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Studies on Sensory Evaluation, Quality Improvement and Acceptability of Treated and Frozen Cuttlefish (*Sepiella Inermis*)

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Abstract: ***Introduction: The research work done on overall improvement of quality and acceptability of frozen cuttlefish (Sepiella inermis). International markets depend on quality of product. Quality is often related to the price at which the commodity is purchased or the purpose for which it is to be used. In relation to seafood, the quality is the sum total of its composition, nutritive value, degree of freshness, physical damage, deterioration while handling, processing and storage, distribution and marketing, hazards to health etc. From the consumer's point of view, some of the important factors that determine the quality of the product are: species, odour, appearance of the species, flavour, texture, presence of parasites, presence of food poisoning bacteria, presence of toxic metals, presence of foreign matter, composition of fish, and finally the packing. Cuttlefishes are utilized as an important food item in various countries because of its delicacy as raw consumed food. The Russians and Japanese eat raw cuttlefish and squid with sauce and they have a wide range of culinary preparations out of squid, cuttlefish and octopus. The freshness of the products is very important when the product is consumed raw. There is, therefore a need to improve the quality and safety of seafood products in the International market as well as for domestic trade. Methodology: Speciemens of Sepiella inermis were collected from the fishing trawlers of Visakhapatnam fishing harbour. Raw cuttlefish was preprocessed and treated with the food grade chemicals (Hidratech_4A and Whitech_3), treatments were done in fresh water, salt water along with control (without chemicals in ice), and treated cuttlefishes were stored in deep freezer maintained at -20±1ºC. The quality of mantle was evaluated at every stage of processing and during storage once in a month for the period of 7 months. Evaluation of sensory quality revealed marked variation between treatments and the months of storage. Results: Upon storage, the overall sensory scores decreased significantly (P<0.01) for all samples. Chemicals were effective in preserving the quality with the progression of storage, especially in samples treated in fresh water, as revealed by better score compared to control. The overall sensory scores revealed better acceptability of treated samples than control. A comparison of the quality changes in pre-processed and frozen stored cuttlefish (sepiella inermis) revealed that the sensory changes were relatively less in preprocessed cuttlefish than that of frozen stored cuttlefish. Highly significant differences were found in frozen stored cuttlefish with progression of storage.***

Keywords: cuttlefish, fish processing, sensory studies, organoleptic studies

1. Introduction

Cuttlefish and Squid form an important marine resource and these cephalopods were used by man as food from the time immemorial. The meat of the cephalopods is clean with good flavor, nourishing and delicious. The nutritive value is high and comparable to some of the good quality fishes. The edible portion consisting of the mantle, arms, tentacles and fins forms 60-80% of the body weight, and this is much higher than in finfish or other shellfish. The main reason for this increasing demand is that cephalopods are a good protein and lipid source (Kreuzer *et al*., 1984; Sinanoglou *et al*., 1998; Laskaridis *et al*., 2000; Reale *et al*., 2006; Zlatanos *et al*., 2006; Ozogul *et al.,* 2008), thus a highly nutritious food that represents an alternative to fish resources. Due to their nutritional and market value, cephalopod aquaculture has also shown an increasing interest during the past few years (Lee, 1994; Rosa, 2005). The value of cephalopods is increasing in the world market, due to their good nutritive value, and in India, it is earning a good foreign exchange through export (Ramasamy, 2012).

In India cuttlefishes and squids were considered as "poorman's food" for a long time, and in recent times, their consumption has increased. The various aspects of study and exploitation of this commercially important fishery resource have been drawing the attention of central and state fisheries institutes in India.

Several studies have been reported on the storage characteristics of iced and frozen stored cuttlefish and squid (Selvaraj *et al.,* 1991; Prafulla *et al.,* 2000; Joseph and Sherief, 2003; Mohanan, 2004, and Vikas Kumar, 2014). Various aspects of application of food additives and preservatives have been reported (Khan, 2003; Mohanan, 2004; Agrafioti and Katsanidis, 2012; Benjakul *et al.,* 2012, and Vikas Kumar, 2014). However, the study on the application of additives in improving the quality of cuttlefish during frozen storage is scanty.

Moreover, the cuttlefish is processed and treated with imported food grade chemicals (Hidratech_4A and Whitech_3) before freezing in industry. The industry seeks studies on overall improvement of quality and acceptability of frozen cuttlefish upon the treatment with these chemicals.

The industry need to know whether fresh water or salt water used for chemical treatment works equally or else have a significant difference in processing the quality of frozen cuttlefish.

In this study, an attempt was made to investigate the quality changes in cuttlefish (*Sepiella inermis*) treated with and without chemical treatment during frozen storage and to help the seafood industry with relevant suggestions for suitable treatments for improving overall quality. The quality of cuttlefish (*Sepiella inermis*) was evaluated for sensory, characteristics. Samples were tested after preprocessing, treatments, freezing and during storage at monthly intervals for 7 months. The overall sensory scores revealed marked variation between treatments as well as between months of storage.

2. Materials and Methods

Speciemens of *Sepiella inermis* were collected from the fishing trawlers of Visakhapatnam fishing harbour. Preferably mature and live specimens were selected for the experiments. *Sepiella inermis* with mantle lengths ranging between 80 mm and 94 mm and weighing 100 ±10 gm and 120±10 gm were used to estimate the sensory characteristics. The details of sample preparation and procedures for the determination of sensory analysis given below.

2.1 Preparation of sample for sensory analysis.

Raw material:
The captured species of cuttlefish (*Sepiella inermis*) was procured from Visakhapatnam fishing harbour. A total of 25 kg cuttlefish (8 to 10 cuttlefishes /kg) were placed in ice with a cuttlefish/ice ratio of approximately 1:1 (w/w) and transported to the processing hall of the laboratory and Research Institute, within 1h. Crushed block ice was used during the procurement and transportation of cuttlefish from landing center.

2.2 Pre-processing and Treatment

Raw cuttlefish (Sepiella inermis) was collected and pre-processed into tube style. A total of 25 kg of cuttlefish was processed into 9.0 kg of tube. Raw material preparation is given in the flow chart. The material was divided into three lots of almost equal weight. Two imported chemicals with trade names Hidratech_4A and Whitech_3 were used. One lot was treated with Hidratech_4A (0.4 %), Whitech_3 (0.25 %) common salt (2%) in 3.6 litre of fresh water chlorinated to <2 ppm level of available chlorine and 2.5 kg of ice. The material was stirred for 20 minutes along with the chemical mixture. After stirring, the material was maintained at 4±1 °C for 20h with intermittent stirring of 5 minutes for every 2h. Another lot was treated similarly but in salt water (salinity 2 ppt). The third lot was kept in ice for 20h without any chemical treatment as control. However, good quality flake ice was added to lower the temperature of control.

2.3 Freezing and Frozen Storage

Cuttlefish (*Sepiella inermis*) was wrapped in low density polyethylene (LDPE) Low density polyethylene films (thickness 225 micron) and was frozen in horizontal contact plate freezer in commercial condition (-40ºC for 90 minutes) at a seafood freezing plant. Subsequently, it was stored in deep freezer (Blue Star, India) maintained at -20±1ºC.

2.6 Sampling

The samples were collected aseptically in a sterile container at the following stages, for sensory analysis.

a) Raw material
b) After pre-processing and treatment
c) Immediately after freezing
d) At monthly intervals for 7 months.

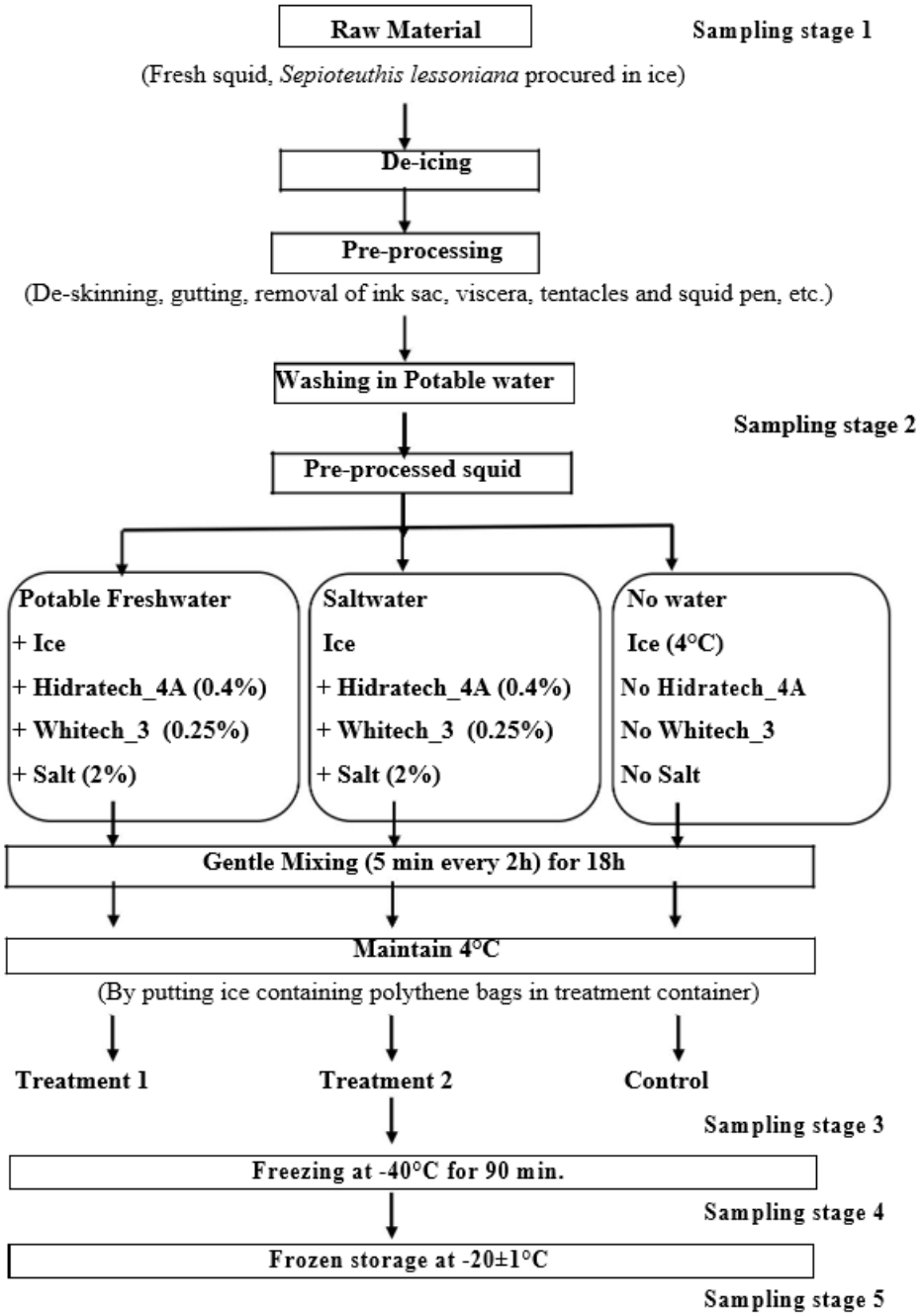
2.7 Sensory Analysis

Sensory analysis of cuttlefish was achieved by six trained panelists according to the method of Woyewoda and Ke (1980). The variables for the organoleptic evaluation included flavour, odour, appearance, texture and overall acceptability. Overall acceptability was the mean of scores of all the sensory attributes. The mean panel score was calculated and recorded. Table A presents the quality and acceptability for the corresponding organoleptic scores

Table A: Quality and acceptability for the corresponding organoleptic scores

Organoleptic Scores	Quality	Acceptability
10-9	Excellent	Highly acceptable
8-7	Good	Acceptable
6-5	Fair and acceptable	Poorly Acceptable
4-3	Poor	Unacceptable
2-1	Very poor.	Unacceptable

Flow Chart of Squid Processing



3. Results and Discussion

Sensory characteristics of cuttlefish (*Sepiella inermis*) under different stages of processing i.e. raw material, pre-processed, treated and just frozen and during frozen storage were analysed and the results are presented below.

3.1 Sensory quality

Sensory attributes namely flavour, odour, appearance, texture and overall acceptability of cuttlefish under different stages of processing aforesaid were analysed and the results are presented below.

3.2 Raw material

The quality of raw material was excellent and it had high acceptability. Raw cuttlefish scored the value of 10.0±0.00, 10.0±0.00, 9.50±0.10, 10.0±0.00 and 9.88±0.00 for flavour, odour, appearance, texture and overall acceptability, respectively on a 10-point scale for sensory analysis. The data showed raw material with slightly lower score (9.50±0.10) for appearance when compared with other attributes for which the score was 10.0±0.00 except overall acceptability which was averaged to 9.88±0.00. The sensory quality presented in terms of the sensory scores of raw material is shown in Table 1.

3.3 Pre-processed cuttlefish

Raw material was pre-processed before treatment. The pre-processing included de-skinning, gutting, removal of cuttlebone, viscera, and tentacles. The sensory quality of pre-processed cuttlefish remains excellent with high acceptability. The sensory score showed higher value (10.0±0.00) in pre-processed cuttlefish than raw cuttlefish (9.50±0.10) for appearance. It indicates the improvement in

appearance of raw material upon pre-processing. The sensory scores for all the sensory attributes were 10.0±0.00.

Table 1: Sensory scores of raw material

Scientific name		*Sepiella inermis*
Telugu name		Chinna Kanduva' or 'Chinna Komatisanchi'.
Stage of Processing		Raw material
Sensory Scores	Flavour*	10.0±0.00
	Odour	10.0±0.00
	Appearance	9.50±0.10
	Texture	10.0±0.00
	Overall acceptability	9.88±0.00

*partially steam cooked before evaluation

3.4 Treated cuttlefish (*Sepiella inermis*)

The sensory scores of treated cuttlefish are presented in Table 2. The scores for control were lower compared to both the treatments among the treatments, treatment 2 (salt water) had lower scores than treatment 1 (fresh water) for flavour, odour and appearance.

3.5 Just frozen cuttlefish (*Sepiella inermis*)

The sensory scores of just frozen cuttlefish are presented in Table 2. The scores for control were lower compared to both the treatments and among the treatment 2 (salt water) lower than treatment 1 (fresh water) for flavour, odour and appearance.

3.6 Frozen stored cuttlefish

The sensory scores of frozen stored cuttlefish are shown in Table 2. All the sensory attributes including overall acceptability showed scores in decreasing trend. However, there was specific decrease of each attribute for individual treatment.

3.7 Changes in sensory quality

The changes in sensory quality under different stages of processing i.e. pre-processed, treated and just frozen and during frozen storage are shown in Table 2. The changes in flavour, odour, appearance, texture and overall acceptability during processing and frozen storage of cuttlefish are shown in Fig. 1, 2, 3, 4 and 5, respectively. Table 3, presents the Analysis of Variance (ANOVA) in sensory quality during frozen storage. Results inferred significant difference ($P<0.01$) between treatments for all the sensory attributes. The table also showed all the sensory attributes to be significantly different ($P<0.01$) between the months of frozen storage.

Table 2: Overall sensory characteristics of cuttlefish (*Sepiella inermis*) from pre-processed to the end of 7 month of frozen storage

Parameters	Pre-Processed	Treatment	Treated	Just Frozen	Storage period (Months)						
					1st	2nd	3rd	4th	5th	6th	7th
Flavour*	10.0± 0.00	F	9.62±0.11	9.20±0.06	8.92±0.09	8.54±0.04	8.22±0.04	8.11±0.02	7.54±0.03	6.92±0.08	6.52±0.03
		S	9.28±0.16	8.82±0.04	8.50±0.02	7.92±0.06	7.31±0.02	6.84±0.04	6.21±0.04	5.92±0.03	5.22±0.01
		C	8.90±0.10	8.21±0.06	7.92±0.01	7.11±0.06	6.84±0.04	6.11±0.03	5.64±0.02	4.84±0.02	3.94±0.01
Odour	10.0± 0.00	F	9.70±0.08	9.10±0.10	8.85±0.04	8.52±0.11	8.25±0.09	7.82±0.05	7.11±0.08	6.55±0.01	6.10±0.05
		S	9.50±0.01	8.90±0.01	8.50±0.03	8.14±0.06	7.22±0.05	6.34±0.03	5.82±0.07	5.24±0.08	4.92±0.07
		C	9.20±0.03	8.40±0.06	7.92±0.06	7.21±0.08	6.45±0.02	5.22±0.02	4.62±0.09	4.46±0.07	3.94±0.05
Appearance	10.0± 0.00	F	9.50±0.10	9.20±0.06	8.66±0.01	8.26±0.07	7.84±0.09	7.55±0.15	7.04±0.03	6.74±0.02	6.12±0.11
		S	9.30±0.05	8.90±0.01	8.42±0.14	8.06±0.06	7.62±0.03	7.11±0.10	6.91±0.06	6.58±0.14	6.18±0.03
		C	9.10±0.08	8.20±0.05	7.62±0.03	6.94±0.05	6.52±0.04	6.05±0.11	5.61±0.07	4.84±0.12	3.85±0.15
Texture	10.0± 0.00	F	9.50±0.04	9.10±0.05	8.69±0.02	8.16±0.7	7.82±0.05	7.46±0.17	7.11±0.10	6.74±0.01	6.02±0.09
		S	9.70±0.05	9.50±0.03	9.02±0.12	8.52±0.03	8.22±0.03	7.91±0.07	7.68±0.04	7.48±0.02	7.02±0.01
		C	9.60±0.12	9.40±0.09	8.92±0.04	8.64±0.03	7.82±0.03	6.88±0.14	5.64±0.04	4.81±0.11	4.12±0.02
Overall Acceptability	10.0± 0.00	F	9.45±0.09	9.10±0.05	8.94±0.03	8.56±0.07	8.02±0.05	7.85±0.10	7.44±0.03	6.86±0.09	6.43±0.02
		S	9.40±0.05	8.95±0.10	8.78±0.14	8.46±0.11	8.11±0.03	7.88±0.02	7.32±0.05	6.84±0.07	6.55±0.04
		C	9.20±0.12	8.50±0.22	7.72±0.10	7.11±0.03	6.52±0.03	5.72±0.17	4.88±0.16	4.12±0.03	3.86±0.07

***Partially steam cooked before evaluation; F=Fresh water, S= Salt water, C= Control**

Table 3: Analysis of Variance (ANOVA) in sensory quality during froze storage

Parameters	Source of Variation	SS	df	MS	F	P-value
Flavour	Between treatments	10.9719	2	5.485948	66.65086	3.17E-07
	Between months	22.90558	6	3.817597	46.38143	1.3E-07
	Error	0.987705	12	0.082309		
	Total	34.86518	20			
Odour	Between treatments	12.79783	2	6.398914	61.11156	5.11E-07
	Between months	30.73192	6	5.121987	48.91653	9.6E-08
	Error	1.256505	12	0.104709		
	Total	44.78626	20			
Appearance	Between treatments	9.870467	2	4.935233	64.07083	3.94E-07
	Between months	17.54172	6	2.923621	37.95541	4.03E-07
	Error	0.924333	12	0.077028		
	Total	28.33652	20			

Texture	Between treatments	5.9046	2	2.9523	6.717831	0.011026
	Between months	23.54225	6	3.923708	8.928227	0.000748
	Error	5.273667	12	0.439472		
	Total	34.72051	20			
Overall acceptability	Between treatments	18.90927	2	9.454633	66.50647	3.21E-07
	Between months	20.5229	6	3.420483	24.06061	4.99E-06
	Error	1.705933	12	0.142161		
	Total	41.1381	20			

(SS - Sum of Square, df - degree of freedom, MS - Mean Sum of Square, F - F- ratio)

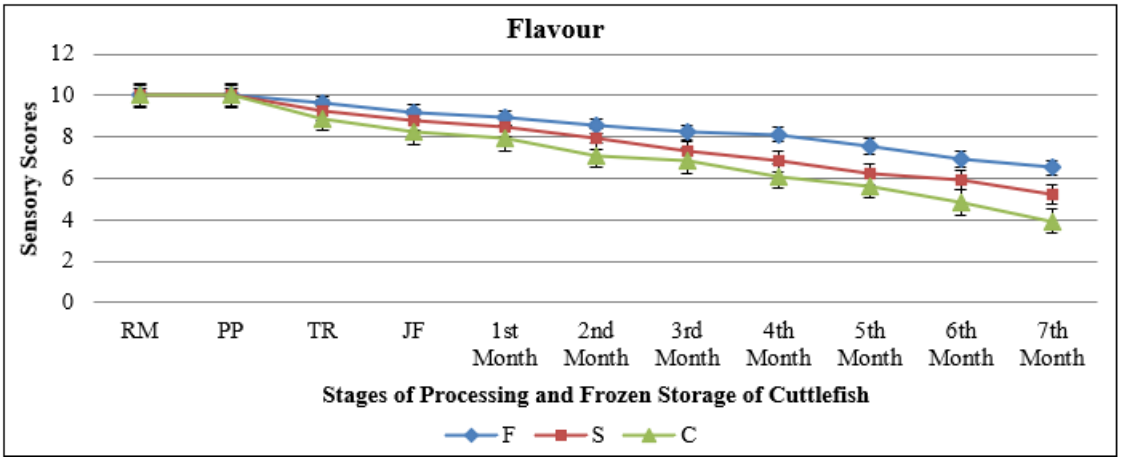


Figure 1: Changes in flavor during stages of processing and frozen storage of cuttlefish

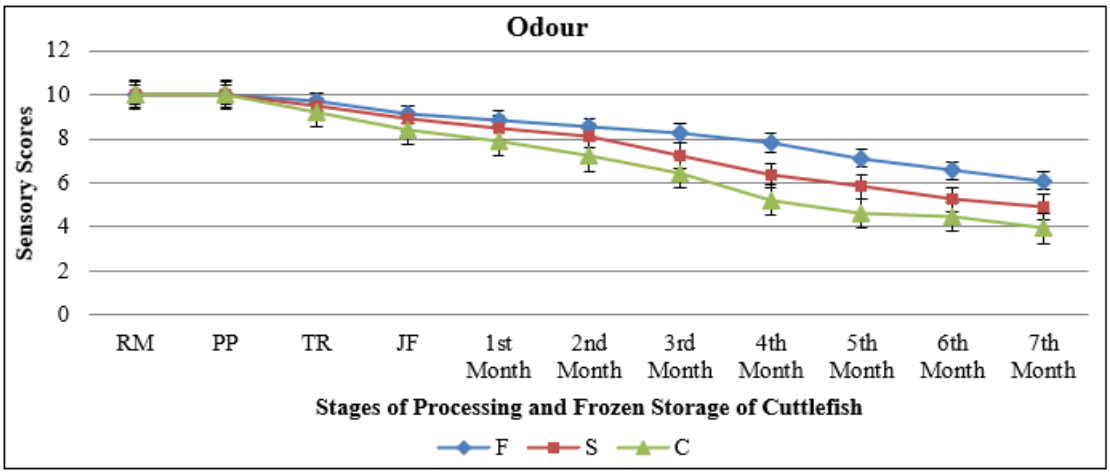


Figure 2: Changes in odour during stages of processing and frozen storage of cuttlefish

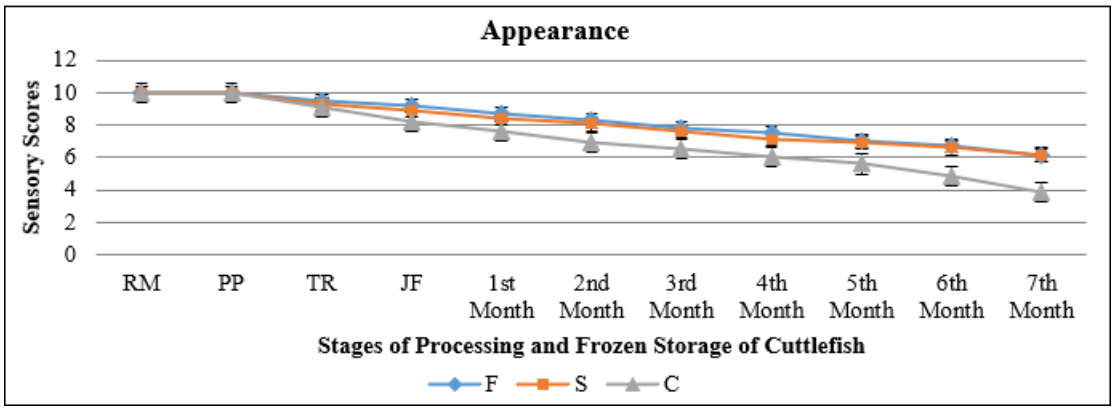


Figure 3: Changes in appearance during stages of processing and frozen storage of cuttlefish

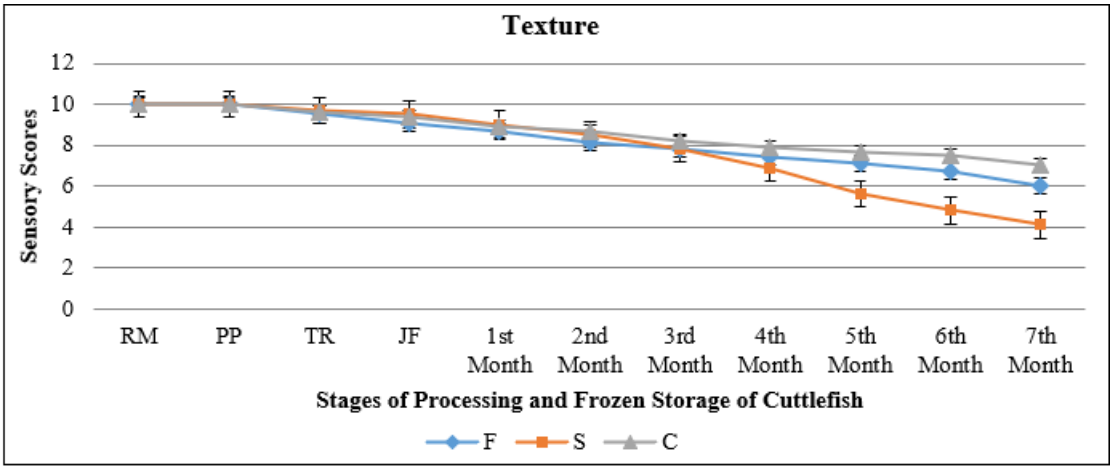


Figure 4: Changes in texture during stages of processing and frozen storage of cuttlefish

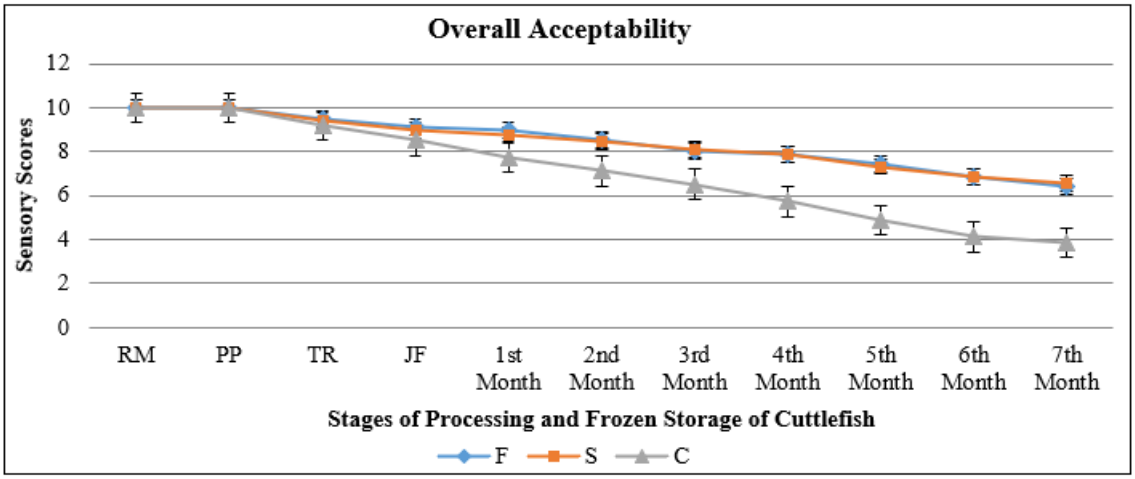


Figure 5: Changes in overall acceptability during stages of processing and frozen storage of cuttlefish

4. Summary and Conclusion

The sensory quality of raw material (Cuttlefish, *sepilia inermis*) was found excellent with high acceptability. Raw cuttlefish scored the highest value (10.0±0.00) for flavour, odour and appearance and 9.88±0.00 for overall acceptability. It had a sensory score of 9.50±0.10 for appearance. Raw material showed the excellent quality with high acceptability. The results were similar with the findings of Lakshmanan *et al.* (1993). They found the quality levels of around 90% of industrial samples of squid (*Loligo* sp.) and cuttlefish (*Sepia* sp.) were moderately good to excellent based on sensory testing. Gram and Huss (1996) reported that the changes in flavour, odour, texture and colour reflect the level of freshness or decomposition, caused primarily by microbial activity in the seafood products.

The sensory score for appearance showed a higher value (10.0±0.00) in pre-processed cuttlefish than raw cuttlefish (9.50±0.10). It indicates the improvement in appearance of raw material upon pre-processing. LeBlanc and Gill (1984) reported that sensory quality analyses are particularly useful for the measurement of quality in cephalopods such as cuttlefish.

Mohanan *et al.*, (2004) documented that the frozen cuttlefish can be stored for a maximum period of 15 weeks at -18°C, which can be extended up to 19 weeks by suitable treatment. In agreement with the above study, the treatment improved the overall quality, acceptability and shelf life of cuttlefish compared to the control in the present study. There was a decreasing order of sensory scores for flavour, odour and appearance of treated cuttlefish in fresh water, salt water and control. Better quality of treated samples than control could be attributed to the preservative effect of chemicals. However, lower sensory score of flavour, odour and appearance for treated samples in salt water may be due to saltiness of water. For texture, the score of treated cuttlefish in salt water was highest (9.70±0.05) than that of control and treated cuttlefish in fresh water. This can be attributed to the role of salt present in salt water in maintaining the texture. The overall acceptability shows a decreasing score of samples treated in fresh water, salt water and control thereby indicating the role of chemicals in preserving the sensory attributes. The result is similar with the one reported by Vikas Kumar *et al.,* (2014) and Selvaraj *et al.,* (1991). They reported no discolouration in ascorbic acid treated sample and found the texture of control samples very soft and sticky in uncooked meat. They concluded that the ascorbic acid treated samples had better qualities. However, Agrafioti and Katsanidis (2012) reported the citric acid to increase toughness. Warrier *et al.*, (1975) found pre-treatments in sodium chloride or sodium tripolyphosphate to reduce the drip loss and maintain good quality of a number of fish species during frozen storage.

The present study found the decreasing trend in sensory scores of just frozen cuttlefish treated in fresh water, salt water and control for flavour, odour and appearance. Better quality of treated samples than control could be attributed to the preservative effect of chemicals. However, lower sensory score of flavour, odour and appearance for treated samples in salt water may be due to salt content of water. For texture, the score of just frozen cuttlefish treated in salt water was highest followed by control and just frozen cuttlefish treated in fresh water. This showed the salt water to be advantageous in maintaining texture. However, salt water is not good for others attributes. This can be attributed to the role of salt in salt water in maintaining the texture. Overall acceptability remains higher for just frozen cuttlefish treated in fresh water followed by salt water and control. There was significant ($P<0.01$) decrease in sensory score of all the attributes after freezing in accordance with the findings of Moral *et al.*, (1983).

Moral *et al.*, (2002) reported that during freezing and frozen storage, proteins undergo conformational changes that lead to their aggregation, thus rendering the muscle salter and tougher, dryer, and not succulent. The analysis of the sensory scores of frozen stored cuttlefish, in the present study, indicated in decreasing trend all the sensory attributes including overall acceptability. The control was unacceptable at 7th month for frozen storage for all the attributes except texture that just touched the score for boundary line of acceptability i.e. 4.00±0.00. However, all the sensory attributes remained acceptable for treated sample even after 7th month and thereby it indicated the treatment improved the overall quality, acceptance and shelf life of cuttlefish compared to the control during frozen storage. The result was similar to that reported by Selvaraj *et al.*, (1991). They reported that the ascorbic acid treatment improved the overall acceptance and shelf life of cuttlefish compared to the control during frozen storage in the ascorbic acid treated sample. They documented the treated samples to be acceptable after 9 months storage while the control was acceptable up to 6 months. Result was also in line with that of Joseph *et al.*, (1977) they noted that the cuttlefish lost its sensory quality at the end of 19th week and found to be acceptable and good when treated with salt and polyphosphate on frozen storage.

There was significant ($P<0.01$) changes in sensory quality during frozen storage. For flavour, the study reported the reduction in sensory scores from 10.0±0.00 in raw material to 6.52±0.03, 5.22±0.01 and 3.94±0.01 in frozen stored cuttlefish treated in fresh water treated, salt water and control respectively at the end of 7th month of frozen storage. Quality was good and acceptable for frozen stored cuttlefish treated in fresh water, salt water and control till the end of 7th month, 5th and 3rd month of frozen storage respectively. It remains fair and acceptable at the end of 7th month, 6th month of frozen storage for salt water treated cuttlefish and control respectively. Similar findings were reported by Mohanan (2004) in cuttlefish. He also reported that the needle squid lost its sensory acceptance by 3rd month of storage, but loligo retained the quality till the end of the storage. The quality of commercially caught *Loligo vulgaris*, stored for 100 days at -20°C, showed good sensory quality (Borderias, 1982). There was a significant difference ($P<0.01$) in flavour of cuttlefish between treatments and the months of frozen storage. The flavour was unacceptable at the end of 7th month of frozen storage for control sample. Moreover, flavour of frozen stored cuttlefish treated in fresh water and salt water samples, at the end of 7th month of frozen storage, were though poor but acceptable. Cuttlefish was excellent and highly acceptable till 3rd month for frozen stored cuttlefish sample treated in fresh water, 1st month for sample treated in salt water and just freezing for control.

Similarly, there was significant difference ($P<0.01$) in odour of cuttlefish between treatments and months of frozen storage. The study reports the reduction in sensory scores for odour in frozen cuttlefish treated in fresh water, salt water and control at the end of 7th month of frozen storage. Quality was good and acceptable for frozen cuttlefish treated in fresh water, salt water and control till the end of 7th, 5th and 3rd month of frozen storage respectively. Similar impact of pre-process and on process intervention by external inputs on the quality of frozen stored squids, were also reported by Moral *et al.* (1983).

All the sensory attributes including overall acceptability in general showed scores in decreasing trend. However, there was specific decrease of each attributes for individual treatment. A comparison of the quality changes in pre-processed and frozen stored cuttlefish revealed that the sensory changes were relatively lower in pre-processed cuttlefish than that of frozen stored cuttlefish. Significant differences were found in frozen stored cuttlefish with progression of storage.

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