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QUALITY OF KING SCALLOP (*PECTEN MAXIMUS*) AND SPRAT (*SPRATTUS SPRATTUS SPRATTUS*) PACKED IN ICE, CLING FILM AND ALUMINIUM FOIL AND STORED AT REFRIGERATED TEMPERATURE (0-4°C)

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Abstract: Comparative study of quality of King scallop (*Pecten maximus*) and Sprat (*Sprattus sprattus sprattus*) packed in ice, cling film and alluminium foil at 4°C were conducted. Sensory (Inspection) and chemical changes (TVB-N, TMA-N and TMAO-N) were determined for a period of 16 days. In general, TMA-N increased and TMAO-N decreased progressively with increased storage time for both the species. However, significant differences (P<0.05) were observed in the concentrations of TMA-N and TVB-N in fish packed in alluminium foil and cling film compared to fish stored in ice. The biochemical results were in agreement with the sensory score. Ice packed fish showed better quality and longer shelf life compared to fish packed in either aluminum foil or cline film.

Key words: Fish technology; *Pecten maximus*; *Sprattus sprattus sprattus*; Aluminum foil; Cling film; Ice storage

Introduction

The nutritional importance of seafood has increased substantially because of the beneficial effects of eating seafood fats and oil (Nettleton, 1985; Kinsella, 1989). Seafood is also an important source of high quality, high digestible protein and a respectable source of minerals (Krzyzhowek, 1988). The demand of good quality seafood in the market has been prime concern of the consumers. Usually seafood is being marketed packed in ice. The quality changes during iced storage have been investigated in many studies (Gram *et al.*, 1990). Scanty information is available related to quality of seafood stored in different packages (Rendall *et al.*, 1997).

The rapid decline of retails seafood stores had coupled with a change in consumer buying habits. More and more supermarkets now maintain fresh seafood counters as well as offering pre-packaged fish. Extension of shelf life and better quality seafood by new packaging technologies is an essential pre-requisite for marketing success. It is imperative to provide seafood to consumers with desirable packaging system. A package should be of appropriate size (Jones, 1992) and should allow consumers to rapidly and

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easily purchase, store and unpack the product (Freeman, 1990). The basic function of packaging is to protect the product from physical damage and contaminants and delay spoilage (Ghazala, 1994).

The aim of the present investigation was to compare the quality of King Scallop (*Pecten maximus*) and Sprat (*Sprattus sprattus sprattus*) packed in ice, aluminum foil and cling film stored at refrigerated temperature (0-4.0°C) for 16 days.

Materials and Methods

Raw Materials and Storage: Species used for the experiment were King Scallop (*Pecten maximus*) and Sprat (*Sprattus sprattus sprattus*). Fish were brought frozen from the local market and were thawed over-night. Fish were then repacked; one lot with an equal volume of flaked ice. The other two lots were packed in aluminum foil and cling film. The boxes were stored at refrigerated temperature (0-4°C) in a cabinet. The ice and fish ratio (1:1) was maintained throughout the trials. At set intervals (0, 2, 7, 9, 14 and 16 days), five fish were removed from each boxes and subjected to the evaluation of sensory attributes. Five more fish were taken out from each of the boxes for chemical analyses.

Preparation of Samples: For determinations of TMA-N and TMA-O, 50g minced fish was blended with 100 ml. of 7.5% TCA and filtered while for TVB-N, 10g of minced fish was blended with 90 ml. of 7.5% TCA and filtered.

Flow Injection Analysis for Determination of TMA-O, TMA-N and TVB-N: The determination of TVB-N and TMA-N using the FIA technique was performed according to the methodology used by Sadok *et al.* (1995) with slight modification. The modification was an increase in concentration of NaOH of 0.6M to 1M, and an increased of concentration of formaldehyde from 12% to 20%. TMAO-N was determined by reducing TMAO-N to TMA with 15% TiCl₃ at 100°C until the color disappeared. The concentration could then be found using the FIA system.

Sensory Evaluation: A panel of five persons assessed the sensory parameters of the raw fish. In the raw state, the appearance of skin, gills, flesh color, texture and odor were evaluated. Evaluation for sprat was done according to the scheme of sardine provided by Botta (1995) slightly modified as shown in Table 2 and for sprat completely modified by the authors (Table 1). Limit of rejection was calculated as the ratio of total demerit points for a particular parameter to the number of observed characteristics.

Table 1. Sensory scheme for evaluation of raw King Scallop (Modified from Botta, 1995).

Parameter assessed	Characteristic	Demerit Points
Appearance	White	0
	Off white	1
	Grey	2
	Beige	3
	Yellow	4
	Sea weedy	0

Odor	Sweet	1
	Odorless	2
	Metallic	3
	Sour	4
	Putrid	5

Table 2. Sensory scheme for evaluation of raw sprat (modified from Botta, 1995).

Factor Assessed	Observed Characteristics	Demerit Points
General appearance	Very bright, iridescent	0
	Bright	1
	Less bright	2
	Slightly dull	3
Flesh firmness	Firm, springy	0
	Firm, hard	1
	Springless	2
	Soft	3
Eyes	Clear, transparent	0
	Central opacity	1
	Opaque	2
Odor	Fresh, oily, marine	0
	Oily, musty, slightly rancid	1
	Rancid, sour	2
	Rancid, acrid	3
Gills	None	0
	Slight < 10%	1
	Some < 50%	2
	Bloody	3
Flesh color	Fresh bloom, translucent	0
	Opaque	1
	Dense, bloody	2

Statistical Analyses: Results were analyzed using analyses of variance (ANOVA). Means were separated by the least significant difference test (Chereminsiff, 1987) at $P < 0.05$.

Results and Discussion

Concentration of TMA-N in King Scallop and Sprat due to different packaging during 16 days of storage is summarized in Table 3. There were significant differences ($P < 0.05$) in concentration of TMA-N in both Scallop and Sprat. Fish packed in ice showed significantly ($P < 0.05$) lower values of TMA-N compared to aluminum foil and cling film. Although significant differences have been observed in fish packed in aluminum foil and cling film, differences between them were much lower compared to those packed in ice. The value of TMA-N showed distinct differences between the species. Initial value of TMA-N in King Scallop in general was much lower particularly for fish packed in ice.

TMA-N concentration of Scallop packed in ice did not show value greater than 1.0 (mg/100g) even at the end of storage period. However, scallop packed in aluminum foil and cling film showed TMA-N values that increased progressively with storage time and on 16 day of storage indicated values greater than 20.0 (mg/100g) of TMA-N. For sprat, initial values in all the packages were high (9.37 mg/100g). Sprat packed in ice indicated lower values while those packed in aluminum foil and cling film showed increased values as the time progressed.

Table 3. Effect of packaging and storage time on TMA-N concentration in king scallops and sprat.

Species	Packaging	Storage days					
		0	2	7	9	14	16
King scallops	ICE	0.41a	1.11a	0.27a	0.18a	0.14a	0.70a
	AF	0.41a	0.54b	2.87b	9.29b	15.24b	22.30b
	CF	0.41a	0.28c	8.37c	15.02c	25.36c	24.24c
		LSD = 0.25					
Sprat	ICE	9.37a	8.74a	6.06a	5.98a	3.93a	2.36a
	AF	9.37a	13.71b	25.58b	24.9b	27.87b	25.65b
	CF	9.37a	14.51c	22.43c	23.02c	26.37c	26.96c
		LSD = 0.75					

Means in each column with the same letter indicates no significant differences (*P<0.05)

TMA-N: expressed as mg in 100g; AF: Aluminum foil; CF: Cling Film; LSD: Least significant difference

The results of TMAO-N are presented in Table 4. Statistical analysis showed significant differences (P<0.05) in the concentration of TMAO-N due to different packages and storage time. Initial values of TMAO-N were lower in scallop (11.89 mg/100g) compared to sprat (19.48 mg/100g). TMAO-N decreased as the time of storage period increased in scallop for all the packages. However, sprat packed in ice indicated lower values with storage time while those packed in aluminum foil and cling film showed higher values at the end of study.

Table 4. Effect of packaging and storage time on TMAO-N concentration in king scallops and sprat.

Species	Packaging	Storage days					
		0	2	7	9	14	16
King scallops	ICE	11.89a	12.25a	9.97a	7.41a	4.65a	3.92a
	AF	11.89a	22.59b	19.26b	23.40b	3.22b	1.65b
	CF	11.89a	16.58c	8.49c	6.26c	5.98c	2.25c
		LSD = 0.50					
Sprat	ICE	9.38a	6.55a	5.14a	3.90a	2.30a	76.99a
	AF	22.89b	26.63b	29.36b	25.25b	28.70b	247.97b
	CF	13.21c	28.81c	21.72c	30.65c	33.15c	341.51c
		LSD = 1.10					

Means in each column with the same letter indicates no significant differences (*P<0.05)

TMAO-N: expressed as mg in 100g; AF: Aluminum foil; CF: Cling film; LSD: Least significant difference

Significant difference (P<0.05) in TVB-N values were found between different packages in both scallop and sprat (Table 5). However, in scallop, initial values was much lower while those packed in ice indicated still further reduced values (4.31 and 3.88 mg/100g) on 7th and 9th days of storage. This only increased to 10.25 (mg/100g) at the end of experiment. Scallop packed in aluminum foil and cling film showed very high values at

the end of storage period. Initial value of TVB-N was found to be high for sprat in all the packages. However in ice, concentration of TVB-N did not increase as high as those found in aluminium foil and cling film (247.97 and 341.51 mg/100g respectively).

Table 5. Effect of packaging and storage time on TVB-N concentration in King Scallops and Sprat.

Species	Packaging	Storage days					
		0	2	7	9	14	16
King scallops	ICE	5.98 ^a	6.11 ^a	4.31 ^a	3.88 ^a	7.26 ^a	10.25 ^a
	AF	5.98 ^a	8.25 ^b	34.42 ^b	63.84 ^b	142.18 ^b	265.48 ^b
	CF	5.98 ^a	6.59 ^c	50.71 ^c	56.12 ^c	150.33 ^c	170.04 ^c
Sprat	ICF	29.28 ^a	22.69 ^a	37.70 ^a	38.25 ^a	65.25 ^a	76.99 ^a
	AF	29.28 ^a	32.97 ^b	136.01 ^b	150.62 ^b	210.12 ^b	247.97 ^b
	CF	29.28 ^a	41.27 ^c	73.48 ^c	187.48 ^c	292.65 ^c	341.51 ^c
			LSD =	0.40			

Means in each column with the same letter indicates no significant differences (*P<0.05)

TVB-N: expressed as mg in 100g; AF: Aluminum foil; CF: Cling Film; LSD:Least significant difference

One of the characteristic features attributed to chemical changes occurring in seafood during spoilage is the production of volatile bases. The total volatile based developed during the storage of fish consists primarily of ammonia and trimethylamine (Storey *et al.*, 1984). However, production of both volatile based and TMA-N exhibits a significant degree of variability between fish species (Hebard *et al.*, 1982). This is in agreement with the results of the present investigation. Clearly, there is significant differences in the production of TMA-N in King Scallop (0.41 mg/100g) compared to higher values in Sprat (9.37 mg/100g) on the initial day. Similarly TVB-N values in sprat were very high in sprat (19.48 mg/100g) in comparison to King Scallop (11.89 mg/100g).

The reduced level of TMA-N and TVB-N in both the species packed in ice may be attributed to reduced temperature and leaching of water-soluble proteins and micro-organisms (Connell and Howgate, 1986). King Scallop and Sprat showed higher values when packed in aluminum foil and cling film due to higher temperature in the packet. Also, there was no leaching effect. The rate of increase in TVB-N and TMA-N during spoilage of seafood varies with storage temperature, quite pronounced at room temperature but absent or negligible at sub zero temperature. Even, in low temperature such as refrigeration (0-4^oC) TMA-N and TVB-N formation slows down noticeably (Ishida *et al.*, 1976).

The production of TMA-N and volatile bases is due to the metabolism of bacteria and therefore is influenced by the particular micro flora of the product. Under the conditions prevailing in the pack during storage (low oxygen tension), facultative anaerobes are able to utilize TMAO-N and other oxidized muscles compounds increasing production of TMA-N and volatile bases. Aluminum foil and cling film packaging have probably resulted in the growth of organisms involved in the spoilage of unpacked ice fish indicating shorter shelf life (Debevere and Boskou, 1996). Under this environment, *Photobacterium phosphoreum* may grow producing large amounts of TMA-N volatile bases (Dalgaard *et al.*, 1993; Dalgaard, 1995).

The concentration of TMA-O was found to be higher in sprat compared to King Scallops but reduced progressively in both the species with storage time in different packaging materials (Table-4). However, surprisingly abrupt increase in the concentration of TMA-O was found on the 16th days of storage in sprat. TMA-O exists in a large number of fish and shellfish, generally in marine fish (Harada, 1975). The TMA-O level in fish also varies with the season, size and age of fish as well as environmental conditions (Shewan, 1951). TMA-O is broken down to TMA by bacterial enzymes. Therefore, particular microflora that produces the enzymes are responsible for quick breakdown of TMA-O to TMA. This makes a major differences in the concentration of TMA formation from TMA-O (Shewan, 1971).

Changes in the attributes of raw fish during chill storage were compiled using the score given by the individual panel members according to the description provided to them. Smell appeared to be stronger in King Scallop packed in aluminum foil and cling film (Table 6).

Table 6. Effect of packaging and storage time on sensory quality of King Scallop.

Attribute	Packaging	Storage days					
		0	2	7	9	14	16
Appearance	ICE	0.0a	0.0a	1.0a	1.0a	4.9a	5.0a
	AF	0.0a	0.2b	3b	4.0b	4.7ab	5.0a
	CF	0.0a	0.3b	4c	5.0c	4.9c	5.0a
			LSD =	0.1			
Smell	ICE	0a	2.a	1.1a	1.4a	1.9a	5.0a
	AF	0a	0.2a	4.3b	3.3b	1.8a	5.0a
	CF	0a	0.3a	3.5c	3.4b	1.9a	5.0a
			LSD =	0.1			

Means in each column with the same letter indicates no significant differences (*P<0.05)

Mean scores evaluated with demerit scale from 0 to 4 for appearance and 0 to 5 for smell

AF: Aluminum foil; CF: Cling film; LSD: Least significant difference

While in ice, the odor of King Scallop rose sharply only after 9 days of storage. There were significant differences (P<0.05) in odor between King Scallop stored in ice compared to those packed in aluminum foil and cling film. Limit of rejection of fish stored in ice lied between 9 and 5 days while those stored in aluminum foil and cling film, had rejection time that lied between 2 and 7 days. The results of odor were in agreement with that of appearance (Table 6). The results of sensory score for sprat are summarized in Table 7. There were significant differences (P<0.05) in different sensory attributes of sprat stored in ice compared to aluminum foil and cling film. It is clearly observed that sprat stored in ice compared to aluminum foil and cling film. It is clearly observed that sprat stored in ice had the best overall quality having rejection time between 7 and 9 days). However, overall rejection time for sprat packed in aluminum foil and cling film lied between 2 and 7 days). The results of sensory score were in agreement with those of TMA-N and TVB-N.

Generally, fish freshness assessment has relied on sensory methods (Connell, 1990).The result of the present investigation seems to reflect the results that Burt *et al.* (1975)

achieved in a large number of storage trials. In this study, there was a corresponding pattern between sensory characteristics and TMA and TVB.

Table 7. Effect of packaging and storage time on sensory quality of King Scallop.

Attribute	Packaging	Storage days					
		0	2	7	9	14	16
General Appearance	ICE	1.0a	1.1a	1.4a	2.2a	2.8a	3.0a
	AF	1.0a	1.3b	1.8b	2.6b	3.0b	3.0a
	CF	1.0a	1.5c	2.0c	2.5b	3.0b	3.0a
		LSD =	0.05				
Flesh Firmness	ICF	0.0a	1.1a	1.3a	2.4a	3.0a	
	AF	0.0a	1.0a	2.2b	2.8b	3.0a	
	CF	0.0a	1.0a	2.6c	2.9b	3.0a	
		LSD =	0.1				
Eyes	ICF	0.0a	1.0a	1.0a	1.6a	1.6a	
	AF	0.0a	1.0a	1.4b	2.0b	2.0b	
	CF	0.0a	1.0a	1.4b	2.0b	2.0b	
		LSD =	0.2				
Odor	ICF	0.0a	1.1a	1.6a	2.5a	n.e.	
	AF	0.0a	1.6b	2.0b	3.0b	n.e.	
	CF	0.0a	1.4c	2.2c	3.0b	n.e.	
		LSD =	0.1				
Gills	ICF	0.0a	0.8a	1.0a	1.5a	2.0a	
	AF	0.0a	1.0b	1.6b	2.0b	2.0a	
	CF	0.0a	1.0b	1.6b	2.0b	2.0a	
		LSD =	0.4				
Flesh Color	ICF	0.0a	0.6a	0.6a	1.0a	1.5a	
	AF	0.0a	0.8b	1.0b	1.5b	2.0b	
	CF	0.0a	0.8b	1.0b	1.8c	2.0b	

Means in each column with the same letter indicates no significant differences (*P<0.05)

Mean scores evaluated with demerit scale from 0 to 4 for general appearance and flesh firmness and for eyes, gills, smell flesh color from 0 to 2.

Conclusion

The shelf life of both king scallop and sprat was shortest in aluminum foil and cling film packages and longest in ice. The differences in the environment created due to aluminum foil and cling film had probably resulted in the growth of different micro flora. Also, the temperature within the aluminum package and cling film were higher compared to fish packed in ice. Therefore, the investigation indicated better quality of fish stored in ice compared to packages such as aluminum foil and cling film.

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References

Botta, J.R., 1995. Sensory Evaluation: Freshness quality grading. In: *Evaluation of Seafood Freshness Quality*. VCH publisher Inc. pp. 85.

Azam, K, Capillas, R., Mostafa, M. and Rahman, M., 2000. Quality of king scallop (*Pecten maximus*) and sprat (*Sprattus sprattus sprattus*) packed in ice, cling film and aluminum foil and stored at refrigerated temperature (0-4°c)

- Burt, J.R., Gibson, D.M., Jason, A.C. ND sanders, H.R., 1975. Comparison of methods of freshness assessment of wet fish. Part II. Instrumental and chemical assessment of boxed fish. *Journal of Food Technology*. 11: 73-89.
- Cheremisinnif, N.P., 1987. *Practical Statistics for Engineers and Scientists*. Lancaster, U.S.A. Technomic Publishing Company Inc., pp. 84-88.S
- Connell J.J. and Howgate, P.F., 1986. Fish and fish products. In: *Quality control in the fish industry*. Academic Press, London, pp 347 -405.
- Connell, J.J., 1990. Control of fish quality. University Press, Cambridge, pp. 83229
- Dalgaard, P., 1995. Qualitative and quantitative characteristics of spoilage bacterial flora from packed fish. *International Journal of Food Microbiology*, 20: 319-33.
- Dalgaard, P., Gram. L. and Huss, H.H., 1993. Spoilage and shelf life of cod fillets packed in vacuum or modified atmosphere. *International Journal of Food Microbiology*, 19: 223-294.
- Debevere, J. and Boskou, G., 1996. Effect of modified atmosphere packaging on the TVB/TMA producing micro flora of cod fillets. *International Journal of Food Microbiology*, 3: 221-229.
- Freeman, L.K., 1990. The quest for quality. *Food Engineering*, 62: 62-71.
- Ghazala, S., 1994. New packaging technology for seafood preservation shelf life extension and pathogen control. In: A.M. Martin (ed.), *Fisheries processing biotechnological applications*. Chapman Hall, London, pp. 82 -110.
- Gram L., Wedell-Neergaard, C. and Huss, H.H., 1990. The bacteriology of fresh and spoiling Lake Victorian Nile perch (*Lates niloticus*). *International Journal of Food Microbiology*. 10: 303-316.
- Harada, K., 1975. Studies on enzyme catalyzing the formation of formaldehyde and dimethylamine in tissues of fishes and shells. *Journal of Shimonoseki University, Fish.*, 23: 163-241.
- Hebard, C.E., George, J.F. and Martin, R.E., 1982. Occurrence and significance of trimethylamine oxide and its derivatives in fish and shell-fish. In: R.E. Martin, J.F. George, and D.R. Ward, (eds.), *Chemistry and biochemistry of marine products*. AVI Publishing Company, Westport, Connecticut pp. 149-272.
- Ishida, Y., Fuji, T. and Kadota H., 1976. Microbiological studies on salted fish stored at low temperature. I Chemical changes of salted fish during storage. *Bulletin of the Japanese Society of Scientific Fisheries*, 42: 351-358.
- Jones, T.P., 1992. Marketing seafood: When the consumer talks we need to listen. *Seafood Business*, 11: 192-193.
- Kinsella, J.E., 1989. Food components with potential therapeutic benefits. The n-3 polyunsaturated fatty acids of fish and oils. *Food Technology*, 40: 89-97.
- Krzyzhowek, J., 1988. Effects of handling, processing and storage of fish and shellfish. In: H.E. Karmas (ed.), *Nutritional Evaluation of Foods Processing*. New York: Van Nostrand Reinhold, pp. 244-265.
- Nettleton, J.A., 1985. *Seafoods Nutrition*. New York: Van Nostrand Reinhold, 280 pp.
- Rendall, K., Hattula, T. and Ahvenainen, R., 1997. Effect of packaging method on the quality of rainbow trout and Baltic Herring fillets. *Lebensmittel - Wissenschaft und-Technologies*, 30: 50 -61.
- Sadok, S., Uglow, R. and Haswell, S.J., 1995. Determination of trimethylamine in fish by flow injection analysis. *Analytical Chemistry Acta*, 321: 69-74.
- Shewan, J.M., 1951. The chemistry and metabolism of the nitrogenous extractives in fish. *Biochemical Society Symposium*. 6: 28-48.
- Shewan, J.M., 1971. The microbiology of fish and fishery products – A progress report. *Journal of Applied Bacteriology*. 34: 299-315.
- Storey, R.M., Davis, H.K., Owen, D. and Moore, L., 1984. Rapid approximate estimation of volatile amines in fish. *Journal of Food Technology*, 19: 1-10.