasing trend compared to marine production (Joshy *et al*., 2017). At the same time, India is also importing fish from different parts of the world to meet the requirements of consumers and industry. In 1993, the import of fresh and chill stored fish was 74.386 tonnes, which increased to 3797.146 tonnes in 2016. The respective trade value was ₹ 32.41 lakhs in 1993 and ₹ 76.69 crores in 2016. India has imported

0.382 tonnes of frozen fish worth ₹ 1.945 lakhs in 1993 and the same was increased to 11213.68 tonnes worth ₹ 74.604 crores in 2016. During this period, the quantity of fish imported has undergone structural changes. Therefore, an attempt was made to summarize the time series data on fish import during the period 1993 to 2016. The secondary fish import data on fresh and chill stored fish and frozen fish were collected in tonnes from the database https://comtrade.un.org/data/ (A trade Statistics compiled and maintained by Department of Economic and Social Affairs, United Nations, Rome).

The changes in trend of quantity of fish imported during 1993 to 2016 are depicted in Figure 1. and corresponding trade value is given in Figure 2. The quantity of imported fresh and chill stored fish showed an increasing trend up to1998 and then decreasing trend for the next five years up to 2003. From this point, it again showed an increasing trend for almost one decade up to 2012, and then again a decreasing trend. The trade value of imported fish also showed the same trend during this period. The quantity of imported frozen fish showed mild increasing trend up to 2009 except in 2005 where 1827 tonnes of frozen fish was imported. The time series data then showed an exponential trend with 11213.68 tonnes of frozen fish in 2016. The trade value of frozen fish imported also showed an exponential trend during the period 1993-2016.

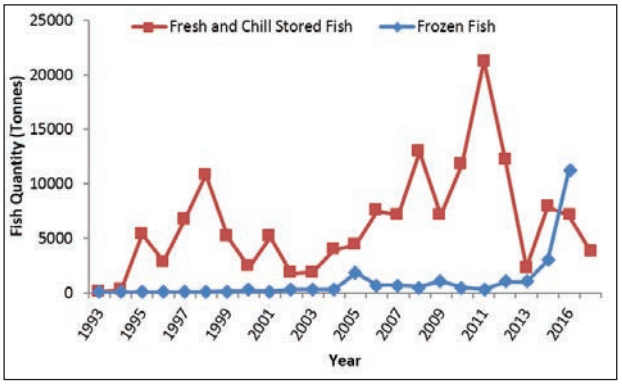

Fig. 1. Trend of imported fish quantity

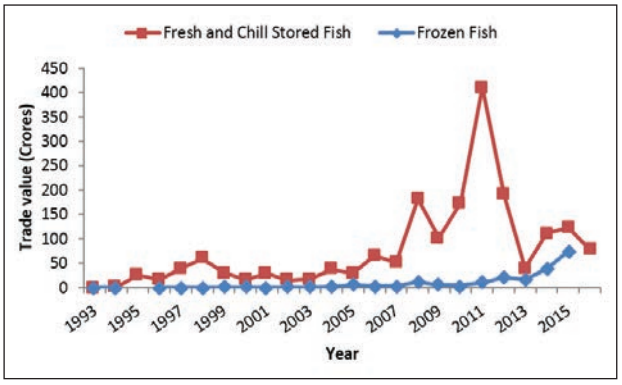

Fig. 2. Trend of trade value of imported fish

Time series analysis of available fish import data on fresh and chill stored fish and frozen fish was carried out to see the possible trend and forecasting of fish import. Linear trend model with auto regressive moving average model (ARMA-1,1) was fitted to the time series data (Montgomery *et al.*, 2008) on fresh and chill stored fish. The root mean square error

Table 1. Future predicted values of fish import

Year	Fresh and chill stored fish		Frozen fish	
	Lower 95% Confidence limit	Upper 95% Confidence limit	Lower 95% Confidence limit	Upper 95% Confidence limit
2017	1136	16672	17381	11311
2018	1572	19420	18670	9154
2019	1465	19452	19585	9215
2020	1837	19832	20757	10131
2021	2107	20103	22194	11488
2022	2405	20401	23840	13109
2023	2695	20692	25649	14911
2024	2988	20984	27591	16850
2025	3280	21276	29647	18906

of resultant model was 3644 and the same was used to predict the future values of import of fresh and chill stored fish. Quadratic trend model with auto regressive moving average model (ARMA-1,1) was fitted to the time series data (Montgomery *et al*., 2008) on frozen fish with less root mean square error value of 1398. This fitted model was then used to predict the future values of import of frozen fish.The 95% lower and upper confidence limit for forecasted values of fish import to India is given in Table 1.

Based on the predicted values, the quantity of fresh and chill stored fish import to India will continue to produce a non-decreasing trend for fresh and chill stored fish, whereas, the quantity of frozen fish import to India will continue to produce exponential trend.

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Antibiotic resistance pattern in heterotrophic bacteria isolated from finfish cultured farms

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World fisheries production recorded 167.2 million tonnes in 2014 with total capture production was estimated to be 93.4 million tonnes and aquaculture production of 73.8 million tonnes (FAO. 2016). Diseases are proven to be one of the major constraints reported in the cultured fishes impeding both economic and social development in many developing countries. Initially, antibiotics are being administered in aquaculture as growth-promoting agents as well as therapeutic agents against bacterial infections. Indiscriminate use of antibiotics in aquaculture have been criticized widely for their negative impacts like accumulation of drugs in the fish as residues, development of antibiotic resistance in bacteria present in aquatic environment etc. (Anderson, 1992). Therefore, the present study was carried out to determine the extent of antibiotic resistance in heterotrophic bacteria isolated from four finfish farms fed with commercial feed. Water and sediment collected from ponds were serially diluted, spread on to Trypticase soy agar (TSA) and incubated at 30 °C for 24-48 h. A total of 56 species of bacteria were purified and characterized as described in 'Laboratory manual on microbiological examination of seafood' (Surendran *et al*., 2013). Bacterial genera identified were *Micrococcus* spp. (21.42%), *Bacillus* spp. (17.85%), *Acinetobacter* spp. (12.5%), *Pseudomonas* spp. (12.5%), *Planococcus* spp. (10.71%), Enterobacteriacae (8.92%), *Arthrobacter* spp. (7.142%), *Vibrio* spp. (5.35%) and *Staphylococcus* spp. (3.57%). The antibiotic selection was made based on Gram reaction. A total 14 antibiotics were employed in this study (Table 1). Antibiotic resistance profile of these

Table 1. Antibiotics used against for gram positive and negative bacteria

Sl. No.	Groups	Antibiotics
1.	Pencillin group (Beta lactam)	Penicillin G, Ampicillin
2.	Cephalosporins	Cefotaxime, Cefoxitin, Cefpodoxime
3.	Aminoglycoside	Gentamicin, Kanamycin
4.	Macrolides	Erythromycin
5.	Tetracyclines	Tetracycline
6.	Fluroquinolones	Nalidixic acid, Ciprofloxacin
7.	Phenolics	Chloramphenicol
8.	Nitrofurans	Nitrofurantoin
9.	Folate pathway inhibitors	Sulfamethoxazole-trimethoprim (Co-trimoxazole)

isolates were tested simultaneously using the standard agar disc diffusion method (CLSI, 2012) using Mueller-Hinton agar. All these isolates were grown overnight in Tryptic soya broth at 30 °C and adjusted to 0.5 McFarland Standard. Antibiotic resistance profile of these bacterial isolates is shown in Figure 1. The plates were incubated at 30 °C for 18-24 h. The diameters of inhibition zones were measured in millimetre, and interpreted in accordance to CLSI recommendations The bacterial isolates showed highest resistance towards ampicillin (82.1%,), followed by penicillin (55.3%) and nalidixic acid (23.21%). All the isolates were sensitive to gentamicin (100 %) followed by sulphamethaxazole-trimethoprim (98.3%) and ciprofloxacin (98.22%). Multidrug resistance (MDR) of bacterial isolates was observed is 14.2%. The present study gave showed strong testimony supporting the prevalence of antibiotic resistance in aquafarms. The abuse of antibiotics is well known and strict enforcement should be regulated and government agencies and other leading organizations should conduct awareness programmes for aquaculturists on the antimicrobial stewardship and innovation therein. Stringent regulations are essential for the usage of antibiotics and continuous monitoring of antibiotic resistance should be mandatory for sustainable aquaculture production.

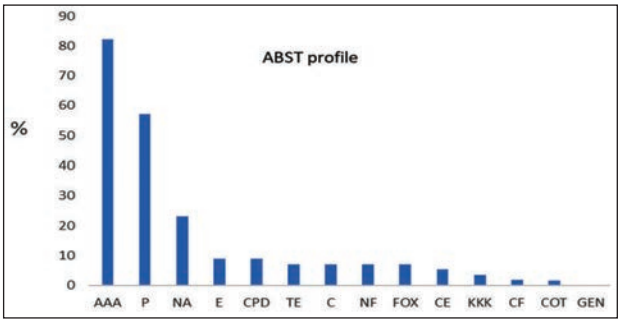

Fig. 1. Antibiotic resistance pattern of heterotrophic bacteria

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Detection of *Shigella* spp. from seafood: Need for protocol harmonization

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***S**higella*, is an enteric pathogen responsible for causing Shigellosis characterized by watery diarrheal like symptoms accompanied by presence of blood in the stool, fever and abdominal pain. Mortality is also seen in case of children with age less than five years (WHO, 2005). The severity of infection is observed more in case of developing countries where frequent outbreaks are occurring due to contamination of food and water. The presence of this bacterium in very low numbers is sufficient to cause an infection in human beings. In the recent years, there is significant increase in consumption of seafood, apart from increased inter-continental mobility which enhanced the chances of spreading this pathogen. There are limited studies available on the presence of *Shigella* in seafood. Hence, a study was conducted to screen seafood from the local markets in and around Cochin, Kerala for *Shigella* spp. A total of 183 seafood samples comprising of fish, shellfish, molluscs, dried fishery products and ice were collected aseptically and brought to the laboratory for analysis. The protocol as described in FDA BAM (2001) was followed for the isolation of *Shigella* spp. Enrichment of samples was carried out in an aerobic jar with gas generating sachet at 44 °C for 24 h in incubator. After enrichment, loop full of broth was streaked on MacConkey agar plates and incubated at 35 °C for 20 h. In addition, Xylose Lysine Desoxycholate and Hektoen Enteric agars were also used to improve the chances of *Shigella* isolation. Presumptive colonies were selected based on colour and size from the respective agar plates and biochemical tests were performed for 1093 isolates. Further confirmation of these isolates were carried out by API 20E and PCR-based method targeting invasion plasmid antigen (*ipaH*) gene specific to *Shigella* spp. None of these isolates were found positive for *Shigella*. Details of the samples used for isolation, identification and confirmation of isolates by PCR are given in Table 1 and Figure 1.

In order to rule out the inhibitory effect of surrounding microflora present in seafood on the growth of *Shigella*, an inoculation study was performed with reference strain of *Shigella*

Table 1. Samples studied for isolation, identification and confirmation of *Shigella* from seafood

Sl. No.	Sample	Number	Presumptive isolates	Suspected isolates	Confirmed isolates by PCR
1	Fish	95	512	45	0
2	Dry fish	18	61	4	0
3	Shellfish	52	276	21	0
4	Ice	18	244	15	0
	Total	**183**	**1093**	**85**	**0**

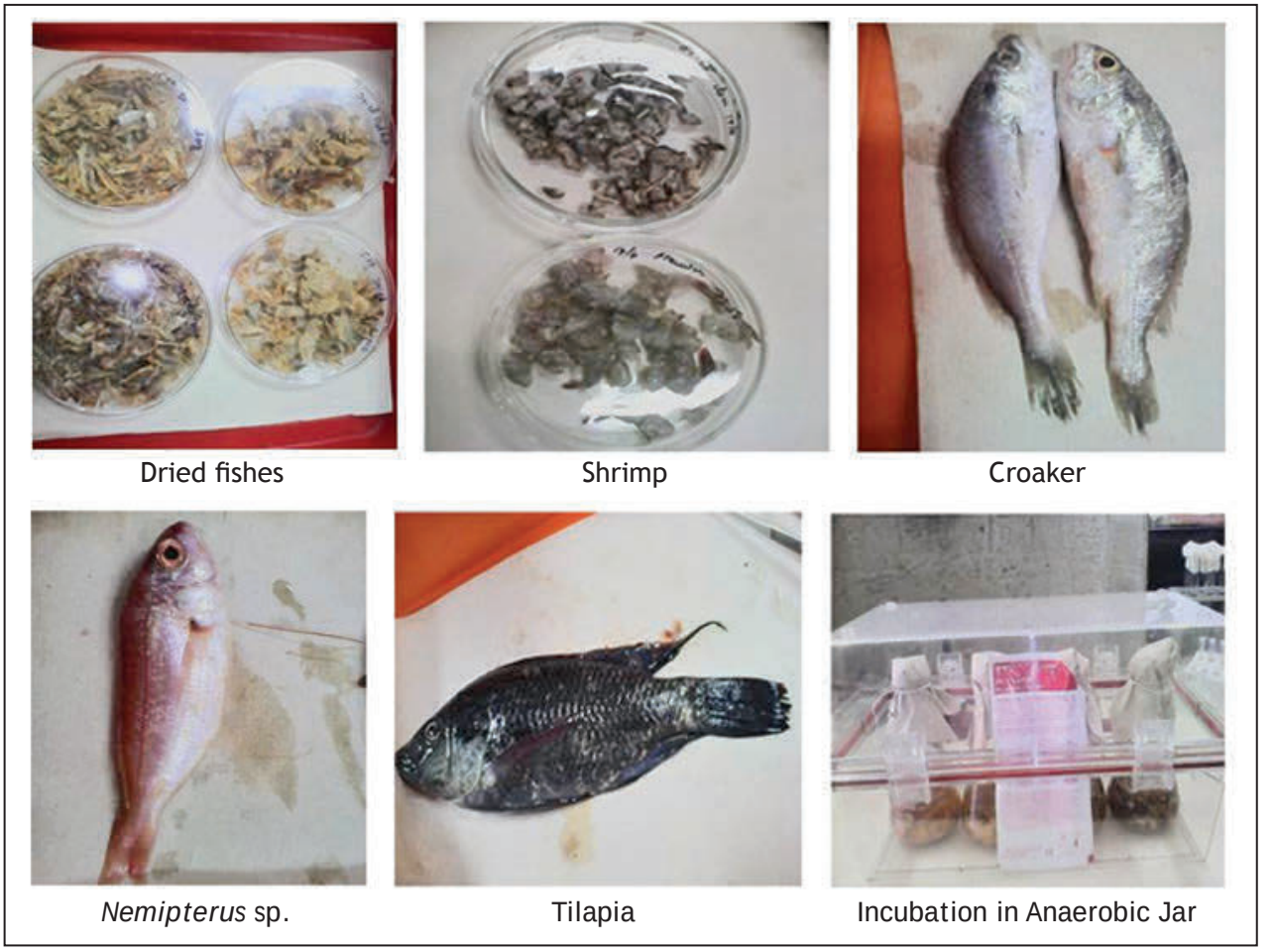

Fig. 1. Samples used for screening of *Shigella* spp. from seafood and incubation in anaerobic conditions using sachet

flexneri separately for raw and sterile fish in triplicate. Fish was sterilized before inculcation. Serial dilutions were performed for isolation, identification and characterization. *S. flexneri* was recovered from 10^2, 10^3 and 10^4 $cfug^{-1}$ from fish only which was sterile using conventional methods of recovery. Contrary, molecular methods was found significant to detect the presence of *S. flexneri* as seen in case of spiked raw fish broth by PCR, although individual colonies were not found on agar methods by conventional isolation method.

The possible reason for not detecting *Shigella* by conventional detection methods is that low numbers of *Shigella* strains are present in samples and the competing ability to grow in presence of other microflora which showed inhibitory effect on the growth and multiplication. It is also understood that *Shigella* is easily overgrown by other members of Enterobacteriaceae such as *E. coli*, *Proteus* spp., *Pleisomonas*, *Citobacter* and *Kliebsiella.* These bacteria also shows similar morphological features with *Shigella* spp. on agar plates and also makes it difficult while picking individual colonies. Therefore, for isolation of *Shigella* from seafood, there is a need of optimized protocol in view of the effect of surrounding microflora on growth of *Shigella.*

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Electron Beam Irradiation: A novel approach for shelf stable vacuum packed and chill stored vannamei shrimp

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Microorganisms are key factors for seafood spoilage, particularly a few members of microbial community being responsible for major spoilage processes; referred to as Specific Spoilage Organisms (SSOs). Control of these SSOs would facilitate shelf life extension of the seafood products. Hydrogen sulphide (H_2S) forming bacteria like *Shewanella* sp., *Brochothrix thermosphacta, Pseudomonas* sp. and *Lactobacillus* sp. are among the main SSOs in seafoods. Various researches are being carried out to control these SSOs in fish/shrimp and fishery products. Electron Beam Irradiation (EBI) is a non-thermal processing technique, which is gaining much attention recently by food processors because of its antibacterial activity. Electron Beam (EB) is the flow of electrons with energy, and the energy is obtained as kinetic energy when the electron moves in a high electric field. Even though EBI is an ionizing radiation technique, it is different from the gamma irradiation wherein the latter employs emission of gamma rays from radioactive isotopes such as Cobalt-60 and Caesium-137 for irradiation; which are hazardous to handle and the processing technique is time consuming. The benefit of EB lies in its simplicity and since it is machine source, no hassles of source replenishment and disposal problems arise as well as also require less radiological safety precautions. But, on the other hand it has the disadvantage of poor penetration i.e., 5 MeV machine will penetrate upto 2.5 cms in unit density material and in addition it consumes high electric power and needs proper maintenance. The dose of EBI is measured in KiloGray (kGy). The fast dose delivery by EB machines make it economical to operate at higher throughputs. On account of its potential bactericidal effect, there are sufficient reports available on the reduction of pathogenic and spoilage bacteria in chicken and other meat products. However very scanty literature is available on its application in seafoods.

In the present study, an attempt was made to extend the shelf life of the shrimp by controlling the SSOs by EBI technique. For this, 16/20 grade headless shell-on vannamei shrimp (*Litopenaeus vannamei*) was used. The Electron Beam treatment was carried out using 5Mev, 15 kV machine available with Electron Beam Processing Section of IRAD, BARC at BRIT-BARC Complex, Vashi (Fig. 1). The shrimp samples (3 cms thickness) were given treatment at melting ice temperature with 2.5, 5.0, 7.5 and 10 kGy of EBI. After the treatment, all the sample lots were chill stored at 4 ^{o}C. One lot was untreated and kept as control for comparison.

Analysis of the effect of EBI on SSOs indicated that the *Pseudomonas* count for 2.5 kGy treated

Fig. 1. Electron Beam Processing Section of IRAD, BARC

samples had around 1 log reduction than control. Other EBI treated samples *viz.,* 5.0 kGy, 7.5 kGy and 10 kGy exhibited about 2 log lesser count compared to control. *B. thermosphacta* count was around 4 log for control, while it was 3 log for EBI treated ones. H_2S forming bacteria also indicated 1 log reduction when treated with doses *viz.*, 2.5, 5.0 and 7.5 kGy compared to control; while treatment with 10 kGy resulted in 2 log reduction compared to control lots. In untreated samples (control), *Lactobacillus* count was 2 log on First day of storage. In case of treated samples, it reached 2 log count on 8, 15, 15 and 23 days of storage in 2.5, 5.0, 7.5 and 10 kGy treated ones, respectively. In the present study, based on the psychrophilic count, control samples were rejected on 5th day (Fig. 2). However 2.5 and 5.0 kGy irradiated sample were rejected on 15th day, whereas 7.5 kGy and 10 kGy treated samples had enhanced shelf stability with respect to microbial spoilage and were rejected on 19th day of chill storage.

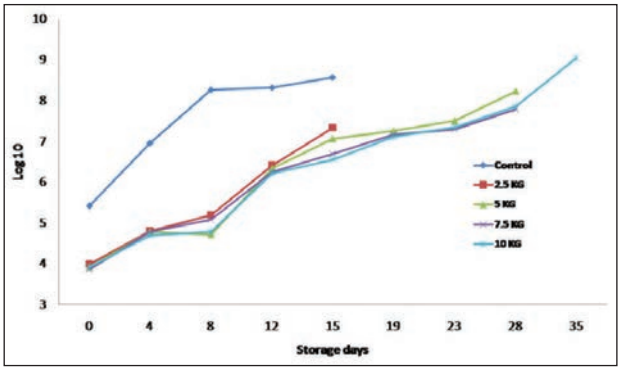

Fig. 2. Effect of EBI on SSOs

Back Pack Model of CIFT-Fish Bag

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Insulated fish bag was earlier developed by ICAR-CIFT as a convenient means for transportation of iced-fish for short distance. Recently, a back pack model of the CIFT-fish bag (Fig. 1) was designed to aid the retail fish vendors for easy carrying and transportation of chilled fish products (fish fillet, peeled shrimp etc.) and iced-fish (whole/ dressed). The back pack model of fish bag is made up of three layers *viz*., an outer water proof covering, a middle insulation layer and an inner plastic lining. Outer covering is made up of cotton coated rexin that minimizes the seepage of melt ice water. The middle layer is made up of thick expanded polyethylene foam which helps in slowing the melting of ice. The foam layer is basically a multi-layered unit composed of two foam sheets with a plastic coated iron mesh in the middle. The mesh provides rigidity to the fish bag and prevents sagging of the bag. The inner polythene layer prevents the contact of fish with the thermo foam thereby maintaining the quality of fish and makes the bag easy to wash. A plastic plate is provided at the base for bearing the

Fig 1. Back pack model of CIFT fish bag

weight of the contents placed in the bag.

Dimensions of the back pack model fish bag

The back pack model is basically a cylindrical bag with straps for carrying the bag on the back while walking or riding on a motorcycle. The back model of fish bag has a height of 20" (50.8 cm) and a diameter of 17" (43 cm). A rigid plastic plate (18 mm thickness) is provided at the base of the fish bag for bearing the weight of the material placed in the bag. The straps for the back pack bag are made of 2" thick foam. The empty weight of the back pack model fish bag is 1.18 Kg. The volume of the bag is 50 litres and can easily hold 10 kg of iced-fish and fishery products.

Field trails

The back pack model of fish bag developed by ICAR-CIFT was given to a fish retailer (Tirumala Aqua Food Products, Visakhapatnam) for field trials. Earlier the fish retailer was carrying fishery products in thermocol boxes on a motorcycle, from processing site to different vending locations within Visakhapatnam city. The retailer was finding it difficult to carry the thermocol boxes on motor cycle and opening and closing of the thermocol box at each vending location was time consuming and leading to loss of cooling. The retailer used the back pack model daily for a period of one month for transporting chilled fishery products and the response indicated that

Fig 2. Field trial of back pack model of CIFT fish bag

the back pack model of fish bag is convenient, maintained fish in chilled condition for 6 hours with no flies, no off-odour and dust contamination (Fig. 2).

The trails indicate that the back pack model of CIFT-fish bag can replace the conventional fish carrying aids used in retail transport and help in maintaining superior quality products.

Silver pompano: An emerging farmed species for processing industry

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Silver pompano (*Trachinotus blochii*) is an emerging aquaculture species in India. Due to its gaining popularity among the farmers and customers, there is a need to study the shelf life of this fish in most commonly used method of storage i.e ice storage. Icing is an ordinary preservation method that is commonly used to control the quality of fish during storage. With the evolution of successful breeding and seed production technology of silver pompano, farmers now are being engaged in culturing this species in cages. It has excellent meat quality and fetches high prices in the market. To our knowledge no reports have been found on the shelf life study of farmed silver pompano during ice storage. Freshly caught pompano (Figure 1) were procured from ADAK Farm and brought to the laboratory in ice for studying its shell life during ice storage. Biochemical, physical and microbial quality parameters were studied during the period.

Proximate composition of the pompano showed 71.52% moisture, 12.50% protein, 3.75% ash and 12.28% fat. The pH of the fish muscle ranged from 6.21 to 6.91 during the storage period. Biochemical parameters such as PV, TBA and TVN, were under the acceptable limits throughout the storage periods. However *K*-value exceeded permitted limit of 50% at 12th day of storage. Microbiologically, sample was rejected on 25th day of storage. However, sensorily the fish was not rejected till 27 days of storage.

In processing front, this species is an ideal one for filleting as it is devoid of intramuscular bones (called pins) and spines, except the larger bones running along the vertebrae. Also it has thick, smooth and shining skin, making the removal of skin easy for the processor (Fig. 2).

Fig. 1. Silver pompano used for the study

Fig. 2. Processing of Silver pompano

Table 1. Composition of silver pompano

Component	Weight (%)
Fillet	41.00
Head	20.04
Viscera	20.45
Frame	12.98
Skin	7.06
Fins	1.62
Off cut from fillet	2.11

The fillet constitutes up to 41% of its weight and is a good indication of yield. The average processing yield of different components of silver pompano is represented in Table 1.

Owing to its similarity to high value fish, pomfret in terms of shape and meat quality, pompano is an alternate species. Hence developing processing protocols for such farmed species is the need of the hour.

Antimicrobial activity of Silver nanoparticles (AgNPs) against human significant pathogens

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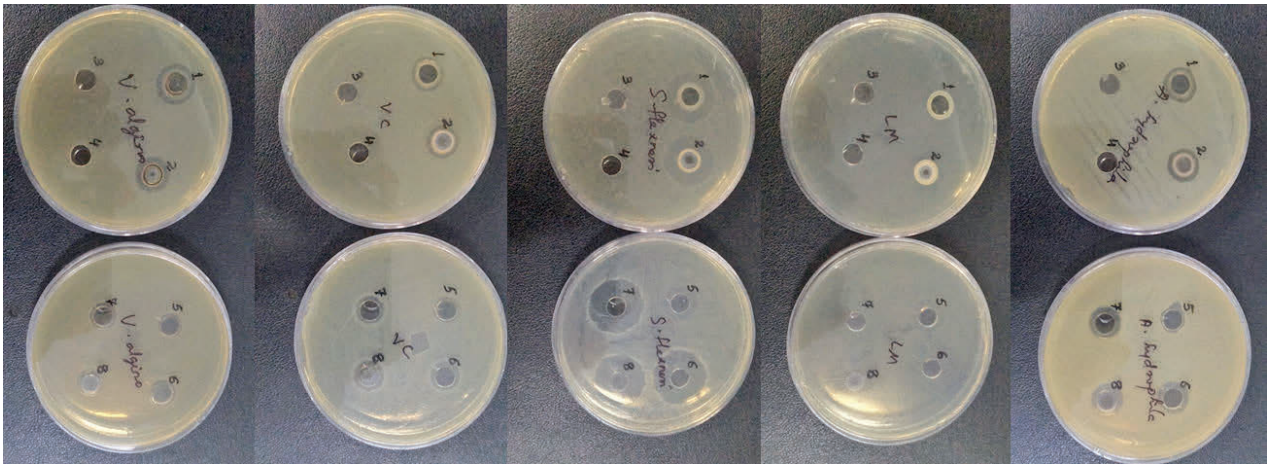
There is a quest for searching new antimicrobial agents as there are frequent reports on the multidrug resistance of many pathogens. Currently many researchers and pharmaceutical companies are examining novel antibacterial agents to save millions of lives (CDC, 2015; Rai *et al*., 2009). Nanotechnology is a rapidly growing field with its various applications for the purpose of manufacturing new materials at the nanoscale level (Albrecht *et al*., 2006). Nanoscale materials have been used as novel antimicrobial agents due to their high surface area to volume ratio and the unique chemical and physical properties (Kim *et al*., 2007). Since centuries silver has been used for the treatment of burns and chronic wounds as well as for water treatment (Richard *et al*., 2002; Castellano *et al*., 2007). It is also being used in many food varieties, cosmetics and ayurvedic preperations. Nano-silver particles present several advantages which make them as useful antimicrobial agents. They possess very high activity against a broad range of microbes and parasites, even at very low concentrations. Silver causes very little systemic toxicity toward humans, and is relatively inexpensive and available commonly (Le Ouay and Stellacci, 2015).

In the present study we have assessed the antimicrobial effect of silver nanoparticles (AgNPs) against eight different pathogens. Different reducing agents like high molecular weight chitosan, low molecular weight chitosan, trisodium citrate, ascorbic acid, ethylene glycol, combi-



Inhibition zone of pathogens with synthesized AgNP

nations of trisodium citrate and cetyl trimethyl ammonium bromide (CTAB), ascorbic acid and CTAB, ethylene glycol and CTAB were used separately for AuNP synthesis. Young cultures of *Listeria monocytogenes*, *S. flexineri*., *P. aeruginosa*, *Y. enterocolitica*, *V. parahaemolyticus, V. cholerae*, *A. hydrophila*, *V. alginolyticus* and *S. aureus* were used in the study. Antimicrobial assay was performed on Muller Hinton agar (MHA) plates and the plates were observed after overnight incubation at 35±2 °C. Most of the AgNPs prepared showed good antimicrobial properties against all the pathogens studied. Highest zone of inhibition was observed for AgNPs prepared using combination of TSC and CTAB against *L. monocytogenes*. For *P. aeruginosa* and *Y. enterocolitica*, AgNPs prepared using high molecular weight chitosan exhibited maximum antimicrobial properties whereas for *V. cholerae*, AgNP prepared using low molecular weight chitosan was found better. Among all the different reducing agents, AgNP prepared using combination of trisodium citrate and CTAB was found effective against all the pathogens studied. AgNPs prepared using trisodium citrate and ascorbic acid did not show any antimicrobial activity against all the pathogens studied. The results indicate that silver nanoparticles can be used effectively to control the growth of pathogens. As there is growing concern on the direct use of nanoparticles in food, possible applications for this may include cleaning solution for food processing machineries and utensils and for disinfection of hospital waste etc.

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