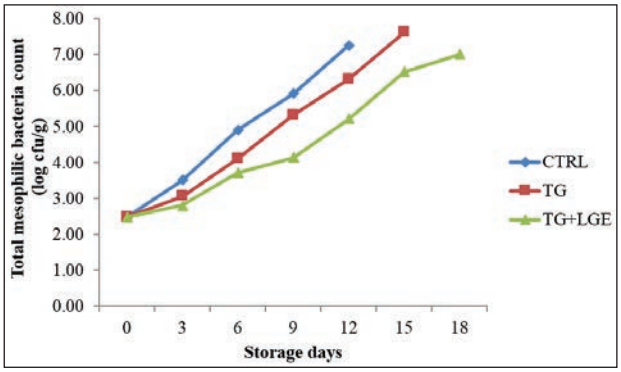

Fig. 3. Changes in the total mesophilic bacteria count of fish steaks during chilled storage

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)

References

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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.

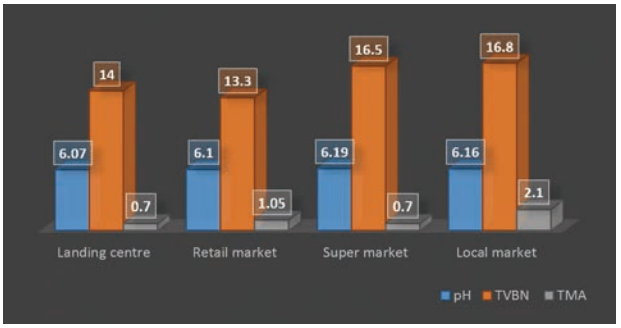

Fig. 1. Biochemical quality of mackerel from different nodal points

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