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Influence of Storage Temperature on Quality Index of Commercially Important Food Fish Indian Mackerel (*Rastrelliger kanagurta*) (Cuvier, 1817)

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ABSTRACT

The effects of temperature on quality of *Rastrelliger kanagurta* were investigated at various storage temperatures. The fishes were preserved at different cold temperature 4°C, -4°C and -20°C for duration of 48 hrs. The quality variations of fishes were investigated at various time periods 0 hrs, 24 hrs and 48 hrs. The quality assessment of fishes was observed by different Quality Index Method (QIM) which consisted of sensory observation, physicochemical and microbiological examinations. In the sensorial assessment after 48hrs of storage period the fishes preserved at 4°C and -4°C shows less percentage (9.2 and 10.5 %) of excellent quality. But, fishes preserved at -20 °C was observed with higher percentage (72.8 %) of excellent quality. The pH levels of fishes preserved at various temperatures were raised gradually during storage. The log value of Aerobic Plate Count (APC) for fishes stored at 4°C, -4^{O}C and -20°C were found as 6.94, 5.98 and 5.3 $\log_{10}$ CFU/gm. The quality index examined in the sensorial investigation is reflected with microbial examination.

Keywords : Quality Changes, Fish, *Rastrelliger kanagurta*, Seafood, Temperature

I. INTRODUCTION

The Indian Mackerel is one of the commercially valuable fish with wide range of distribution in the Indo–Pacific region, which is occupying the major fishery resources in most of the countries including India. In the eastern part of India, massive catches landed mostly in Tamilnadu and Pondicherry states (Noble, 1985). High level of histamine production in mackerel during storage induce health problem for customers. Growing demand for fishery products and customer attentiveness of seafood quality ensue superior quality of fishery products. But, the highly perishable characteristic of fishery products makes it difficult to maintain (Miget, 1991). The desiredness of consumer acceptance is influenced by various factors such as appearance, taste and odour (Marshall and Lehigh, 1993). Fish freshness is a significant and basic single criterion for assessing the excellence of fishery products (Rodriguez-Jerez, Hernandez-Herrero, and Roig-Sagues, 2004). The seafood products degrade rapidly due to the effects of post-mortem changes (Pigott & Tucker, 1987; Sikorski & Bonnie, 1994).

Fishes form an important food in most of the developing countries and form a major source for animal protein. Fish has a character of being rapidly perishable than other sources of food protein (Bongess and Shewan, 1970). Psychrotolerant bacteria have the capability to grow at very chilled conditions; the presence of autolysis enzymes also cause the rapid growth of undesirable odours and flavors (Dalgaard, 2000 and Silvertsvik et al. 2002).

The assessment of quality at different stages of fish processing is very much essential; generally the quality of the fishes is decided by the fish freshness (FAO, 2005). Time delayed after catch and the temperature “history” of fish is the key factor determining the quality of fishery products (Olafsdottir et al. 2004).

During the periods of huge catch, the seafood’s manufacturer is unable to process the entire lot on the

same day. Hence, it is necessary to maintain the quality by keeping it in proper storage conditions. Another important aspect is the fish marketing in India, mostly carried out by the local fish sellers in the chilled condition. Therefore understanding of spoilage patterns of tropical fishes and their shelf life assessment at different storage temperatures is extremely important.

Hence, the present investigation has been focused to assess the quality variations and shelf life observation in relation to time and storage temperature.

II. MATERIALS AND METHODS

Collection of samples

Fresh fish samples of Indian Mackerel (*Rastrelliger kanagurta*) captured in the Trawler operated in the Parangipettai coastal water (lat.11°29´N and long.79°46´E) is one among the potential fishing zone of Tamilnadu, the Southeast coast of India. Time gap between catching and arrival of fish to the landing center was 4hrs during which samples were iced. They were immediately kept in a sterilized container brought to the laboratory and were washed in clean water (30°C). Fish samples were identified by using FAO fishery species identification sheets. 85 individuals had an average weight of 185g with a total length of 22cm were taken for the analysis. After the sensory evaluation, the gut and the flesh were separated and used for the bacterial analysis as raw material. Samples have been kept in three different cold storage temperatures (4°C, -4°C and -20°C) by using refrigerator and deep freezer for further analysis.

Sensory evaluation

The freshness of the fishes were examined daily for organoleptic evaluation by five expert panelists from the laboratory, the score for fishes were given as per the European Community (EC) grading scheme (Howgate et al., 1992). Sensory evaluation was carried out in clean laboratory under good illumination of light, controlled humidity and temperature. The appearance of skin, gills, eyes, peritoneum and internal odours of each fish were examined into four different quality grades. In this EC grading scheme, excellent quality (perfect condition), high quality (slight loss of excellent characteristics), good quality (some deterioration but fit for sale) and unfit for sale were graded as E, A, B and C, respectively. The total grade of individual fish was examined from the grades attributed by each panelist and the final grade of individual fish species was estimated in each day of evaluation. Scores in each grade were expressed as a percentage of the final grades of each fish species at each date of sampling. Every sensory parameter was also scored on a scale of 1–4 (1, 2, 3 and 4 corresponded with E, A, B and C, respectively), prior to the results of sensory assessment were subjected to statistical analysis. An average grade (sensory score) for all the experimental parameters were made on each fish.

Bio Chemical Analysis

pH measurements

The evolution of pH values in Indian mackerel muscle along storage duration was determined. pH measurements were performed in pH meter Hanna Instrument, 471, Italy-made, by homogenizing a 5g. portion of the muscle in 45ml of deionized water, and the homogenate was used for pH determination. Duplicate measurements were taken and average results were obtained for each fish sample.

Bacteriological analysis

Bacteriological analysis in fish flesh were determined using aerobic plate counts (APC) enumeration of Total Coliform, *Escherichia coli*, *Vibrio cholerae*, *Vibrio paraheamolyticus* and *Salmonella typhi*. Media used in this experiment were obtained from Hi-Media laboratories, Mumbai, India. Each 25-g sample was aseptically taken by sterilized knife and homogenized with 225ml of physiological saline (0.85%) and serial dilutions of each homogenate were carried out with the same diluents for the relevant bacteriological examination. Appropriate dilutions were spread, plated onto Zobell Marine Agar for the enumeration of total bacterial load, Macconkey agar for Total coliform groups, Tergitol 7 agar for *E. coli*, Xylose Decarboxilase agar for *S. typhi* and Thiosulfate-citrate-bile salts-sucrose agar for *Vibrio* sp. Three replicates of as a minimum three appropriate dilutions were enumerated. All the plates were observed visually for typical colony characteristics and morphologically associated with each growth medium. Each pathogenic bacterium was isolated and confirmed by Gram staining and further biochemical tests (APHA (2001), EIC, (1995a and 1995b).

III. RESULTS

Sensory evaluation

Freshness grades of Indian mackerel are shown in Table 1. On 24hrs of storage, a higher percentage (94.6%) was recorded in the fish stored at -20^{o}C as E grade than stored at –4^{o}C (72.8%) and 4^{o}C (45.2%). Grades of deep freezer fishes (Stored at -20^{o}C) characteristics remained excellent with high quality (grades E (83.6%) and A (16.4%)) even on 48hrs of storage, whilst at normal freezer -4^{o}C some fishes had scores (10.5%) in the E grade most of the fishes were scored as A grade (76.2%) category on 48hrs of storage. In the refrigerated fishes stored at 4^{o}C after 48hrs, the majority of fish were scored as A grade (12.5%) and B grade (74.2%) since quality had been decreased and few fishes were scored in the C grade (4.1%) category (Figure 1, 2, and 3).

Table 1. Sensorial evaluation of indian mackerel (Each grade represents the mean of 20 fish evaluated by individual assessor's grade category E. Excellent, A. High quality, B. Good and C. Unfit).

Criteria	Raw materials	Deep freezers (-20^{0} C)		Freezers (-4^{0} C)		Refrigerated temperature (4^{0} C	
	0 hrs	After 24 hrs	After 48 hrs	After 24 hrs	After 48 hrs	After 24 hrs	After 48 hrs
Skin	E	E	A	A.	A	B	C
Eyes	E	E	A	A	B	A	B
Gills	E	E	B	E	A	A	B
Peritoneum	E	A	A	A	A	B	B
Texture	E	E	A	A	B	E	B
Odour	E	E	A	E	A	A	B

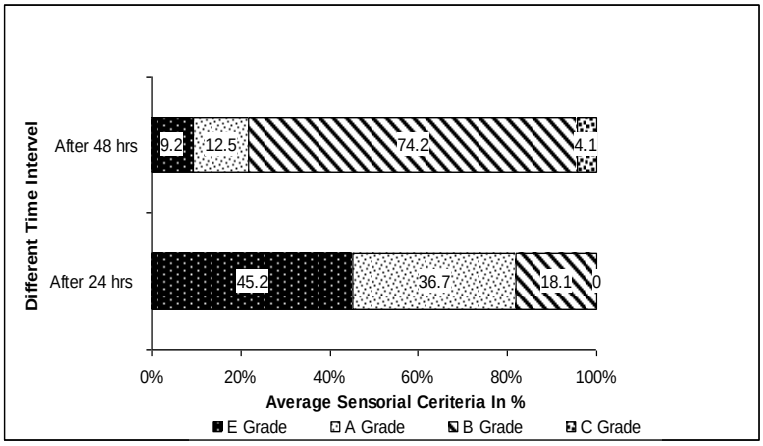

Figure 1. Sensorial evaluation of freshness of fish stored at 4^{0}C.

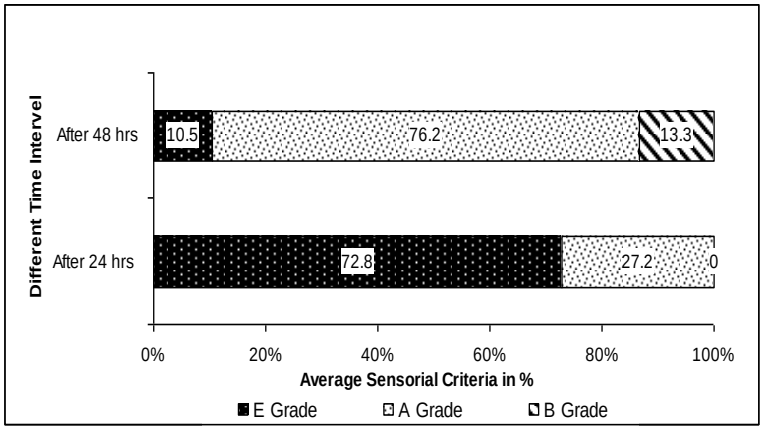

Figure 2. Sensorial evaluation of freshness of fish stored at -4^{0}C.

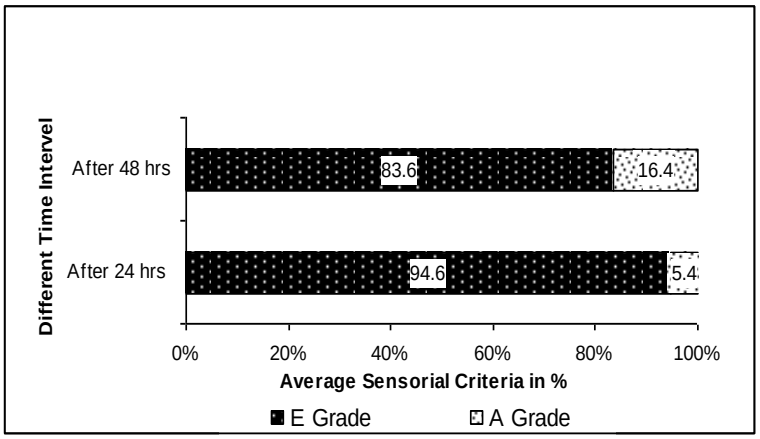

Figure 3. Sensorial evaluation of freshness of fish stored at -20^{0}C.

pH measurements

The pH changes fish muscle during cold stored in different temperature are shown in fig.5. The assessment of pH measurements in fish samples showed significant differences between the three different intervals stored at different temperature. During the initial period the mean pH of raw fish muscle was (6.23) consistently lower than 48hrs of storage period. The pH was slightly increased in the fish muscle after 48hrs period fishes stored at 4°C which have higher (6.44) value when compared with fishes stored in -4^{o}C and -20^{o}C (6.36 and 6.30) Figure 4.

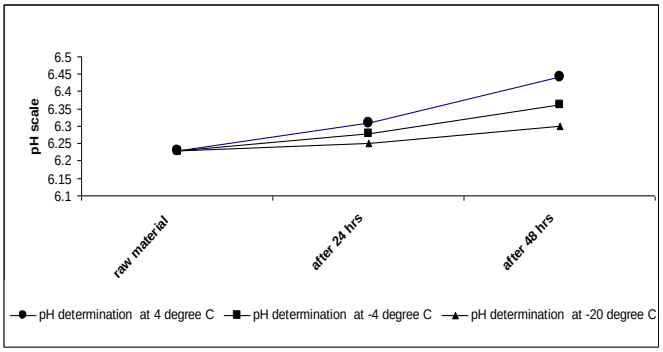

Figure 4. Changes in pH in different storage temperatures.

Microbiological results

In the present study APC, Total Coliform, *E.coli*, *Vibrio cholerae*, *Vibrio paraheamolyticus* and *Salmonella typhi* were used as microbial index to assess the microbiological quality of the Indian mackerel tissues during storage at different time interval.

Changes in Aerobic Plate Count (APC)

The initial counts of APC in fish muscle were 35×10^3 (4.54 $\log_{10}$) CFU/gm and during cold storage periods the APC were significantly increased in all the three type of storage. APC 7 log CFU / g, is measured as the greater acceptability limit for fresh water and marine species as described by ICMSF (2002). Exceeded the value of Both 24hrs and 48 hrs time period the higher count were recorded at (4^{o}C) 62×10^4 (5.79 $\log_{10}$) CFU/gm and89×10^5(6.94 $\log_{10}$) CFU/gm. After 48hrs time of storage period fishes preserved at -4^{o}C and -20^{o}C the APC values were 20×10^4 (5.98 $\log_{10}$) CFU/gm and 96×10^4 (5.30 $\log_{10}$) CFU/gm. From the present study minimum of APC were recorded in the fishes preserved at -4^{o}C, -20^{o}C and the maximum were observed in the fishes stored at 4^{o}C (Fig. 5, 6 and 7) On day 6 (Sample A), on day 9 (Sample B) and on 12th day. After 15 days of storage, C and B samples had a significantly lower APC count than the A sample.

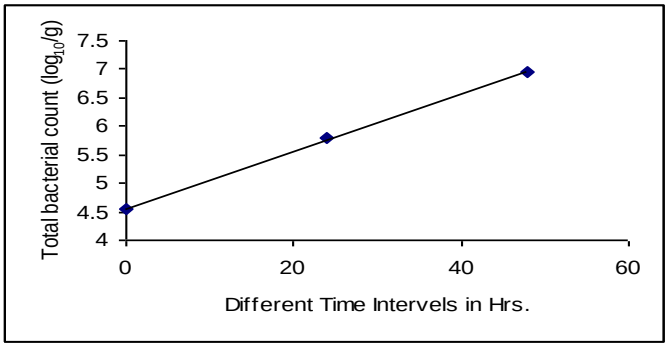

Figure 5. Changes in APC at 4^{0}C storage temperatures.

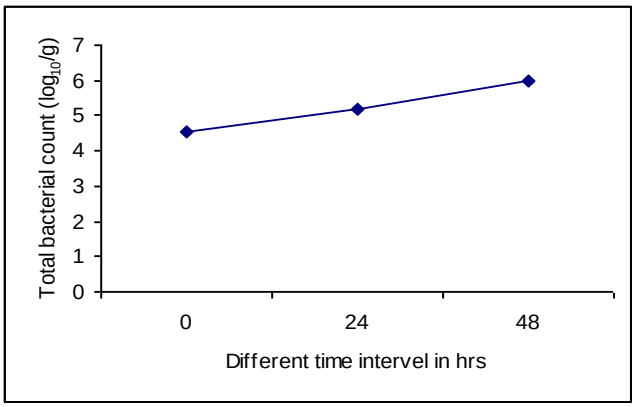

Figure 6. Changes in APC at -4^{0}C storage temperatures.

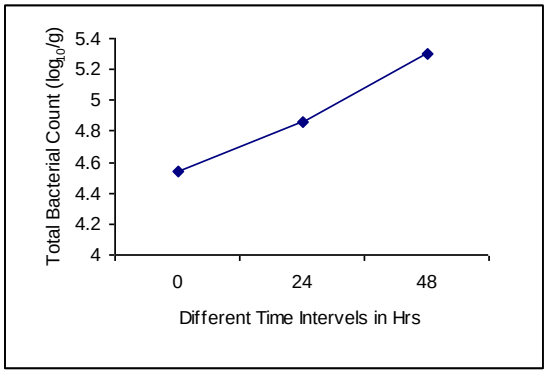

Figure 7. Changes in APC at -20^{0}C storage temperatures.

Changes in pathogenic bacteria

After 24hrs of storage period at 4^{o}C the numbers of Total coliforms were 6 CFU /g but the numbers were doubled (14 CFU /g) after 48hrs of time period. The fishes kept in the -4^{o}C and -20^{o}C the Total coliform groups were reduced during the storage period. There is no much variation shown in the other pathogenic organisms such as *E. coli* and *V. paraheamolyticus* were kept at 4^{o}C for the period of 48hrs but the number was reduced in the fishes kept at -4^o C and -20^{o}C. The pathogen such as *Salmonella typhi* and *Vibrio cholerae* were absent in all the samples throughout the study period (Table 2).

Table 2. Changes in pathogenic bacteria count stored at different temperatures and time intervals.

Species		**Stored at 4^0 C**		**Stored at -4^0 C**		**Stored at -20^0 C**	
	Raw material	**After 24 hrs**	**After 48hrs**	**After 24hrs**	**After 48 hrs**	**After 24 hrs**	**After 48 hrs**
Total coliform	7	6	14	4	2	2	1
E. coli	5	3	2	1	1	1	1
Vibrio parahaemolyticas	14	15	18	1	2	1	1
Vibrio cholera	0	0	0	0	0	0	0
Salmonella typhi	0	0	0	0	0	0	0

IV. DISCUSSION

Several factors such as species, size, catching methods, handling of fish temperature, and the physical condition of the fish can affect the shelf life of fish during storage (Huss, 1988). There are several methods to assess fish quality and deterioration. However, there is a vast variation from species to species in the chemical, bacteriological, and sensory changes depending on storage temperature and conditions of the product are fresh or processed and the type of processing is carried out. Therefore, the acceptable limits for each quality criteria may vary for each species (Huss, 1988 and Botta, 1995).

The result of the sensory examination shows that the freshness of Indian mackerel stored at different temperature was decreased during the storage time. Grades of fishes Stored at -20°C and -4^{o}C characteristics remained excellent and high quality even on 48hrs of storage. In the refrigerated fishes stored at 4^{o}C, the majority of fish were graded as A and B grade since quality had been decreased and few fishes were graded in the C grade category. According to previous researches the quality of horse mackerel reduced after five or six days of iced fishes and fish exhibited unacceptable quality on day eight (Simeonidou et al.1998; Losada et al. 2005).

The initial post-mortem pH varies with individual species, catching ground, and the season. Knowledge about pH of fish muscle may provide some vital information about its quality (Huss, 1988). The pH of fish just after catching is reported between 6.0-6.5. The fish is acceptable up to pH 6.8 and the pH of spoiled fish is above 7.0. In the present observation, the pH of fish muscle ranged from (6.23 to 6.44) during the 48hrs storage period. However, the pH values of fishes stored in different temperature were increased gradually during storage. At 4°C the pH values of mackerel muscle

increased gradually reaching 6.44 after 48 hrs storage, while the pH of mackerel muscle stored at -20°C was 6.3 even after 48hrs the pH values of whiting (*Merlangius merlangus euxinus*), samples stored at ambient temperature show acceptable quality for 2 days, and 3 days for refrigerated samples (Kose and Erdem, 2001). The increasing of pH during storage periods was perhaps due to the increase of organic compounds such as ammonia and TMA, mostly resulting from microbial action. Therefore, the pH value should be an indicator for fish freshness (Inal, 1992).

The freshness of live healthy Fish is sterile; microorganisms are only present on the outer surfaces (gills, skin) and in the gastro-intestinal tract. Immediately after post-mortem, the fish is colonized by a diversity of microorganisms with wide temperature variations, attributable to the poikilotherm nature of Fish (Gram and Huss, 1996).

An acceptability limit of 10^6 colonies per gram (6.0 log CFU/g) based on chemical and organoleptic properties have been proposed for fresh fish products (Huss, 1988; Aguilera et al. 1992). In the present study the APC count shows the bacterial results has acceptable limits even at ambient temperature (4°C) after 48 hrs. These results were very much linked with the sensory values. In a study carried out by Ryder et al. (1984), observed aerobic plate counts never exceeded 10^6CFU/g for meat of jack mackerel samples kept in an ice during 11days.

V. CONCLUSION

The sensorial and microbiological evaluation of Indian mackerel revealed that quality index was changed due to the storage temperature and time duration. The elevated the storage temperature, heavily impact the quality of the fishery products. Variations in fish freshness observed from the fresh materials to stored fish at four different storage temperatures. The highest freshness and least microbial load were noticed in the fishes stored at -20°C. The freshness and quality of fishes was inversely proportional to time and temperature. Hence, the present investigations recommend that, maintaining the temperature speed up the processing is very much useful to uniform maintenance of fish freshness.

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