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Quality Changes in Whale Shark (*Rhiniodon typus* Smith) Meat During Storage in Ice

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The biochemical, bacteriological and organoleptic changes in whale shark (*Rhiniodon typus* Smith) meat during storage in ice have been studied. There was a decrease in the proportion of soluble fractions of protein during storage. It was observed that the meat could be stored in ice up to 12 days in acceptable condition.

Key words: Whale shark, ice storage, soluble proteins, quality changes, urea

Whale shark (*Rhiniodon typus* Smith), popularly known as basking shark, is an important part of the fishery at Veraval. Harvested mainly for liver and fins, they are caught throughout the year except during the closed season i.e. July to September (Philippose, 1994). Meat of whale shark in the frozen form, is a new item of export from Veraval to countries like Korea, Taiwan and Singapore (Kumar *et al.*, 1996). Not much work has been reported about the processing and utilisation of whale shark, except on the processing of its fins to extract rays (Ramachandran & Sankar, 1990). Due to its huge size, the meat is cut into large chunks at the landing centres and transported to the factories for further processing. The meat is transported without proper care and hence it poses problems of deterioration, discolouration and contamination with sand particles, etc. (Kumar *et al.*, 1996). This makes the meat unfit for further processing and the material is diverted for curing purposes. Therefore, systematic investigations on proper processing and preservation of this item has become very important and this paper reports the changes in biochemical, bacteriological and organoleptic qualities occurring in whale shark meat during storage in ice.

Materials and Methods

Chunks of whale shark meat were collected from landing centres in pre-rigor condition and transported to the laboratory in ice. On arrival, the meat was immediately washed in cold potable water and was cut into smaller pieces, weighing 2-2.5 kg. The chunks were then stored in flake ice (1:2) in a thermocole insulated box with a drain hole. The ice was replenished daily. Samples were taken at regular intervals for biochemical, bacteriological and organoleptic analyses.

Moisture, total nitrogen (TN), crude fat, non protein nitrogen (NPN), water soluble nitrogen (WSN) and ash of the samples were determined as per AOAC (1984). The salt soluble nitrogen (SSN) was determined by the method of Dyer *et al.* (1950). Total volatile basic nitrogen (TVBN), trimethyl amine (TMA) and urea nitrogen were determined by micro diffusion method of Conway (1947) from the trichloro acetic acid extract of the meat. The samples for the sensory studies were cooked in 2% brine for 10 minutes (Joseph & Perigreen, 1983). An experienced taste panel consisting of ten members conducted organoleptic evaluation. Scores were given on a scale ranging from 9 to 1, 9 for extremely good and 1 for extremely spoiled meat and 4 was the acceptability limit. All the microbiological analyses were carried out as per APHA (1976).

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Results and Discussion

In whale shark, a thick layer of fat (blubber) is seen adjacent to the skin followed by a thin layer of red meat and then white meat (Prater, 1941). The flesh of whale shark is soft and whitish in colour. The proximate compositions of the white meat, red meat and blubber are shown in Table 1.

Table 1. Proximate composition of different portions of whale shark

Sample	Moisture	Crude protein	Crude fat	Ash
White meat	71.08	18.58	9.81	1.03
Red meat	80.25	11.91	6.51	1.06
Blubber	85.28	8.31	4.28	1.62

Moisture content of the white meat was 71.08%. High moisture content of whale shark meat was also reported by Rao (1986). The moisture content of red meat was higher than white meat by 9.17%. The moisture content of blubber was still higher. The proportion of crude protein was relatively high, as this included urea nitrogen also. Fat content of the white meat was more compared with that of the red meat. This was because the white meat had thin layers of fat interlaced between the tissues. The ash content was higher, when compared with that of other varieties of shark.

Changes in biochemical parameters during the storage of whale shark meat in ice are shown in Table 2. The moisture content registered a steady increase from 71.08% to 72.91% over a period of 16 days. The total nitrogen content showed a gradual decrease from 2.97 to 2.02%. This decrease can be attributed to leaching out of the soluble components, especially urea. This was further evident from the decreasing trend of WSN and SSN contents.

It was observed that the meat contained high amount of NPN. Urea was the major constituent in the NPN fraction and urea nitrogen constituted more than 55% of the total NPN in the meat. Sikorski *et al.* (1994) also observed a similar trend in the urea content in elasmobranchs. Concentration of NPN decreased steadily from 957 mg/100g to 321 mg/100g on storage. More than 88% of the urea had leached out after 4 days of storage. Similar observations were also made by Solanki & Venkataraman (1978) for elasmobranchs.

It was observed that the initial value of the TVBN in the meat was high, which might have been due to the presence of urea in meat (Solanki & Venkataraman, 1978). The TVBN content increased on storage from an initial level of 15.49 mg/100 g to 21.36 mg/100g. The pattern of increase of TMA was also similar to that of TVBN.

The changes in bacterial quality of shark meat during iced storage are given in Table 3. The initial bacterial load was 1.23 x 10^4/g. The meat had a low count of *E. coli.*

Table 2. Changes in biochemical parameters of whale shark during ice storage.

Days of Storage	Moisture %	TN %	WSN (% of TN)	SSN (% of TN)	NPN (mg / 100g)	Urea N (mg / 100g)	TVBN (mg / 100g)	TMA (mg / 100g)
0	71.08	2.972	27.26	39.23	957	526.4	15.49	Nil
2	71.32	2.878	26.84	37.91	628	238.1	15.63	1.43
4	71.86	2.829	25.32	37.03	503	58.23	17.24	1.95
6	72.24	2.632	23.15	35.12	441	28.21	17.86	2.13
8	72.49	2.615	21.06	34.73	397	12.61	18.72	2.28
10	72.71	2.596	20.45	33.51	378	8.12	19.51	3.68
12	72.76	2.428	18.68	31.95	365	2.35	20.24	5.75
14	72.81	2.211	17.15	30.28	354	Nil	22.13	5.63
16	72.91	2.028	17.03	30.06	321	Nil	21.36	6.21

Table 3. Changes in bacterial counts during the ice storage of whale shark meat.

Days of storage	TPC/g	*E.coli*/g	FS/g	*Staph.*/g	*Sal.*/g	*VC*/g
0	1.23×10^4	2	1.25×10^2	6.90×10^1	ND	ND
2	1.21×10^4	Nil	8.00×10^1	Nil	ND	ND
4	2.83×10^4	Nil	2.20×10^1	Nil	ND	ND
6	5.13×10^4	Nil	2.10×10^1	Nil	ND	ND
8	5.38×10^4	Nil	1.90×10^1	Nil	ND	ND
10	6.7×10^4	Nil	2.50×10^1	Nil	ND	ND
12	1.68×10^5	Nil	2.70×10^1	Nil	ND	ND
14	3.29×10^5	Nil	3.10×10^1	Nil	ND	ND
16	2.8×10^6	Nil	3.00×10^1	Nil	ND	ND

TPC - Total Plate Count, *E. coli* - *Escherichia coli*, FS - Feacal *Streptococci*, Staph- Coagulase +ve *Staphylococci*, Sal - *Salmonella*, VC - *Vibrio cholera*.
ND - Not detected.

Table 4. Sensory characteristics of whale shark meat stored in ice.

Days in ice	Raw muscle			Cooked muscle					Score
	Colour	Texture	Urea smell	Colour	Texture	Urea smell	Taste	Gaping	
0	White	Firm	Present	Dull white	Firm	Absent	Slight sweetness	Absent	8.0
2	White	Firm	Slight	Dull white	Firm	Absent	Slight sweetness	Absent	7.5
4	Slightly dull	Slightly firm	Absent	Dull white	Slightly rubbery	Absent	Little sweetness	Absent	7.0
6	Dull white	Slightly soft	Absent	Light brown	Slightly rubbery	Absent	No sweetness	Absent	6.5
8	Dull white	Soft	Absent	Light brown	Slightly rubbery	Absent	No sweetness	Slight	6.0
10	Slightly yellow	Soft	Absent	Brown	Paste like	Absent	Bland	Moderate	5.0
12	Yellow	Very soft	Absent	Brown	Paste like	Absent	Bland	Prominent	4.0
14	Yellow	Very soft	Absent	Brown	Putty like	Absent	Bland	Prominent	2.5
16	Yellow	Extremely soft	Absent	Brown	Putty like	Absent	Bland	Prominent	2.0

Feacal *Streptococci* was detected in the range of 10^2/g. During storage, the plate count increased steadily from 10^4/g to 10^6/g. *E. coli* was not detected from the second day of storage. The count of feacal *Streptococci* decreased from 1.25×10^2/g to 3×10^1/g after 16 days of storage. Neither *Salmonella* spp. nor *Vibrio cholerae* was detected during the study.

The overall organoleptic quality of the meat progressively deteriorated over the period of storage. The fresh meat was white in colour and had moderate smell of urea. The urea smell totally disappeared on cooking. The texture of the meat was moderately soft. On storage in ice, the colour of the raw meat changed from white to dull, white during the initial four days of

storage and finally became slightly yellow. Similarly, the colour of the cooked meat also changed from dull white in the initial stages to light brown. The smell of urea was not detectable after three days of storage. On the eighth day, the meat became soft and gaping was seen on cooking. On the twelfth day, the meat became softer on cooking. On further storage, the meat became very soft and pasty. Sikorski, *et al*, (1994) have reported that this may be due to partial hydrolysis of protein by the enzymes present in the tissue itself, as well as by bacterial action.

The meat on cooking had a good flavour and slight sweet taste. The flavour gradually decreased and on the fourteenth day, the meat had a bland taste. On the sixteenth day, the meat had slight off taste. Hence, after the sixteenth day, sensory examination was discontinued. However, no bad smell was noticed during any stage of this study. Based on the above observations, it can be concluded that, the whale shark meat could be stored in ice for 12 days in acceptable condition. Though the meat did not become totally unacceptable after 12th day, the organoleptic qualities of the meat reduced considerably.

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