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QUALITY OF TOMATO HIND FISH (*CEPHALOPHOLIS SONNERATI)* AT DIFFERENT STAGES OF POST HARVEST PROCESSING

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ABSTRACT

Quality deterioration of Tomato hind fish Cephalopholis sonnerati during different stages of post harvest handling and processing were assessed. The biochemical, microbial and sensory quality parameters were analysed in the fish samples immediately after harvesting, before and after icing the fishes and after landing the sample. Also the microbial quality, spoilage indicators were analysed in the harvested area surface water and shore water used for post harvest washing at in different seasons. The results showed an increase in microbial and biochemical parameters during post harvest processing of the samples. It was concluded that, samples of Cephalopholis sonnerati obtained were heavily contaminated after landing with feacal pollution due to post harvest washing of the fishes using the polluted coastal water. Fish handling obviously contributed to the increased microbial load after harvesting. Awareness creation to fisher folks is required for the hygienic practices of handling and should be followed by regular hygiene inspections.

Key words: Post harvest processing, biochemical and microbial quality, sensory analysis, faecal indicator, pathogenic bacteria.

1. INTRODUCTION

Fishes are the sources of protein, vitamins, minerals, low content of carbohydrate and its role in nutrition is recognized. Fish is more perishable than other protein foods (Burgess and Shewan, 1970) and its freshness is the most important criteria for judging the quality with the pH of 7 (Rodriquez-Jerez *et al.*, 2004). These characteristics make the seafood as a suitable living and proliferation place for bacteria under unhygienic storage conditions. This may harmful for human health by causing infection and intoxication (Liston, 1980; Lundborg, 1986; Goktan, 1990). Fish meat spoil more quickly than other meats, particularly when poor handled and such spoilage is primarily bacterial in nature; about 30% of landed fish are lost through microbial activity alone (Ghaly *et al.*, 2010). Contamination of fish with microorganism reflected environment pollution, unhygienic handling and improper icing (Adeyemo, 2003). If the fish habitats and environment are contaminated by pathogenic bacteria, the consumption of these fish may risk for human health.

The microbial population on seafood produces pronounced off-odours leading to short shelf life and economic losses (Reddy *et al.*, 1994). The deteriorative changes occurring in fish results in the gradual accumulation of volatile and carbonyl compounds in the flesh due to the effect of varieties of biochemical and microbial mechanisms. Quantification of these compounds can provide a measure of the progress of deterioration (Connell, 1995). Bacterial contamination, especially if faecal, is an indicator of pathogenic presence in the environment (Sinell, 1985). Proper handling of fish between capture and delivery to the consumer is a crucial element in assuring final product quality. With a few exceptions, fish are considered free of pathogenic bacteria of public health significance when first caught. The presence of pathogenic bacteria harmful to human generally indicates poor sanitation in handling and processing and the contamination is almost always of human or animal origin.

The coastal waters are contaminated due to human activity, dumping of waste and discharge of domestic sewage into the coastal environment. A survey of indicator bacteria such as total coliform ,faecal coliform, *Escherichia coli* and faecal streptococci will throw considerable light on the sanitary condition of water and serve as guidelines for fisheries related activities (Bitton, 1994) The pathogenic bacterias (*vibrio, salmonella, Shigella*, etc.) were introduced to water bodies through human

or animal faeces contaminants (Krishnan *et al*., 2007). Presence of faecal indicator organisms in water and beach sand samples have been reported in several beaches along the Indian coasts (Raveendran *et al.,* 1978; Gore *et al.,* 1979; Vaidya *et al.,* 2001; Nallathambi *et al.,* 2002).

Consumer's greatest concern is the quality and safety of food they eat. To achieve these, it is important to popularize good hygienic practices. The post-harvest handling of catch is the most important step in the production of a high quality finished product (Balasubramaniam *et al.,* 2009). The freshness of the fish is very important and has become a major issue in the fishing industry. The quality of the product reaching the end user will greatly depend on how the fish was handled onboard, how it was processed etc. Many factors affect the quality of fish onboard and post harvest such as cleanliness of the deck, equipments, utensils, quality of water used, personal hygiene of the fish handlers, sanitary conditions of the landing centers, and infrastructure facilities at the auction halls. Monitoring the sanitation quality of water and fish is necessary for predicting potential public health hazards.

Cephalopholis sonnerati (Valenciennes, 1828) is one of the most important fish commercially harvested in southern India and it is commonly known tomato hind, locally called as 'thakkali kalava' or 'sivappu kalava'. It is a highly demanded fresh fish in the export and local market due to its good taste and high nutritional composition. Tuticorin region, southeast coast of India about 19 seafood processing plants, which export a substantial quality of frozen seafoods include *C. sonnerati*. The present study was undertaken to study the changes in quality parameters and sensory score of *Cephalopholis sonnerati* at different stages of post harvest handling at different seasons and quality analysis of seawater using post harvest handling at different seasons along Thirespuram coast of Tuticorin.

2.MATERIALS AND METHODS

2A. Sample Collection

A total of approximately, 1kg of each fresh *Cephalopholis sonnerati* with individual weights between 300-400g and total lengths between 45-55 cm were collected from Thirespuram, Tuticorin for their biochemical and microbiological quality analysis at each of the following stages of fish production: at sea immediately after capture; beginning of icing; end of icing and after landing at landing auction halls during marketing and it was named as sample 1, sample 2, sample 3 and sample 4 respectively. Sampling was conducted once in each season (Monsoon, Post monsoon and summer) of the study period (2013 - 2014). Collected samples were placed in well labeled sterile plastic bags (ziplock bags) and immediately transported to the laboratory on ice box under hygienic condition for analysis.

2B. Water samples collection

The surface and shore water samples were collected from the sea and analyzed for their microbiological quality. These samples were collected at locations where catch was made at a depth of 22m from surface of water and shore where the sample was washed before landing to the auction hall at different seasons (Monsoon, Post monsoon and summer). The samples were collected into sterile bottles (500 ml) fitted with tight screw caps. Care was taken to avoid accidental contamination of the water during collection and transportation to the laboratory for analysis.

2.C. Chemical evaluation

pH analysis was done by the method of Goulas and Kontaminas, (2005) using HANNA pH213 microprocessor pH meter. The changes in total volatile base nitrogen (TVB-N) and trimethylamine nitrogen (TMA-N) contents were determined by the Conway micro diffusion technique (Cobb *et al.,* 1973) and the values were expressed as mg/100 g of fish muscle. Each parameter were analysed in triplicate.

2D. Microbial evaluation

The total plate count (TPC) was determined for fish and water samples using plate count agar medium by spread plate method (AOAC, 1990). Total fungal count was enumerated on Potato Dextrose Agar after incubation at 25°C for 3-5 days (AOAC, 1990) and the values were expressed as cfu/g & ml. Fish and water samples were also analyzed total coliform, faecal coliform, *E. coli* and faecal streptococci and were enumerated by three tube Most Probable Number (MPN) technique (Speck, 1976).

For the detection of *Salmonella* and *Shigella spp.* were used Goja, (2013) and for *Vibrio spp.* used

by the method of FDA BAM (2004). For the detection of pathogens in water samples used serial dilution spread plate method and the values were as cfu/ml (AOAC, 1990).

2E. Sensory evaluation

The sensory evaluation was performed by 15 trained panelists. The assessment was conducted for the appearance, eye, gills, color and odor of raw samples using a 9-point hedonic scale (Mailgaad *et al.*, 1999): 1, extremely dislike; 2, dislike very much; 3, moderately dislike; 4, slightly dislike; 5, neither like nor dislike; 6, slightly like; 7, moderately like; 8, like very much; 9, like extremely.

2F. Statistical evaluation

Data collected from this study were analysed using the Excel XP 2007 computer software. First, the data were subjected to a descriptive statistical analysis where it was summarized numerically for easy understanding of the result. In doing this, descriptive statistics such as means and standard deviations were computed. Two-way analysis of variance (ANOVA) was used to test the significance difference in levels of quality indicators and sensory parameters from fish species sample 1 (at harvest), sample 2 (beginning of icing), sample 3 (end of icing) and sample 4 (after landing). Correlations between the quality and sensory parameters during different stages of post harvest handling were also done.

3. Results and discussion

Fish and marine products freshly caught are in general free of contamination with microorganisms. However, contaminations and subsequent decomposition of these products may occur when handled and treated un-hygienically. The processing and preservation of fresh fish were of utmost importance since fish is highly susceptible to deterioration immediately after harvest and to prevent economic losses (Okonta and Ekelemu, 2005). Lack of adequate fish handling, processing techniques and storage facilities contribute significantly to the low supply of fish to poor rural dwellers that form three quarters of the population in developing countries (Ayuba and Omeji, 2006). Fish harvesting, handling, processing, storage and distribution provide livelihood for millions of people as well as providing valuable foreign exchange earnings to many countries (Al-Jufaili and Opara, 2006). It had been noted that more than 20% of the processed fish were lost before reaching market. Fish processors identified the problems due to the following factors: delays in landing and processing of fish caught, inadequate processing, and poor handling prior to marketing. This report is in agreement with Regenstein and Regenstein (1991).

3A. pH

pH is a very important index to determining the quality of fresh fish (Pacheco-Aguilar *et al.*, 2000). In the present study the initial pH value of fish (Table 1) was 6.64 ± 0.1 it would be significantly increased ($P < 0.05$) end of the handling stage of sample 4 (7.58 ± 0.2) during monsoon. In post monsoon and summer the pH values had some changes which was 6.55 ± 0.2 - 7.3 ± 0.17 and 6.58 ± 0.3- 7.5 ± 0.29 respectively. Present results show four stages of post harvest handling, the sample 4 (after landing to the auction hall) had high pH. The increasing pH values could be associated with the production of basic components induced by the growth of bacteria (Simeonidou *et al*., 1997). Lower pH value is related to greater losses during further meat processing and high pH value is related to shorter shelf life but also better eating quality (Gregory *et al*., 1994). The pH changes are in agreement with the findings of Manthey *et al.*, (1988) and Ryder *et al.*, (1993). According to Bremner (2002), the pH level of live fish is 7.0 and the post mortem pH varies from 6.0 to 7.1 was found to be sensorially acceptable (Erkan and Ozden, 2008). The increase in pH levels with regard to increase in volatile bases and accumulation of ammonia due to decomposition of nitrogenous compounds by the microbial activities. The increase in pH values after initial period reflected the production of alkaline bacterial metabolites in spoiling fish and coincided with the increase in Total Volatile Basic Nitrogen (TVBN) (Kyrana *et al*., 1997). This acidic pH of the fish muscle has an ability to support the bacteria and formation of a wide variety of amine compounds resulting from the direct decarboxylation of amino acids. Most spoilage bacteria possessing decorboxylase activity in response to acidic pH presumably, so that the organism may raise the pH of the growth medium through the production of volatile basic compounds, such as ammonia through amino degradation (Galli *et al*., 1993). This leads to proteolysis and the anaerobic breakdown of protein or putrefaction, which releases foul-smelling amine compounds. In this event, the flesh becomes more alkaline through alkalinity of fish flesh may inhabit

bacterial growth and their subsequent deteriorative effect on the product alter the normal texture of the fish flesh making it unreasonably and unacceptably firm and tough (Gould and Peters, 1971). The deep sea surface water and coastal surface water pH level was 7.9 ± 0.07- 8.0 ± 0.09 respectively and it was significantly ($P < 0.05$) increased post monsoon and summer 8.2 ± 0.09 - 8.1 ± 0.09 and 8.4 ± 0.05 - 8.4 ± 0.06 respectively.

3B. TMA- N and TVB – N

Trimethylamine (TMA-N) and Total volatile basic nitrogen (TVB-N) content are the most chemical parameters used for determination of fish quality. The levels of these volatile compounds increased with the onset of spoilage. This chemical compound is the primary cause for the fishy odors, which increased as spoilage proceeds and show good correlation with sensory analysis (Ruiz-Capillas and Horner, 1999; Özoğul and Özoğul, 2000). TMA is the best known compound produced during fish spoilage and it is mainly derived from bacterial breakdown of trimethylamine oxide (TMAO) which is an osmolyte naturally found in marine fish (Pedraso-Menabrito and Regenstein, 1990). Normally, fresh fishes are having 0.2–2.0 mg/ 100g TMA-N (Govindan, 1985). TMA does not increase much during the early stages of spoilage. Trimethylamine oxidase produce by spoilage organisms reduces trimethylamine oxide of fish flesh to trimethylamine that is believed to react with fish fats to produce the typical spoilage odor that are associated with fish beyond their prime (Sikorski, *et al*., 1990; Triqui and Bouchriti, 2003). Total volatile bases are mostly formed by bacterial or tissue autolysis leading to deteriorative odors (Connell, 1980).

TVB-N measures the total content of TMA, DMA, ammonia and other basic nitrogenous compounds. Trimethylamine is produced by spoilage bacteria, dimethylamine by autolytic enzymes and ammonia by deamination of amino acids and nucleotides and other volatile base compounds. The present study quality parameters such as TMA-N and TVB-N values vary in fishes in different seasons and the results are presented in Table 1. The value of TMA-N in sample 1 was 0.81± 0.09 and it was increased more rapidly to 14.47 ± 0.11 and for the TVB – N ranges 0.99 ± 0.1 - 29.69 ± 0.08 at the sample 4 in monsoon. During summer the range of TMA-N was 0.07 ± 0.28 - 14.31 ± 0.2 and TVB – N was 0.69 ± 0.09 - 28.52 ± 0.1 while significant increases ($P < 0.05$) were occur at each of remaining samples. From the post monsoon and summer the TMA-N and TVB – N values slightly decreased in season vise but the handling stages the sample 4 values noticed as nearly exceeding the acceptable limit proposed for marine species (Connell, 1975) in monsoon. It may be due to high microbial contamination of handling process in auction hall. The low value of TVB-N initially is an indication of quality of fresh fish, whereas increases may be due to the action of autolytic enzymes and spoilage bacteria (Benjakul *et al*., 2003). Increase of TVB-N value during the storage time was reported by Jeyasekaran and Saralaya (1991) and Karungi *et al*., (2004). TVB-N level in fish has also been used to indicate the growth of microorganisms leading to spoilage (Lakshmanan, 2002). Horse and Sekine (1956) found a sudden increase in TMA-N to be concurrent with onset of bacterial putrefaction. In our result TMA-N increased with the increase of spoilage bacterial count. These results agreed with the results of (Huss 1988; Sinduja *et al.*, 2011; Saritha *et al.*, 2012).)

3C. Microbial analysis

For the assessment of spoilage, total plate count and total fungal count is the most common method (Rahman, 1980).Comparative analysis of TPC and TFC showed great variation from sample 1 to 4. Among the samples the highest bacterial and fungal count was found in sample 4 which were $10.1x10^8$ and $1.4\ x10^4$ respectively at monsoon season. Even though the sample 2 and 3 also noticed high bacterial count at monsoon and during the post monsoon and summer season sample 3 also found high level of TPC this may be due to ice made with the contaminated coastal water. Similar results reported by Mandal *et al*., (2009). The quality of ice is of utmost importance to preserve fishery products from being spoiled. The ice should be made of fresh water or portable water to produce good quality ice (Singh *et al.*, 2012). This indicates that bacteriological quality of sample 1 was better than the other samples. Besides, TPC was almost beyond the acceptable limit in above mentioned samples. The level rise to exceed 10^7 count/g maximum microbiological limits for fresh fish recommended by the international commission of microbiological standard for foods (ICMSF, 1986). By detecting the bacterial and fungal load in the fish it apparently gives an idea about the quality of the samples. When TPC reaches to 10^5/g or more in food product, it is

considered that these food items are spoiled (Begum, 2010). The high microbial load at rejection may have been because of the environmental where the fishes were caught and polluted water used for post harvest processing. Shewan (1961) reported bacterial flora on newly caught fish depends on the environment in which it is caught rather than on the fish species. High bacterial load in fresh fish with no visible signs of spoilage is an indication of poor handling process of the fish handlers and washing the catches in polluted coastal water with the disposal of sewage that add to the microbial load of fishes (sugumar, 2002). The lowest bacterial count was found in 3.2 $x10^5$ at post monsoon and summer while the low fungal count was 0.1 $x10^3$ (Table 2 & 3) noticed during summer.

Water quality is therefore, an important factor that determines the environmental conditions of fish. It is an indicator of excellent and poor living conditions of any fish. The seasonal variation of TPC and TFC in water were represented in Table 2, 4 and 6. Among three seasons high TPC and TFC (278 $x10^4$ and 5 $x10^3$ cfu/ml) was found in the coastal water during the monsoon season. The high population recorded during monsoon season may be attributed to the increasing quantity of flood by monsoon rains. The same trend has been recorded in Gulf of Mannar water and sediment by Kanapiran *et al.,* (2008). The detritus particles enriched the waters due to land run-off largely increased the distribution of organic matter and increased the bacterial population during monsoon season (Sreepada *et al.,* 1993). Rest of coastal water samples TPC and TFC were 198 $x10^4$ - 1.5 $x10^3$ cfu/ml, 187 $x10^4$ - 1.3 $x10^3$ at post monsoon and summer respectively. This indicates the coastal water heavily contaminated with heterotrophic bacteria. Thirespuram coastal water and sediment sample are highly polluted with mixing of domestic sewage at landing site already reported by Sugumar (2002) and in the present study also agreed with the above statement. The deep sea surface water TPC and TFC was less than the shore water (Kombat, *et al*., 2013). This further confirmed the fact that, the deep sea surface water was less polluted and that the water did not have any adverse effects on the quality of fish.

Coliform bacteria are indicator organisms whose presence in food and water in large quantity indicates the probability of presence of pathogenic bacteria. Coliforms are abundant in the feces of warm-blooded animals, but can also be found in the aquatic environment, in soil and on vegetation (APHA, 2005). In the present study indicator organisms of total coliform, feacal coliform, *E.coli* and feacal streptococci were found in almost all the samples at each of the season. These indicator organisms very less and within the acceptable limit in sample one while significant increases ($P < 0.05$) were occur beyond the standard acceptable value except the total coliform at each of remaining samples at each season. Especially, the monsoon period sample 4 highly contaminated with feacal coliform bacteria followed by post monsoon and summer. The extent of faecal pollution increases during monsoon and post monsoon (Raveendran *et al.,* 1978; Gore *et al.,* 1979) is mainly due to land drainage and other environmental factors like salinity, temperature, turbidity, pH, condition the persistence of faecal pollution in water (Serrano et al., 1998). According to the IAMS, (1962) acceptable limit of total coliform was 100/g and 11/g for feacal coliform. That means the Thirespuram coastal area supply low quality of fish and unsuitable for human consumption. The presence of coliform group (*E.coli*) in higher range suggests contamination of the samples before or during handling and processing. These results coincided with the results of Begum *et al.,* (2010). FC comprised about 18% of the total coliform while presence of coliform in the order of TC > FC > *E.coli* > FS.

The coastal surface water sample highly polluted with coliform bacteria due to mixing of domestic sewage at Thirespuram area. sugumar (2002) reported Thirespuram coastal water heavily contaminated with feacal coliform and *E.coli*. In the present study during monsoon the contamination level was much high followed by the post monsoon and summer. During the time of rainy season the fecal matters of various sources are washed away from the contaminated land and are ultimately carried into different water bodies. Moreover, due to the poor sanitary condition of the country most of the latrines in rural settings are directly connected to the seawater. High numbers of faecal coliforms during monsoon and post-monsoon months have been reported in Cherai beach, Cochin backwaters, Bhavnagar coast, Port Blair bay, Andamans and Nagore, east coast of India (Goyal *et al*., 1977) which was due to land runoff Continuous dispose of untreated sewage. Present study higher density of coliform bacteria in water especially the faecal coliform, is responsible for higher density of these bacteria in fish body. Quick spoilage of fish after catching might be due to this higher density of these

bacteria. *E. coli* are human originated bacteria which may be responsible for different enteric disease in human body. The higher density of human originated bacteria in fish body may be due to secondary contamination during handling and storage large quantities of coliform bacteria in water (Doyle and Ericson, 2006). Dysentery, typhoid, bacterial gastroenteritis and other water borne disease may arise by the faecal coliform contamination (Doyle and Ericson, 2006). Fecal streptococci have greater resistance when compared with classical indicators of coliform bacteria. This has led to an increasing tendency to include fecal streptococci in microbiological criteria as an indicator of direct fecal contamination in plant sanitation, in waters and various food products; including seafood (EI – Zanfaly and Shaban, 1991; Shapton and Shapton, 1991). In the present study coliform and faecal streptococci presence in the fresh fish samples obtained at harvest was an indication that they were present in the fish's environment and that there is a probability that there may be pathogenic bacteria in the fish or its environment or both this finding supported with the results of Kombat (2013) at *E. encrasicolus* and *S. aurita* from Tema and Accra.

Presence of pathogenic bacteria such as *Salmonella*, *Shegella* spp. and *Viprio* spp. were high in sample 4 at monsoon season and their population significantly decreases in post monsoon and summer while *Salmonella* and *Shigella* spp. were not present in sample 1, 2 & 3. *Salmonella* have been found in fish from fish-holds washed with polluted water and also isolated from coastal waters worldwide including Indian coastal environments (Vaidya *et al.*, 2001; Aulicini *et al.*, 2001; Iyer, 1989). In the present study high level of pathogenic bacteria was found in coastal surface water in all the season. The detection of *Salmonella* and *Shigella* in fresh fish samples will cause health risks to the fish consumers. The presence of *Salmonella* and *Shigella* in these fishes indicates the contaminant environment habitats of fish and poor personal hygiene of sellers and fishermen, similar results were found by Goja (2013) found Salmonella and Shigella in three fresh fishes.

3D. Sensory analysis

The mean sensory scores of 15 panelists experienced at evaluating fish from sample 1 to sample 4 at each season were presented in Fig.1-3. The entire season, sample 1 displayed good with the score of 9. Other remaining samples shows the sensory score was significantly decreased ($P < 0.05$) especially, sample 4 nearly rejected by panelist at entire season because their terrible odor. These results highly correlated with the present study chemical and microbial results. Ola et al., (2004) reported rejection of raw fish by the taste panelists was mainly characterized by strong fishy to sour odours and soft texture.

Statistical analysis showed a strong (positive) correlation between the total viable counts, coliform bacterias and the values of pH, TMA and TVN at the processing stages at entire season, implication that the formation of pH, TMA and TVN at the processing conditions is bacterial in nature thus the observation of the strong offensive odours by the taste panelists at rejection and no one shows the negative correlation.

3. E Conclusion

Based on our findings it can be concluding that, although the bacterial load, total coliform, faecal coliform, *E.coli* and total streptococci counts were come beyond the acceptable standard limit at entire season except the sample 1. During monsoon period contamination level was very high. Biochemical quality parameters pH, TMA – N and TVB – N level were near to exceeded in sample 4 (after landing at auction hall) at entire season. Presence of pathogens and coliform bacteria in fishes indicates the contaminant environment, poor post harvest processing and handling of fisherman. Thus, the following recommendations are made: fishes should be appropriate handling, cleaned, washed and cooked before consumption; fishermen should be educated on the adverse effect of lack of proper personnel, environmental hygiene, sanitation and the Public health authorities in Tuticorin, Thirespuram should inspect the landing fishes before sold to the consumers. Therefore, precaution should be taken to prevent contamination during harvesting as well as post harvest handling of fishes.

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Table 1: Changes in Quality parameters of *Cephalopholis sonnerati* at different stages of post harvest handling during monsoon

Quality parameters	Sample 1	Sample 2	Sample 3	Sample 4
pH	6.64 ± 0.1	6.89 ± 0.09	7.17 ± 0.23	7.58 ± 0.2*
TMA – N (mg N/100g)	0.81± 0.09	4.99 ± 0.09	6.12 ±0.18	14.47 ± 0.11*
TVB – N (mg N/100g)	0.99 ± 0.1	6.32 ± 0.1	7.10 ± 0.09	29.69 ± 0.08*
TPC (cfu/g)	$3.9x10^5$	$5.1x10^5$	$5.4x10^8$	$10.1x10^8$
TFC (cfu/g)	$0.3x10^3$	$0.6 x10^4$	$0.6 x10^4$	$1.4 x10^4$
Total coli form (MPN / g)	47	58	63	280
Faecal coli form (MPN / g)	14	17	20	220
E. coli (MPN / 100ml)	11	20	20	170
Faecal streptococci (MPN / g)	6.8	9.3	11	70
Salmonella sp (25g)	ABSENT	ABSENT	ABSENT	PRESENT
Shegella sp (25g)	ABSENT	ABSENT	ABSENT	PRESENT
Viprio sp (25g)	PRESENT	PRESENT	PRESENT	PRESENT

* **- P < 0.05 (Significant at 5% level)**

Sample 1- Immediately after capture, Sample 2 - Beginning of icing

Sample 3 - End of icing, Sample 4 – After landing

Fig.1: Changes in Sensory scores of *Cephalopholis sonnerati* at different stages of post harvest handling during monsoon

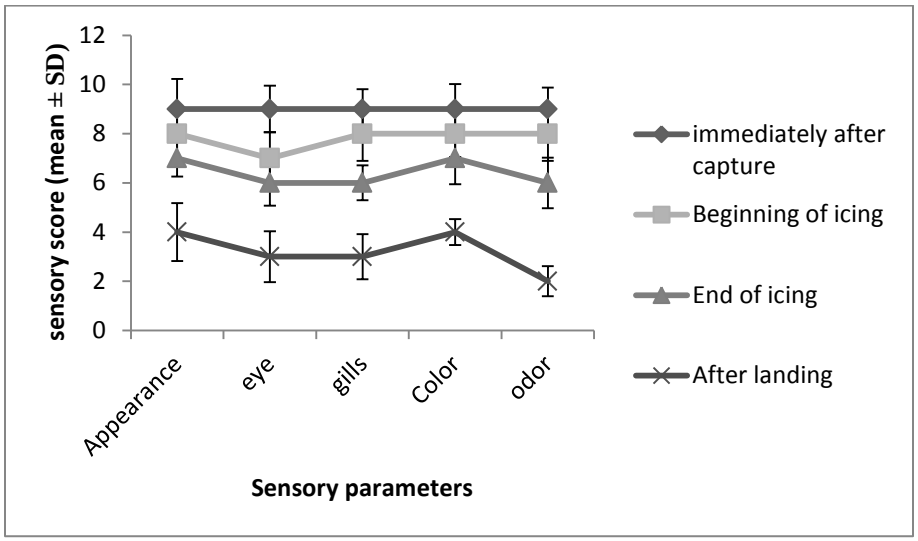

Table2. Quality analysis of seawater using post harvest handling during monsoon.

Quality parameters	Deep sea surface water	Coastal surface water
pH	7.9 ± 0.07	8.0 ± 0.09
TBC (cfu/ml)	10 $x10^4$	278 $x10^4$
TFC (cfu/ml)	2 $x10^3$	5 $x10^3$
Total coli form (MPN / 100ml)	47	430
Faecal coli form (MPN / 100ml)	32	280
E. coli (MPN / 100ml)	27	210
Faecal streptococci (MPN / 100ml)	25	210
Salmonella sp (cfu/ml)	1 $x10^2$	8 $x10^2$
Shegella sp (cfu/ml)	1 $x10^2$	7 $x10^2$
Viprio sp (cfu/ml)	6 $x10^3$	15 $x10^3$

Table 3: Changes in Quality parameters of *Cephalopholis sonnerati* at different stages of post harvest handling during post monsoon

Quality parameters	Sample 1	Sample 2	Sample 3	Sample 4
pH	6.55 ± 0.2	6.89 ± 0.2	7.08 ±0.19	7.3 ± 0.17*
TMA – N (mg N/100g)	0.48 ± 0.35	4.83 ± 0.22	5.91 ± 0.2	13.47 ± 0.18*
TVB – N (mg N/100g)	0.59 ± 0.26	6.13 ± 0.2	7.10 ± 0.19	25.69 ± 0.18*
TBC (cfu/g)	$3.2x10^5$	$4.8x10^5$	$5.2x10^8$	$8.2 x10^8$
TFC (cfu/g)	0.2 $x10^3$	0.6 $x10^3$	0.6 $x10^3$	1.2 $x10^3$
Total coli form (MPN / g)	16	16	17	170
Faecal coli form (MPN / g)	8.2	10	10	120
E. coli (MPN / 100ml)	6.8	9.1	9.3	84
Fecal streptococci (MPN / g)	4.5	6	6.8	55
Salmonella sp (25g)	ABSENT	ABSENT	ABSENT	PRESENT
Shegella sp (25g)	ABSENT	ABSENT	ABSENT	PRESENT
Viprio sp (25g)	PRESENT	PRESENT	PRESENT	PRESENT

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Fig. 2: Changes in Sensory scores of *Cephalopholis sonnerati* at different stages of post harvest handling during post monsoon.

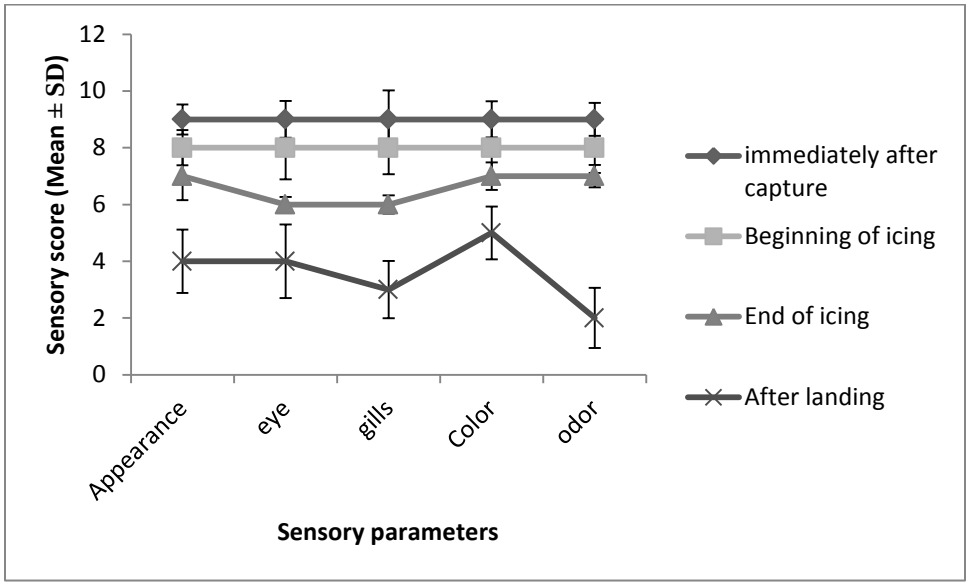

Table 4: Quality analysis of seawater using post harvest handling during post monsoon

Quality parameters	Deep sea surface water	Coastal surface water
pH	8.2 ± 0.09	8.1 ± 0.09
TBC (cfu/ml)	39 $x10^4$	198 $x10^4$
TFC (cfu/ml)	0.8 $x10^3$	1.5 $x10^3$
Total coli form (MPN / 100ml)	40	350
Faecal coli form (MPN / 100ml)	27	220
E. coli (MPN / 100ml)	24	170
Faecal streptococci (MPN / 100ml)	25	210
Salmonella sp (cfu/ml)	1 $x10^2$	4 $x10^2$
Shegella sp (cfu/ml)	2 $x10^2$	3 $x10^2$
Viprio sp (cfu/ml)	5 $x10^3$	10 $x10^3$

Table 5: Changes of Quality parameters in *Cephalopholis sonnerati* at different stages of post harvest handling during summer.

Quality parameters	Sample 1	Sample 2	Sample 3	Sample 4
pH	6.58 ± 0.3	6.75 ± 0.26	7.19. ± 0.22	7.5 ± 0.29 *
TMA – N (mg N/100g)	0.07 ± 0.28	3.49 ± 0.21	3.92 ± 0.09	14.31 ± 0.2*
TVB – N (mg N/100g)	0.69 ± 0.09	6.13 ± 0.2	7.10 ± 0.16	28.52 ± 0.1*
TBC (cfu/g)	$3.2x10^5$	$4.2 x10^5$	$5.1 x10^7$	$7.4 x10^8$
TFC (cfu/g)	$0.1 x10^3$	$0.3 x10^3$	$0.3 x10^3$	$0.7 x10^3$
Total coli form (MPN / g)	12	14	14	150
Faecal coli form (MPN / g)	6.8	8.2	9.3	94
E. coli (MPN / g)	3.7	4	6.1	63
Faecal streptococci (MPN / g)	3.6	4	4.5	47
Salmonella sp (25g)	ABSENT	ABSENT	ABSENT	PRESENT
Shegella sp (25g)	ABSENT	ABSENT	ABSENT	PRESENT
Viprio sp (25g)	PRESENT	PRESENT	PRESENT	PRESENT

Fig. 3: Changes in Sensory scores of *Cephalopholis sonnerati* at different stages of post harvest handling during summer

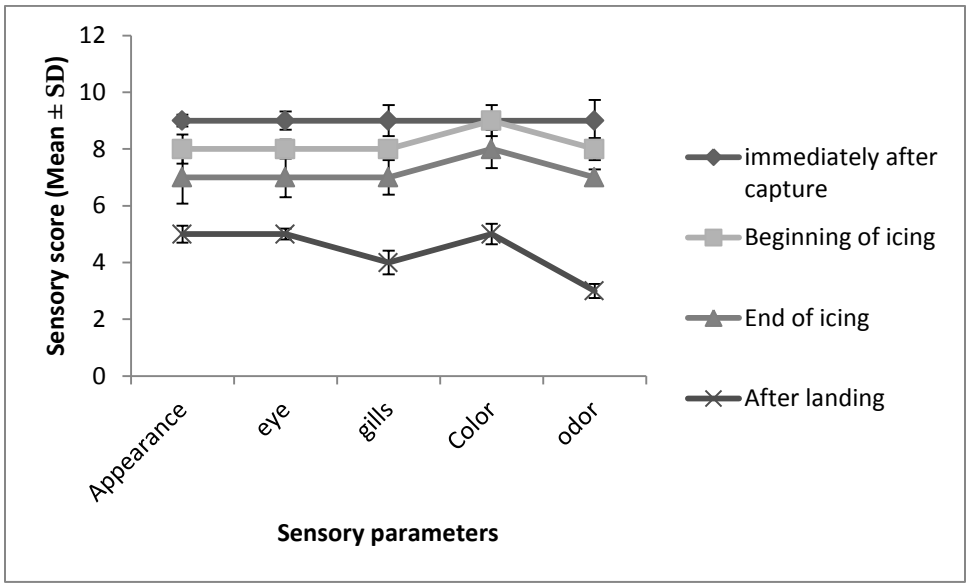

Table 6: Quality analysis of seawater using post harvest handling during summer

Quality parameters	Deep sea surface water	Coastal surface water
pH	8.4 ± 0.05	8.4 ± 0.06
TBC (cfu/ml)	35 $x10^4$	187 $x10^4$
TFC (cfu/ml)	0.7$x10^3$	1.3 $x10^3$
Total coli form (MPN / 100ml)	39	290
Faecal coli form (MPN / 100ml)	25	210
E. coli (MPN / 100ml)	23	150
Faecal streptococci (MPN / 100ml)	25	210
Salmonella sp (cfu/ml)	1 $x10^2$	4 $x10^2$
Shegella sp (cfu/ml)	2 $x10^2$	2 $x10^2$
Viprio sp (cfu/ml)	3 $x10^3$	9 $x10^3$