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CHANGES IN POSTMORTEM QUALITY AND SHELF LIFE DETERMINATION OF FRIGATE MACKEREL (*AUXIS THAZARD*) AND STING RAY (*DASYATIS MARGARITA*) DURING ICE STORAGE

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INTRODUCTION

The major problems faced by the fishing industry are high rate of loss of freshness of fish and implementation of stringent microbiological and physical standards for the fish exports set by importing countries. A potentially economically and technologically viable method for reducing fresh fish losses is the use of chemical preservatives and modified atmosphere in addition to adding of ice or refrigeration. The extended shelf life of fish stored in ice is important for both the transportation of fish and for processors who keep fish until processed. On the other hand icing is the cheapest way of storing and the most common practice among the industry people. Despite the commercial importance of the species, very few studies have been conducted in Sri Lanka about the changes occurring in fish through typical handling, distribution and storage conditions. Among them also little literature exist on the changes in quality of frigate mackerel and sting ray when stored in ice as whole un-eviscerated fish, which is one of the most common way of storage. Furthermore, there were no studies carried out to find the differences of rate of freshness losses in fatty fish and lean fish species. Therefore, an attempt was made to study and to determine the rate and the type of deterioration processes occurring during the ice storage of sting ray and frigate mackerel by using sensory, bacteriological, physical, and chemical assessments.

METHODOLOGY

Changes in chemical, physical, sensory and microbiological parameters of whole un-gutted frigate mackerel and sting ray which were stored in ice immediately after caught were analyzed over 21 days. Proximate composition, pH, water holding capacity (WHC), and total plate counts were determined for both fish species according to standard procedures (AOAC, 1996). Total volatile basic nitrogen (TVB-N), trimethylamine nitrogen (TMA-N) and 2-thiobarbituric acid reactive substances (TBARS) were analyzed in 3 days interval using the modified micro-kjeldhal distillation method, modified pictrate method and method described by Siu and Draper (1978) respectively. Sensory characteristics for overall acceptability of cooked fish as well as appearance, odour and colour attributes of raw fish were evaluated by 30 untrained panelists. All analytical determinations were performed in triplicate for each fish species for a total eight sample times, as on day 1,3,6,9,12,15,18, and 21. Statistical analysis was performed by analysis of variance and mean separation procedure using SAS and sensory data by Friedman test using Minitab program at the 95% confidence interval.

RESULTS AND DISCUSSION

According to the proximate composition results, the muscles of frigate mackerel contained high protein and high fat whereas muscles of sting ray contained high protein but low fat content ($P<0.05$).

In frigate mackerel TVB-N values were less than the critical limit 30-35 mg muscle TVB-N/ 100 g (Connell, 1995) with initial value of 9.47 ± 0.56 mg TVB-N/100 g muscle and 28.37± 0.73mg TVB-N/100 g muscle, at the time of rejection at day 12. However, the level exceeded the rejection level at day 16. The TVB-N content in whole un-gutted sting ray samples ranged from 27.43 ± 0.23 to 65.82 ± 0.6 mg TVB-N/100g during the 21 days period of storage.

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Production of TVB-N and spoilage of fish depend on the fish species and the cut off value of 30 mg/100 g flesh may not be applicable to every species. High level of TVB-N detected in sting ray muscle could be due to breakdown of non-protein nitrogenous compounds of urea (Huss, 1995). Results from the current study suggested that 50 mg of TVB-N/100g could be considered as the marginal spoilage level for sting ray fish.
In frigate mackerel muscle, TMA-N remained below critical limit, 5 to 10 mg TMA-N/100g muscle (Sikorski *et al.*, 1990) when it was rejected by sensory panel with the value of 2.31±0.03 mg TMA-N/100 g muscle at day 12. It was found 1.07±0.04 and 3.14±0.19 mg of TMA-N/ 100g level on day 1 and day 18 respectively in sting ray.

Table1: Changes in TMA-N and total plate count Log $_{10}$ CFU/g in frigate mackerel and sting ray during ice storage

Days	Log $_{10}$ CFU/g		TMA-N (mg/100g)	
	Frigate mackerel	Sting ray	Frigate mackerel	Sting ray
1	NA	NA	0.21±0.00^{a}	1.07±0.04^{a}
3	3.50±0.03^{a}	3.35±0.05^{a}	0.23±0.02^{b}	1.40±0.01^{b}
6	4.60±0.01^{b}	4.70±0.01^{b}	0.34±0.02^{b}	1.55±0.01^{b,c}
9	5.05±0.03^{c}	5.00±0.03^{c}	0.45±0.01^{b}	1.61±0.02^{b,d}
12	7.31±0.02^{d}	6.20±0.02^{d}	0.76±0.02^{c}	2.31±0.03^{e}
15	7.96±0.16^{e}	7.19±0.08^{e}	0.76± 0.02^{d}	2.57±0.02^{f}
18	9.02±0.27^{f}	8.16±0.35^{f}	1.20±0.05^{d}	3.14±0.05^{f}
21	NA	NA	1.35±0.06^{d}	5.30±0.19^{f}

NA-Not analyzed, Mean value ($P<0.05$) different within columns

The bacterial counts increased ($P<0.05$) from an initial load of 10^3 CFU/g up to 10^8 CFU/g at day 16 in sting ray. Frigate mackerel showed initial load of 10^4 CFU/g whereas it was reached 10^8 CFU/g at day 12. When stored aerobically, levels of 10^8-10^9 CFU/g in the flesh are required to cause spoilage in iced fish (Gram and Huss 1996). The panelists rejected fish early in spoilage even though the microbial load did not exceeded the limit of 10^8 CFU/g at that time. This early rejection indicated that not only bacterial number plays a role in the shelf life of fish, but also other factors such as bacterial types (Huss, 1985) autolytic activity (Fletcher *et al.*, 1986), the biochemical properties of fish and storage conditions (Hunna, 1992).

Maximum level of TBARS value indicating the good quality of the fish is 5 mg malonaldehyde/kg, while the fish may be consumed up to the level of 8 mg malonaldehyde / kg (Connell, 1995). TBARS value was 3.64 malonaldehyde/100g in sting ray at day 16 whereas in frigate mackerel it was 4.78±0.02 malonaldehyde/100g at day 12 which is close to rejection limit of 5 mg malonaldehyde/100g. Present results indicated that oxidative rancidity remained relatively low ($P<0.05$) in sting ray fish than frigate mackerel throughout the storage.

pH values fluctuated from 6.27±0.04 to 6.24±0.02 and 6.80±0.02 to 6.83±0.03 in frigate mackerel and sting ray, respectively. The post-mortem lowering of pH causes a decrease in the WHC of the proteins since it brings them closer to their isoelectric point (Huss, 1995). In this study the WHC decreased ($P<0.05$) from 52.43 ± 0.30 at day 1 to 42.74 ± 0.14 at day 21 in sting ray where as in frigate mackerel it decreased ($P<0.05$) from 43.73 ± 0.63 to 40.0 ± 0.11.

Appearance scores from sensory analysis for cooked fillets indicated that sting ray fish maintain its freshness up to 18 days, where as in frigate mackerel it was 11 days. According to taste panel, texture of the sting ray muscles remained fresh until day 15, where as in frigate mackerel it remained fresh only 11 days. However, according to the overall acceptability, the shelf life of sting ray could be extended up to 16 days satisfactorily and it could be only up to

11-12 days for frigate mackerel.

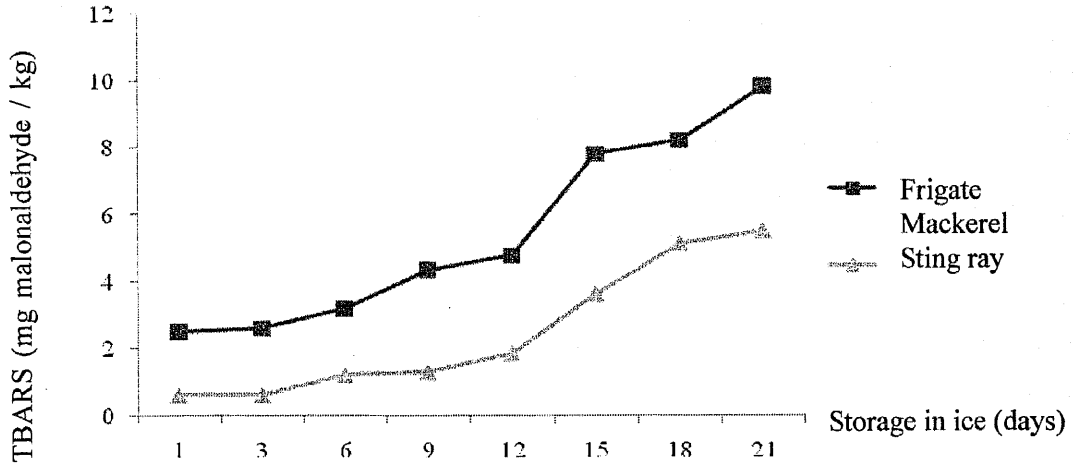

Figure 1: Changes in TBARS of frigate mackerel & sting ray in ice storage for 21 days

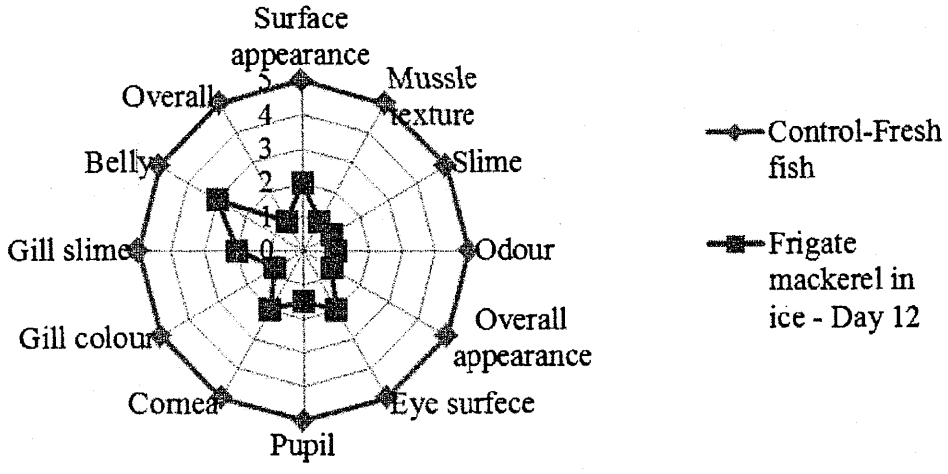

Figure 1: Sensory scores for whole raw frigate mackerel in control and day 12 in ice

Rejection of raw samples by panelists was due to rancid, sour and fishy odours and very soft texture. Appearance was rated below the acceptable limit based on sunken, opaque eyes with yellowish, reddish or slightly greenish cornea and faded colour of the skin and gills.

The skin slime and odour changes had the same trend in both species. But in sting ray, scores were decreased ($P<0.05$) after day 8 whereas for the frigate mackerel it was in after day 4. Texture changes increased linearly, throughout the storage time in sting ray but in frigate mackerel it was only up to day 12.

Statistical analysis showed that quality did not change ($P<0.05$) during the first 4 days in frigate mackerel whereas 6 days in sting ray. At day 10, eyes were slightly sunken or somewhat dull in frigate mackerel. However, this condition was still considered good and remained unchanged until day 12, when quality was graded between good and acceptable.

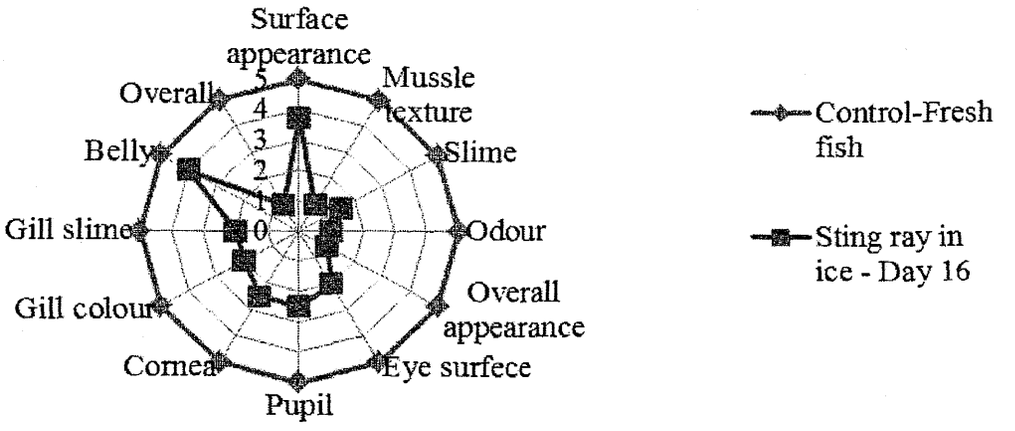

Figure 2: Sensory scores for whole raw sting sting ray in control and day 16 in ice

After day 12 (Figure 1), all frigate mackerel samples showed completely sunken and cloudy eyes; discoloured gill and fishy odour, and were rejected by the panelists. In sting ray, the rejection occurred at day 16 (Figure 2) due to discoloured eyes and gills.

CONCLUSIONS / RECOMMENDATIONS

Overall results indicated a 12 day maximum shelf life for the frigate mackerel (*Auxis thazard*) and 16 day for sting ray (*Dasyatis margarita*) stored at 0 °C in ice.

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