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Quality assessment of fishes caught by single-day and multi-day gillnet fishing off Satpati Coast, Maharashtra, India

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ABSTRACT

The present investigation was aimed at elucidating the importance of freshness and quality for the consumer and its relationship to sensory and non-sensory properties of fish caught by single-day and multi-day gillnet fishing off Satpati Coast, Palghar District, Maharashtra, India. Selected species of marine fishes *viz*., *Pampus argenteus*, *Ilisha filigera*, *Osteogeneiosus militaris*, *Thryssa mystax* and *Sardinella gibbosa* from single-day and multi-day gillnet fishing trips were collected and assessed based on freshness score, microbiological and biochemical parameters. The average values of sensory score, total plate count (TPC) and pH for fish samples from single-day fishing were 25 to 26; 1.9×10^4 cfu g^{-1} to 7.3×10^4 cfu g^{-1} and 6.8 respectively, whereas for multi-day fishing, it was 12 to 17; 7.1×10^4 cfu g^{-1} to 1.8×10^5 cfu g^{-1} and 7.07 respectively. Significant difference ($p<0.05$) was observed for the values of pH, trimethyl amine (TMA), total volatile base-nitrogen (TVB-N) and thiobarbituric acid reactive substances (TBARS) between the fish samples from single-day and multi-day fishing for two species *viz*. *T. mystax* and *I. filigera*. The study indicated that fishes caught from both single-day and multi-day units were acceptable for human consumption. Results of the study provides insight into the quality aspects of fish landed by commercial fishing crafts by comparing single-day and multi-day fishing.

Keywords: Biochemical evaluation, Fish quality, Freshness, Microbial load, Sensory evaluation

Introduction

Fish is an important food commodity and rich source of protein, vitamins, minerals and omega-3 fatty acids, a key nutrient for brain development (Andrew, 2001; Coletta *et al*., 2010). Consumption of fish in the form of different products has beneficial effects in the prevention of cardiovascular and many other chronic diseases (Cahu *et al*., 2004) due to its richness in high-quality protein and polyunsaturated fatty acids (Senapati *et al*., 2016; Chattopadhyay *et al*., 2019). Fish quality is a complex concept which includes various factors such as freshness, eating quality, safety, nutritional quality, availability, convenience, integrity and the obvious physical attributes of the species, size and product type. One of the most unique characteristics of fish as food is that it is a highly perishable commodity. Information about handling, processing and storage techniques, including time/ temperature histories that can affect the freshness and quality of the products is very important for the partners in the supply chain. Additionally, seasonal conditions that affect the fishing grounds and capture methods and the occurrence of various quality defects influence the overall quality (Huss, 1995). Consequently, time passed after catch (post-catch days) and the temperature 'history' of fish is very often the key factor determining the final quality characteristics of fish products. Storage time and storage conditions have also great impact on the quality of fish and fish products and the storage stability of fish depends on the composition of the fish (Ashie *et al*., 1996). Chilling of fish using ice prolongs the shelf life of all fish species which enables longer fishing trips and thus resulting in increase of catch and returns. Fish product in well preserved condition commands high price both at retail as well as wholesale levels. Smaller vessels have vey little space to accommodate ice but such vessels carry out fishing for few hours and the catch is sold or consumed on a daily basis. Larger vessels conduct fishing for more than a day and the preservation of fish using ice or chilled seawater provides benefits in terms of returns (Shawyer and Pizzali, 2003). Recently many cases were reported in which, toxic substances such as formalin, ammonia and benzoates were used to preserve the fish and to prevent spoilage (Yeasmin *et al*., 2010; Das *et al*., 2018; Nayana and Sabu, 2018). Maintenance of fish quality right from the harvest phase will definitely extend the shelf life and

such cases of using toxic substances for preservation can be avoided.

At present, global marine capture fisheries is suffering from declining catch (FAO, 2016) and in India, Maharashtra is one among the states which is facing crisis in marine capture fisheries due to declining catch (CMFRI, 2017) and increase in fishing effort (Deshmukh, 2013). Satpati is an area in Palghar District of Maharashtra where gillneting is the major fishing activity. Single-day and multi-day gillnet fishing exists in this region where there is changing trend of fishing from single-day to more of multi-day fishing over the last two decades (Devi *et al.*, 2017). Producing high quality fish catch is one of the criteria for ideal fishing gear as per Code of Conduct for Responsible Fisheries (Hanafi *et al.,* 2019). Gillnet fishing results in poor quality due to longer soaking time, which leads to death of fish in nets and even rotting. Thus, a part of catch remains unmarketable which leads to discards (Bjordal, 2002). Shelf life of fish depends on the quality of fish and fish quality in turn depends on the harvesting method, handling and storage (IFST, 1993). The freshness and quality of the fishery products are important aspects for the partners in the supply chain (Abbas *et al*., 2008). It is important to find out the changes taking place in fish in storage condition onboard the fishing vessel to inform the consumer about the condition of fish and to provide suggestions to the policy maker for improvement of the system. As such, there is no comprehensive report regarding the quality aspects of fish caught by single-day/multi-day gillnet fishing. Sensory and non-sensory methods are used for assessing fish quality. Sensory methods include examining the appearance, odour, texture and taste of fish while non-sensory methods consists of physical, biochemical and microbiological means (Huss, 1995). Considering the need for assessment of fish quality landed by commercial fishing vessels, the present study was undertaken to estimate the quality of fishes caught in single-day and multi-day gillnetters landed at Satpati, based on sensory, microbiological and biochemical parameters.

Materials and methods

Sampling site

The study was based on samples collected from single-day and multi-day gillnet fishery of Satpati, Palghar District of Maharashtra. Satpati (Fig. 1) is well-known for high catch of pomfrets and the dominance of gillnet over other types of fishing operations. The fishing and marketing in this region is well organised under the control of Fishermen Co-operative societies.

Raw materials

Fishes used for the study were collected from the Satpati Landing Centre, Mumbai, India. Samples were collected fortnightly from both single-day and multi-day boats. A total of 115 fish samples of different species *viz*., *Pampus argenteus, Ilisha filigera, Osteogeneiosus militaris, Thryssa mystax* and *Sardinella gibbosa* were evaluated for quality based on sensory and non-sensory parameters, over a period of nine months, forming a complete fishing season excluding the 3 months of fishing ban period. Fish species collected from single-day gillnet fishing were *S. gibbosa, I. filigera* and *T. mystax* and

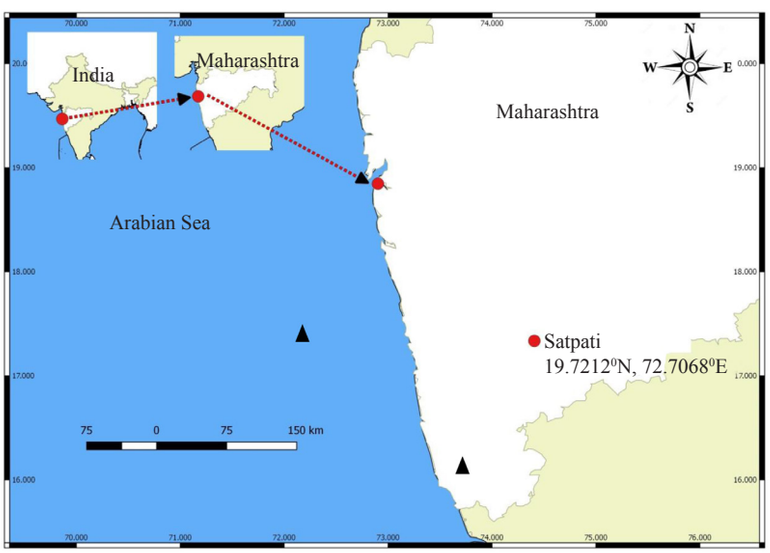

Fig. 1: Map showing sampling location (Satpati)

those from multi-day gillnet fishing were *P. argenteus*, *I. filigera, O. militaris* and *T. mystax*. The fishes sampled were packed inside polystyrene boxes in 1:1 of fish to ice ratio and brought to the laboratory within 4 h. On the same day, fish were analysed for their sensory attributes, other quality indices and microbial load.

Sensory evaluation

Sensory score of the samples were done by the method suggested by Chouksey and Basu (2002). The fishes were analysed based on total score of 35 encompassing sensory parameters such as general appearance (5), flesh (5), odour (10), texture (5) and cooked fish odour (10) by a trained panel of 10 members. Panellists were asked to score the sensory parameters using a scale based on the scores provided. In general, 0 was the score for extremely unacceptable appearance, flesh, odour, texture and cooked fish odour; 5 was the score to be given for extremely acceptable appearance, flesh and texture while 10 was given for extremely acceptable odour (both raw and cooked).

Biochemical and microbiological evaluation

Total plate count (TPC) or total viable bacterial count was done by spread plate technique following the methods of Khuntia (2011). The pH value of fish homogenate was measured by a digital pH meter (Eutech Instruments, Singapore). Determination of trimethyl amine-nitrogen (TMA-N) and total volatile base nitrogen (TVB-N) was done by the methods listed by Conway (1947). The estimation of thiobarbituric acid reactive substances (TBARS) was done following the method of Tarladgis *et al*. (1960).

Statistical analysis

The results were presented as the means±standard deviation of three independent replications. All statistical analyses were performed using Statistical Package for Social Sciences (SPSS, version 16.0 for windows). The results obtained from *T. mystax* and *I. filigera* caught by single-day and multi-day gillnet fishing were subjected to t-test to establish significant differences ($p<0.05$) if any between the measured parameters.

Results and discussion

Satpati is one of the marine fishing zone in Palghar District with gillnets being the major fishing gear operated. The major species landed by gillnetters comprised of elasmobranchs, catfishes, pomfrets, *Otolithes* spp., other sciaenids, mackerel, polynemids and others (Anon., 2013). Details of fish species collected from multi-day and single-day gillnet fishing are given in Table 1. The samples obtained from multi-day fishing were of day 8 post-catch and were in iced condition. The catches from single-day fishing were only 4 to 8 h post-catch and were with minimal ice.

Sensory quality

The values of sensory score of the fishes caught from single-day fishing ranged from 25 to 26 whereas the sensory values from multi-day catch ranged from 12 to 17 (Table 2). A significant difference ($p<0.05$) in values of freshness score between single-day and multi-day fish samples of both the species *viz*., *T. mystax* and *I. filigera* was observed. The fishes caught by single-day fishing were landed a few hours after it was caught and were not subjected to storage and minimally handled resulting in fresh quality. The fishes caught by multi-day fishing were subjected to storage of eight days during the fishing trip and also subjected to more handling than fishes caught by single-day gillnetters. On account of this, the mean values

Table 2. Freshness score of fishes collected from single-day and multi-day gillnet fishing

Species	Single-day	Multi-day
Thryssa mystax (n=12)	26 (24-28)	12 (10-15)
Ilisha filigera (n=30)	25 (24-26)	15 (14-16)
Sardinella gibbosa (n=30)	25 (22-28)	NA
Pampus argenteus (n=28)	NA	17 (12-20)
Osteogeneiosus militaris (n=15)	NA	12 (10-16)

Values are expressed as average of 'n' samples and values in parenthesis indicate the range. NA - Not analysed

Table 1. Length -weight range of fishes used for quality evaluation from single-day and multi-day gillnet fishing

Common name	Scientific name	Family	Length (mm)	Weight (g)
Single-day				
Goldstripe sardinella	*Sardinella gibbosa* (Bleeker, 1849)	Stromateidae	160-180	50-105
Kati/Coromandel ilisha	*Ilisha filigera* (Valenciennes, 1847)	Clupeidae	170-230	70-120
Moustached thryssa	*Thryssa mystax* (Schneider,1801)	Engraulidae	150-170	40-100
Multi-day				
Silver pomfret	*Pampus argenteus* (Euphrasen, 1788)	Stromateidae	150-250	350-500
Kati/Coromandel ilisha	*Ilisha filigera* (Valenciennes, 1847)	Clupeidae	250-300	150-300
Soldier catfish	*Osteogeneiosus militaris* (Linnaeus, 1758)	Aridae	250-310	150-350
Moustached thryssa	*Thryssa mystax* (Schneider,1801)	Engraulidae	180-240	80-120

of freshness score for single-day fishing were higher than that of multi-day fishing. Fishes caught in single-day fishing were in fresh condition in terms of general appearance of the eye, gill and with intact scales. Fishes caught from multi-day gillnetting had lower freshness score with some of the fishes having scale-less areas and bruises on the body. Amos *et al*. (2007) studied the effect of fish age (post-catch days) and mechanical load on the sensory, microbiological and chemical quality of cod (*Gadus morhua*) at Uganda and reported that sensory qualities reduced with increase in number of days of storage after catch.

Total plate count (TPC)

The microbial load in terms of TPC is given in Table 3. In the present study, the average values of TPC ranged from 7.1×10^4 cfu g^{-1} to 1.8×10^5 cfu g^{-1} for multi-day fishing while in single-day fishing the range was from 1.9×10^4 cfu g^{-1} to 7.3×10^4 cfu g^{-1} and both were within permissible limit for consumption according to International Commission on Microbiological Specifications for Foods (ICMSF, 1986). As per ICMSF, the total bacterial load in fresh and frozen fish should not exceed 10^5-10^7 cfu g^{-1} respectively. This study revealed that the fish landed by single-day fishing were fresher than the fish landed by multiday fishing in terms of TPC. The present study also revealed a significant difference ($p<0.05$) in values of TPC between single-day and multi-day fish samples of both the species *i.e*., *T. mystax* and *I. filigera.* Microbial counts of cod (*G. morhua*) caught by gillnetting, long-lining and hook and line at Uganda were shown to be higher on 11th day of post-catch day than 7th day and microbial counts on 7th day were more than 1st day indicating a progressive increase in microbial load with storage days (Amos *et al*., 2007).

Biochemical indices

The results of biochemical parameters of fishes caught by single-day and multi-day gillnet fishing are given in Table 4. Significant difference ($p<0.05$) in values of pH was observed between single-day and multi-day fish samples of *T. mystax* and *I. filigera.* The pH values ranged from 6.8±0.04 to 6.9±0.12 for single-day while for multi-day, it was 7.01±0.12 to 7.07±0.13. The higher value of pH for fish caught in multi-day fishing is due to longer duration of fish storage in the fish hold after harvesting and it was lower in the fishes caught in single-day catch due to comparatively shorter storage period. The results of the present study is in support of the findings that longer the storage duration, higher the value of pH and *vice versa* during storage of fish meat in ice (Kayim and Can, 2010).

The values of TVB-N of fishes obtained from single-day fishing in the present study were found to be in the range obtained for freshly caught fish (5 and 20 mg%) as reported by Kyrana *et al*. (1997) and Boran and Kose (2007). The rejection levels of TVB-N and TMA-N are 35 mg and 15 mg%, respectively (Regenstrin and Regenstein, 1991) and the values found in the present study did not exceed the rejection level. TVB-N of *S. gibbosa* caught from single-day gillnetting was found to lie in the range of 10.92 to 14.13 mg N 100 g^{-1} which was comparatively lower than the one reported by Jinadasa (2014) indicating good quality. Significant difference ($p<0.05$) in values of TMA-N was observed between single-day and multi-day fish samples of *T. mystax* and *I. filigera*.

Table 3. Total plate count (log cfu g^{-1}) of fish collected from single-day and multi-day gillnet fishing

Species name	Single-day	Multi-day
Thryssa mystax (n=12)	7.3×10^4 (6.7×10^4-7.9×10^4)	9.8×10^4 (6.9×10^4-1.5×10^5)
Ilisha filigera (n=30)	1.9×10^4 (1.1×10^4 – 2.7×10^4)	1.8×10^5 (1.6×10^5-1.9×10^5)
Sardinella gibbosa (n=30)	4.6×10^4 (3.7×10^4-5.2×10^4)	NA
Pampus argenteus (n=28)	NA	7.1×10^4 (3.5×10^4-8.9×10^4)
Osteogeneiosus militaris (n=15)	NA	1.1×10^5 (8.7×10^4-1.3×10^5)

Values are expressed as average of 'n' samples and values inside parenthesis indicate the range

Table 4. Biochemical parameters of fishes caught by single-day and multi-day gillnet fishing

Biochemical parameters / Species	pH		TMA (mg N 100 g^{-1})		TVBN (mg N 100 g^{-1})		TBARS (mg MDA kg^{-1} fat)	
	Single-day	Multi-day	Single-day	Multi-day	Single-day	Multi-day	Single-day	Multi-day
Thryssa mystax (n=12)	6.8±0.04	7.07±0.13	4.82±0.90	10.64±2.32	9.43±0.67	17.47±3.27	0.26±0.01	0.52±0.05
Ilisha filigera (n=30)	6.8±0.06	7.01±0.12	1.56±0.30	9.99±1.89	5.13±1.19	22.46±3.26	0.23±0.02	0.56±0.19
Sardinella gibbosa (n=30)	6.9±0.12	NA	6.47±1.04	NA	11.77±0.93	NA	0.56±0.01	NA
Pampus argenteus (n=28)	NA	6.99±0.14	NA	13.40±3.21	NA	25.96±2.61	NA	0.74±0.19
Osteogeneiosus militaris (n=15)	NA	7.05±0.08	NA	10.22±3.08	NA	21.90±2.73	NA	1.03±0.26

Data are expressed as mean±SD.

There was significant difference ($p<0.05$) in values of TVB-N between single-day and multi-day samples of *T. mystax* and *I. filigera*. The quality of *T. mystax* and *I. filigera* caught by single-day gillnetters showed better results compared to multi-day gillnetters. TVB-N was found to increase with the increase in number of days after catch. Overall values of TVB-N and TMA-N were higher in fish from multi-day fishing than that of single-day fishing. The fishes caught by single-day fishing were immediately sold after landing. The time lapse between landing the catch and sale was short and this may be the reason that the quality of single-day fishing remained better. Based on the value of TVB-N, the fish from single-day gillnet fishing could be placed under "high quality" and the fishes from multi-day fishing under "good quality" as per quality classification of Ozyurt *et al*. (2009) according to which fishes are classified as of "high quality" upto TVB-N values of 25 mg 100 g^{-1}; "good quality" upto 30 mg 100 g^{-1}; "limit of acceptability" upto 35 mg 100 g^{-1} and "spoilt" above 35 mg 100 g^{-1}).

The study revealed that fishes caught by both single-day and multi-day gillnetters were in good condition biochemically and microbiologically and fit for human consumption. This indicated good fish handling practices adopted on-board the fishing vessels as the units were targeting high value fish. This may be due to the chilling of fish on-board, immediately after catch using ice which was followed by all the multi-day gillnetters at Satpati, though the fishes caught by multi-day fishing were of 8 days post-catch.

Biochemical and microbiological analysis showed that fishes caught from both single-day and multi-day gillnetting at Satpati were fit for human consumption due to the good handling practices adopted on-board the fishing vessels. The fishes caught by single-day fishing were fresher than that of multi-day fishing in terms of estimated quality parameters. The findings of present study is not in agreement with the previous reports which mention that that gillnet fishing results in poor quality of fishes. The present study can form a basis for further investigations on the impact of fishing duration on the quality of fish. More clear investigations are required keeping in mind the condition of fish hold, the fish and ice ratio in the fish hold, the duration of fishing by each vessel and the amount of load stressed on fish. The study can also be extended to other fishing methods like trawling, long-lining and purse-seining. A more detailed comparative study on the single-day and multi-day fishery with more fish species and extensive sampling will be helpful to the consumers, fishers and policy makers in suggesting better fishing practices which maintain freshness and shelf life quality of fishes for human consumption.

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