

CHANGES IN PHYSICAL AND CHEMICAL CONSTITUENTS OF CRAB MEAT DURING STORAGE AT REFRIGERATOR TEMPERATURE ($7 \pm 2^{\circ}\text{C}$)

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ABSTRACT

The present study was initiated to determine the deteriorative changes in cured and the nutritive quality of crab meat during storage at refrigerator temperature (7 ± 2) for the period of one week. The parameters studied for the assessment of quality are pH, water, total protein, salt soluble protein, TMA-N, TVB-N content. The results indicate a significant increase ($p \leq 0.001$) in pH, water, TMA, TVB while total protein, salt soluble protein, and total lipid contents were significantly decreased ($p < 0.001$) as compared to fresh tissue. Our findings recommended that the quality of crab meat is acceptable up to one day of storage at refrigerator temperature after which it becomes deteriorated.

INTRODUCTION

Low temperature storage is only method that may be used to maintain the freshness of fish and their products, it is recognized that deteriorative changes may still take place during low temperature storage (Qadri and Riaz 1990). On storage fish undergo different phenomena of oxidation, hydrolysis, decomposition of protein, fat and glycogen contents. It results in formation of chemical metabolites which can be used as indicators of spoilage. TMA-N have recently been used as index of meat quality of fish and shrimp (Joseph et al. 1988). The determination of tissue pH has been accepted as a parameter of spoilage by several workers (Bailey et al., 1956). Decrease in protein contents and its solubility in salts also affect the quality of fish and shell-fish meat (Bhobe and Pai, 1986).

Mud Crab *Scylla serrata* (Forsk.) is one of the most important edible shell-fish. The nutritional status and quantitative abundance of it on Karachi coastal area revealed that there is a need to develop processing industry like shrimp industry. To establish a processing industry it is essential to have scientific knowledge on maintenance of quality of edible crab during processing and storage. Unfortunately not a single study has been done on the keeping quality of crab after harvesting.

Purpose of present study is to assess the quality of edible crab during storage at refrigerator temperature ($7 \pm 2^{\circ}\text{C}$) for the period of seven days. The parameters studied for this purpose are pH, water, total protein, salt soluble protein, TVB-N, TMA-N, total lipid content. The results

provide the information on keeping quality of crab during storage at low temperature, which will be helpful to fish processor, exporter and nutritionalist in assessment of their quality.

MATERIAL AND METHODS

Commercially important edible crab (*Scylla serrata*) was purchased from local market. The animal cleaned, and open and their shell were removed, wet tissue were excised on absorbent paper and the weight was recorded on an electrical balance then it was randomly divided in to two aliquots. One aliquot was freshly analysed to determine the physical and chemical parameters. Second was kept at $7 \pm 2^\circ\text{C}$ for seven days. The change in physical and chemical properties were noted after one day interval to assess the quality of pleat. The following physical and chemical parameter were analysed. pH (by electrical pH meter), water content (standard method of A.O.A.C., 1970), total protein (Lowrys method 1951), salt soluble protein (Dyer et al., 1950), total lipid (modified method of Bligh and Dyer, 1956), TMA-N (modified picrate method described by Murray and Gibson, 1972) and TVB-N (Cobbs et al., 1973).

The data obtained from experiments were subject to appropriate statistical analysis by using star personal XT computer. Analysis of ANOVA (F-test. Degree of correlation, regression lines between different parameters were drawn by calculating with the help of least square method (Walpole, 1982).

RESULTS AND DISCUSSION

The changes in physical and chemical constituents of crab meat during seven days storage at refrigerator temperature ($7 \pm 2^\circ\text{C}$) are presented in Table-1.

pH

The pH of freshly caught crab was 6.75 ± 0.03 , it slightly increased (6.9 ± 0.06) after one and two days but after 3 to 4 days, it was changed to 7.16 ± 0.06 . On last day of storage (7th day) it increased to alkaline (7.7 ± 0.13) side, showing statistically significant variation from the fresh value ($P \leq 0.001$).

The pH of fish depend on several physical and chemical factors such as buffering capacity and ionic composition of crab meat. Bhobc and Pai (1986) reported that rise in pH of shrimp (*Metapeneus dohnsnai*) during low temperature storage due to the formation of basic amines through bacterial reduction of TMAO to TMA, decomposition of tissue protein, and deamination process. The change in hydrogen ion concentration of meat is used as an indicator for assessment of quality of fish and shell-fish (Bailey et al., 1956). The pH of fish tissue below 7.7 is considered as good quality, between 7.7 and 7.9 are acceptable and tissue having pH above 7.9 are called spoiled. Our results showed that quality of fresh caught crab meat was prime upto 6 days of storage and acceptable on 7th day of storage. Regression lines determination shows that pH is positively correlated with water. TMA-N TVB-N but negatively with total protein, salt-soluble protein and total lipid contents during seven days storage at $7 \pm 2^\circ\text{C}$. The degree of correlation between pH

and water total protein, salt soluble protein, TMA-N, TVB-N and total lipid are 0.79, -1.0-0.9, 0.8.0.97 and 0.98.

Total protein

The total protein of crab meat was found to be 15.51. 464 g. it gradually significantly decreased to 12.13 ± 0.19 g on 7th th;s of storage. Our results are in good agreement with those reported by. Kolodziejska et al (1987). According to their finding during low temperature storage (above freezing). the rate of denaturation and autolysis of fish protein was markable. The autolysis helps the bacteria to invade the tissue rapidly, the free amino acids and water soluble protein content of tissue serve as an excellent source for their growth and as a result of not only the quality but also the quantity of protein is decreased. Siddiqui and Ali (1979) reported that decrease in protein content of prawn during ice storage is due to the leaching affect the amino acids and water soluble protein leaching out with melting ice.

Our results showed (figure) that changes in total protein content of crab meat is positive correlated with salt soluble protein (0.99). Similar relationship arc also reported by Gagon and Feller (1958) during low temperature storage of shrimp, they found correlation between degradation of tissue protein and lipid with Mc formation of TMA-N as degradative products.

Salt-Soluble Protein (SSP)

The solubility of protein in freshly caught crab meat in salt solution was $5.4g \pm 0.32$ g%. It decreased significantly ($p \leq 0.001$) during storage at $7 \pm 2^\circ\text{C}$. On first and second day of storage. values of salt soluble protein wears $4.96 \pm 0.29g\%$ and $4.2 \pm 0.35g\%$. It was noted that a solubility of protein was decreased with the increase of storage period. On seventh day of storage it reached to a value of $2.2 \pm 0.18g\%$ showing a markable alteration in solubility of protein of crab meat.

Solubility of protein has been used as index of alteration in protein quality daring low temperature storage. From the result it is apparent that al $7 \pm 2^\circ\text{C}$ decrease in protein solubility remarkably and inversely related to storage. This decreased in solubility shows that muscle protein undergo denaturation. A number of causes of denaturation during low temperature storage were noted. Dehydration is one of them, it causes the increase in salt concentration and then change inn pH (Leblance et al., 1989). Formaldehyde produced by demethylation of TMAO (may accelerate denaturation and results in loss of protein) (Bhobe and Pai, 1986) by cross linking the muscle protein forming a three dimensional network, lipid degradation) also results in textural toughness of muscle and loss of protein content.

Salt soluble protein has direct relation with total lipid (0.97) and inverse with TMA-N (-0.92 and TVB-N (-1.0) contents (figure 1).

Changes in TMA-N

At the time of storage (ohour) TMA-N is 2.73 ± 0.15 mg. The results clearly indicate as the storage time increase the TMA-N content also increase. On seventh day of storage TMA-N reached to a value 11.11 ± 1.32 mg% showing a significant rise ($p < 0.001$) during storage at $7 \pm$

2°C. There was a slow but consistent increase in TMA-N during 7 days storage. Bacterial activity cause increase in TMA-N same finding was observed by Vynch (1980) i.e. TMA-N increase with bacterial load of fish during low temperature. TMA-N has been used as an indicator of meat quality during storage of fish and shell fish. The quality of meat is categorised into three classes on the bases of their TMA-N contents (Castel) et al., 1958). The meat containing 0-2.0 mg% TMA-N is considered as grade-I. 2.5-5 mg% as grade-II quality and more then 5mg% TMA-N and called spoiled or grade-III quality of meat. Our results showed that meat of freshly caught crab was not prime ($2.73\text{mg} \pm 1.45\text{mg}\%$ TMA-N) but acceptable upto 3 days of storage ($4.5 \pm 0.15\text{mg}$ TMA-N), afterwards samples of crab meat were spoiled or grade III. Statistical analysis shows that (Figure 8) TMA-N increase with the increase of TVB-N (direct relation) and with the decrease of total lipid (indirect relation) contents. The values of correlation coefficient calculated between TMA-N and TVB-N and total lipid content were 0.97 and -0.97 during seven days of storage at $7 \pm 2^\circ\text{C}$.

TVB-N

TVB-N in freshly caught crab meal was $17.12 \pm 1.31\text{mg}\%$. During 7 days storage period it is significantly raised ($p \leq 0.001$), approximately 12 to 17 mg TVB-N increased at each day of storage. After 7 days values of TVB-N was $118.33 \pm 10.1 \text{ mg}\%$.

Similar to the other spoilage indicators (TMA, SSP, pH) TVB-N also increase during 7 days storage. This increase in TVB-N is mainly due to the bacterial activities which degrade the protein into metabolites and convert the TMA-N into reduced volatile MA and DMA (Kolakowski, 1986). It has also been suggested that increase in TVB-N due to the endogenous enzymatic activity (Cho et al., 1984, Botta el al., 1984). According to Cobb et al (1976) quality of fish and shell fish call be classified into three grades an excellent grade having a value of TVB-N less than 30 mg%. acceptable the values of 30-40mg% TVB-N and more Than 45mg% considered as spoiled or rejected grade. Results show that freshly caught crab meat has excel lent grade upto one day of storage ($34.9 \pm 5.1 \text{ mg}\%$) and alter his period quality decreased to spoiled or rejected grade which shows the maximum bacterial or endogenous activities.

The relation between TVB-N and total lipid was found by drawing regression line (Figure I) during storage at $7 \pm 2^\circ\text{C}$. TVB-N has direct relation with total lipid and strength of correlation between then, was -0.99.

Total lipid

Changes in total lipid during storage at $7 \pm 2^\circ\text{C}$ was presented in Table-1 freshly caught contain $1.8 \pm 0.28\text{g}\%$. It significantly falls ($p \leq 0.001$) during seven days storage. On first and second day of storage it was $1.6\text{g} \pm 0.03\text{g}\%$ and $1.45 \pm 0.15\text{g}\%$. Results indicate that total lipid decreased gradually with the increase of storage time. On 7th day it reached to a value of $0.9 \pm 0.5\text{g}\%$.

Oxidation of lipid is that major factor for the deterioration of fish and shell-fish. A Significant loss in total lipid content (50 to 70%) at 0°C was noted by Gibson and Worthington (1977) and

Riaz and Qadri (1990). The percent decrease in total lipid content of tissue noted in our study is 50 to 65% at refrigerator temperature. This loss in tissue lipid occurred during storage is due to the oxidative rancidity, the rancidity in term of thiobarbutaric acid number (TBAN) is used as an indicator of quality of fish, it has been found by many workers that TBAN increased linearly with the increase of storage period (Hsu et al., 1983, Han and Liston, 1987).

Water content

The water in fresh tissue of crab was $76.0 \pm 3.57\%$. It increased (at $7 \pm 2^\circ\text{C}$) gradually with the increase of storage time. After 7 days it reached to the value of $83.6 \pm 1.45\%$.

The changes in water content occurred during storage at $7 \pm 2^\circ\text{C}$ is may be due to the loss of water holding capacity of fish tissue or it may be due to the reaction between formaldehyde or malanoaldehyde (breakdown product of TMA and total lipid) and tissue protein with the release of water (William et al., 1983). The change in water content is well correlated with the change in total protein salt soluble protein. TMA, TVB and total lipid content. We got an excellent positive relationship with TMA, TVB ($r=0.97$, 0.98) and negative with total protein, salt soluble protein and total lipids (-0.97 , 41.92 and -0.98) of crab tissue. Similar correlations were reported by Leblanc et al. (1988) in cold tissue during storage at storage at low temperature, they suggested that the increase formation of TMA and TVB caused an increase of tissue water and loss of protein and lipid contents.

From the results it is concluded that the quality of crab meat can not be maintained to acceptable limit after one day storage. The deteriorative changes observed in crab tissue is highly significant during 7 day storage the quality gradually decreased from excellent to acceptable and to spoil.

Fig. 1: Relationship between changes in pH and water, pH and total protein, pH and SSP, pH and TVB, pH and total lipid, water and TMA, water and TVB, water and total lipid, water and total protein, water and SSP, total protein and salt soluble protein, total protein and TMA, total protein and TVB, total protein and total lipid, TMA and salt soluble protein, salt soluble protein and TVB, salt soluble and total lipid. TMA and TVB, TMA and total lipid contents of crab meat. The positive and negative correlation found at $7 \pm 2^\circ\text{C}$ are described by the regression lines.

- a) $Y=532.70+83.3(x)$, ($r=-0.98$)
- b) $Y =7.30 - 0.83 (x)$, ($r = -0.97$)
- c) $Y = 71.36 + 0.97 (x)$, ($r = 0.97$)
- d) $Y=-8.56 + 79.16(x)$ ($r=0.98$)
- e) $Y = 10.30 - 0.11 (x)$, ($r =-.98$)
- f) $Y = 43.59 - 0.39 (x)$. ($r =-0.97$)
- g) $Y=67.27 - 0.80 (x)$, ($r=-0.92$)
- h) $Y = 10.40 + 1.02 (x)$, ($r = 0.99$)
- i) $Y = 37.30 - 2.34 (x)$, ($r= -0.94$)
- j) $Y =471.40 - 29.38 (x)$, ($r = -0.99$)

- k) $Y = -2.63 + 0.29(x)$, ($r = 0.98$)
 l) $Y = 10.40 - 1.02(x)$, ($r = 0.99$)
 m) $Y = 172.10 - 28.83(x)$, ($r = -1.0$)
 n) $Y = 0.31 + 0.27(x)$, ($r = 0.97$)
 o) $Y = -3.98 + 11.30(x)$, ($r = 0.97$)
 p) $Y = 7.38 - 0.11(x)$, ($r = 0.97$)
 q) $Y = 38.13 + 5.7(x)$, ($r = -0.9$)
 r) $Y = 14.1 - 0.5(16(x))$, ($r = -492$)
 s) $Y = 266 - 326(x)$, ($r = 493$)
 t) $Y = -38.76 + 15.82(x)$, ($r = 0.91$)

Table 1
 Changes in chemical constituents of Crab meat during storage at refrigerator
 temperature ($7 \pm 2^\circ\text{C}$)

Storage time in Days	pH	Water (g%)	Total Protein (g%)	S.S.P. (g%)	TMA (mg/100g)	TVB (mg/100g)	Total Lipid (g%)
0	6.75 ± 0.03	76.00 ± 3.05	15.50 ± 0.64	5.40 ± 0.32	2.73 ± 1.45	17.12 ± 1.31	1.80 ± 0.08
1	6.87 ± 0.06	75.50 ± 2.91	14.93 ± 0.43	4.96 ± 0.29	3.10 ± 0.21	34.90 ± 5.00	1.66 ± 0.03
2	6.90 ± 0.06	77.30 ± 0.33	14.33 ± 0.43	4.20 ± 0.35	3.80 ± 0.25	50.17 ± 7.70	1.54 ± 0.15
3	7.10 ± 0.05	78.60 ± 0.54	13.90 ± 0.21	3.80 ± 0.15	4.50 ± 0.51	61.86 ± 5.90	1.36 ± 0.09
4	7.61 ± 0.06	79.35 ± 0.71	13.47 ± 0.32	3.30 ± 0.15	5.20 ± 0.31	73.66 ± 6.84	1.23 ± 0.66
5	7.33 ± 0.04	80.66 ± 0.7	13.33 ± 0.25	2.80 ± 0.15	6.150 ± 0.20	85.00 ± 5.77	1.00 ± 0.06
6	7.50 ± 0.06	82.00 ± 1.15	12.70 ± 0.19	2.40 ± 0.17	8.10 ± 0.53	96.16 ± 3.20	0.96 ± 0.08
7	7.73 ± 0.13	83.60 ± 1.45	12.13 ± 0.19	2.20 ± 0.18	11.11 ± 1.32	118.33 ± 10.10	0.90 ± 0.57

Values are statistically significant at the level of $P < 0.001$
 (Each value is $\bar{X} \pm \text{S.E.M.}$)

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