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EFFECTS OF DRYING PROCESS ON BIOCHEMICAL AND MICROBIOLOGICAL QUALITY OF HORSE MACKEREL FISH (*MEGALASPIS CORDYLA*)

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ABSTRACT

Investigations were carried out on quality changes in salted and dried horse mackerel (*Megalaspis cordyla*). Sun drying (T1) and mechanical drying (T2) process for fish cured with salt were selected for estimating their efficiency and effect during six months storage period. Sun dried fish showed mean value of moisture, protein, ash and fat as 27.83 %, 54.13 %, 12.95 %, 5.99 %, respectively, while mechanically dried fish exhibited 30.41 %, 52.93 %, 13.14 %, 5.80 % respectively. Other bio-chemical characteristics TMA-N, TVB-N, FFA and PV were 7.72 mg%, 24.45 mg%,6.44 %,8.26 m.equ./kg for T1 and 8.24 mg% , 22.19 mg % ,7.00 %, 78.58. m.equ./kg % for T2 respectively. TPC count were 1.77×10^5 and 1.91×10^5 log cfu/g, in T1 and T2 respectively. Sensory score of T2 was higher than T1 and it was statistically significant. The use of mechanical drier for drying of horse mackerel has the added advantage of superior quality and longer shelf life than Sun dried fishes.

KEYWORDS: **Biochemical, Microbiological, drying methods, quality changes, *Megalaspis cordyla***

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INTRODUCTION

As a healthy alternative to other animal protein, the seafood is on the increasing demand all over the world. In fish processing sector, 20% of catch is processed by the traditional methods, such as Sun drying and utilized for domestic consumption [1]. However, the higher than ambient temperature of India favours the rapid growth of micro-organisms. Due to of microbial activity fish gives off odour, which can lead to short shelf life and economic loss. The time factor involved in processing the fresh fish has become critical from the standpoint of both quality and profits for marketers of fresh seafood [2]. Since the fish is highly perishable commodity the major methods of preservation followed are chilling, freezing, canning, salting, drying etc. Preservation by freezing, canning or pouch packing requires more sophisticated equipments, highly skilled man power and is high capital intensive, whereas, curing method such as drying and wet salting are simple, economical, does not require highly skilled man power and cost effective. The dried fish products exported from India during 2010-2011 was 79059 tonnes which contributed 10% of the total seafood export [3]. In India, ribbon fish, Bombay duck, silver bellies, anchovies, soles and horse mackerel are used for curing process. During peak fishing season glut quantity of fishes are used for cured fish production which cannot be sold fresh and thus it can only be preserved by this method. Carangids occupy a dominant position with a production of 0.17 million tonnes, constituting 6% of the total marine fish production during 2008. In Saurashtra region of Gujarat, the horse mackerel (*Megalaspis cordyla*) is one of the dominant species especially found in drift gill landing [4]. The present study was conducted to find the quality changes during the traditional Sun dried and mechanical dried horse mackerel. The knowledge generated from this study may help to select the method of drying process for better quality with longer shelf for salt cured horse mackerel.

MATERIALS AND METHODS

Megalaspis cordyla were procured from Veraval fishing harbour and transported to laboratory. The average weight and length of sampled fish were 245.02±41.32 g and 29.25±1.16 cm respectively. Fishes were washed in fresh water to remove the adhering dirt and the blood etc. Then they were treated with normal salt (25%) for curing 24 hrs. Then the fishes were separated in to two lots. The first lot was subjected to Sun drying by spreading fishes on sand for 4 days. The second lot was dried in a mechanical dryer. Both groups were packed in low density polyethylene (LDPE) bags, heat sealed and stored at room temperature. Sample bags were opened at an interval of every 15 days for chemical analyses (proximate composition-PV, FFA, TVB-N, TMA), microbiological analyses (total plate count) and sensory evaluation. Change in organoleptic parameters viz. colour, flavour, taste, texture and overall acceptability, were also recorded.

(i) Biochemical analysis

Moisture, crude protein, fat, ash, free fatty acids (FFA), of fish samples were determined [5].TVB-N and TMA in the samples were determined [6]. The Peroxide value of the lipid was determined from the lipid extract using iodometric method [7].

(ii) Microbiological Characteristics

The fish samples was tested for total plate count of bacteria on NA (nutrient agar).

TPC/g sample = Average count x 2 x dilution factor

(iii) Assessment of organoleptic quality

Organoleptic evaluation of the fresh fish was carried out highly experienced judges on 9-point hedonic scale [8].

(iv) Statistical Analyses

Data on different aspect of dried fish were statistically analyzed [9].

RESULTS AND DISCUSSION

1. Physical characteristics of fish

The average values of total length and weight of the fishes used were found to be 29.25 cm and 245.02 gm respectively. The average number of fish per kg was about 8-9. The average total length of 30 to 70 cm of horse mackerel reported by many researcher[10, 11, 12]. The fish used in the present study falls within the reported size range.

2. Proximate composition of fresh fish

The mean moisture, protein, fat and ash content of horse mackerel was 75.02% 20.13%, 1.1% and 1.6 %, respectively.

3. Biochemical and microbiological characteristics

The raw fish was found 3.12 mg % of TVB-N and 2.11 mg% of TMA-N, an extremely low value indicating the freshness of the raw material selected for study. It was reported that 10-15 mg TMA-N/100g is generally regarded as the limit of acceptability for human consumption that TMA-N and TVB-N increased from 1.68 to 10.0 mg% and 5.60 to 27.0 mg% respectively during quality deterioration in terms of biochemical and sensory evaluation of hilsa fish mince during frozen storage at -20^0C[13,14]. The peroxide value (PV) measures about 2.72 millimoles of oxygen absorbed per 1000g fat, if the PV is above 10-20 millimoles of O_2 per 1000g fat then the fish in all probability is rancid. PV obtained in the present study is lower than the limit for fresh fish[15]. The free fatty acid content of the fish used in the present study is 1.2 % of total lipids as oleic acid for fresh mackerel [16]. The total plate count (TPC) of the fresh horse mackerel was found to be 1.61 X 10^5 cfu/g. Such levels are similar to those found in other species such as ribbon fish *Trichiurus savala*[17,18]. Therefore, a very low TPC value observed clearly indicates that the fish was absolutely fresh with the very low bacterial load when collected for study.

4. Quality changes during storage

a. Proximate composition

The mean moisture content of Sun dried (T1), and mechanical dried fish (T2) were 29.06% and 31.93% respectively. A difference of about 2% was noted in the sample. A gradual decrease in moisture content was noted in both the samples from the first month onward during storage period. All the mechanically dried samples showed slightly higher moisture content compared to sun dried samples. The protein content recorded showed the inverse trend to those of the moisture content during the period of storage. Initially the protein content in Sun dried and mechanical dried fish was 53.38 % and 51.11 % respectively. A difference of about 2% is perhaps due to 2% difference in moisture content of the two samples. The percentage of protein was more with less moisture in Sun dried sample (T1) as compared to mechanically dried sample (T2) as recorded throughout the entire period of storage. This was very much similar to the finding of researcher [19]. The total ash content in T1 and T2 samples of horse mackerel during storage period were initially 13.05 % and 13.20 % respectively. All the samples showed rise during the first fifteen days. Thereafter a decreasing trend was noted with the advance of storage period with the value of 12.48 % and 12.54 %, respectively. The initial total lipid content in T1 and T2 was 5.60 % and 5.4 % respectively, whereas final lipid content was 6.85 % and 6.76 % respectively. Statistically the interaction effect of treatments with storage period were reported not significant ($P>0.05$). These observations are in line with[20,21]. The process of salting or drying does not affect the nutritive value of the protein in any significant way[22]. The effect of various drying methods on the quality of shark and reported that different drying methods affect colour but not the proximate composition[23]. The results obtained in the present study were in accordance with those reported by above investigators.

b) Nitrogenous compound

TVB-N

Volatile bases which include the ammoniacal nitrogen progressively increased from the first day onward in all the treatments. Similar trend of increasing total volatile base nitrogen (TVB-N) has also been reported [24].TVB-N significantly increased in both treatments at the end of 180 days. Initially a value of 19.51

mg % and 16.75 mg % were recorded in T1 and T2 samples. In last days of storage it reached up to 35.53 mg % and 30.57 mg % respectively. The TVB-N value of 200 mg% was suggested as the threshold value for spoilage of cured fish[25,26]. Both Sun dried (T1) and mechanical dried (T2) fish did not reach above threshold level even after storage for six months. Thus both samples were found to be the best for maintaining quality of cured fish. This may be a combined effect of hygienic condition adopted, less microbial load in the surrounding environment and the quality of salt used. TMA-N Change in TMA- N, another chemical index of quality, was also similar to change in TVB-N. It was observed that the TMA-N content of the raw fish (i.e. 2.11 mg %) increased steadily after salting, drying and during subsequent storage period and reached a value of around 3.49. to 12.38 mg % at the end of storage period. TMA-N value range above10-15 mg% as the limit beyond which the fish could be considered as spoiled[27,15] . TMA-N content of 4.60 mg% to 15.96 mg% in salted and sundried fish products[28]. In the present study, a relatively high TMA-N value was found in the treatment T2 as compared to T1 treatments. In dried *Sardinella fimbriata,* the TMA-N ranged between 7.1-16.34 mg/ 100 g during the period of storage[29,6]. This trend is very much similar to the present study.

c) Peroxide Value (PV)

Lipid oxidation leads to the formation of peroxide and the quantity of peroxides in the lipids of fish is used as an index to assess rancidity in it. In the present study, the peroxide value was 2.16 millimoles of oxygen per 1000 g fat of fresh fish which increased uniformly in all the products through the storage period. Generally, higher peroxide value was seen in case of fish treated with mechanical drying with high moisture level than sun drying. Lowest PV was observed in the treatments T1. In T1 sample initial value was 6.53 m.eq O_2/kg lipid while in T2 it was 6.93 6.53 m. eq O_2/ kg lipid. This value reached up to 12.38 m. eq O_2/ kg lipid and 13.10 m. eq O_2/ kg lipid in T1 and T2 respectively in the last period of storage. Increase in PV, an index of rancidity, with the storage period of 90 days indicates the accumulative effects of lipid oxidation in the product. From this period onward the level of PV started sharp increase in level to affect the overall quality as affected by accompanying FFA level in the sample.

d) Free Fatty Acid (FFA)

Increase in the free fatty acid (FFA) indicates lipolysis. Lipases and phospholipase which are present in animal tissue and microorganisms are known to be responsible for liberation of FFA. It has been commonly observed that the rate of production of FFA depends on factors such as lipid concentration, pH and temperature [30]. The FFA increased gradually during the course of storage and trend was very much similar to PV[31]. The formation of secondary oxidation products in fats of fish possibly play an important role in higher free fatty acid value[32,33]. These changes are very much reflected on sensory parameters. The increase in level of FFA in both samples indicates extensive hydrolysis of lipid.

e) Change in microbiological characteristics

During the present investigation, the total plate counts (TPC) in dry salted horse mackerel fish were found to be within the range of 1.03×10^5 to 2.48×10^5 cfu/g of samples. All treatments showed the total plate counts to be increasing marginally throughout the study period. The TPC range was high in T2 and low in the T1. This may be due to relatively high moisture level in T2 which support the growth of microorganism. As per Indian standards (ISI 4950: 2001), a TPC of 10^5 /g is proposed for dried/cured fish in domestic trade[34]. The white bait samples showed SPC of 12.2477×10^3/g[35].The bacterial count ranging from 8.934×10^4 to 4.638×10^6 in white bait[36]. In accelerated freeze dried meat, total count of less than 400/g has been reported[37]. A noticeable high bacterial content ranging from 13×10^3 to 3.3×10^4 /g in market samples of dried white bait in Andhra Pradesh[38].

f) Sensory Evaluation

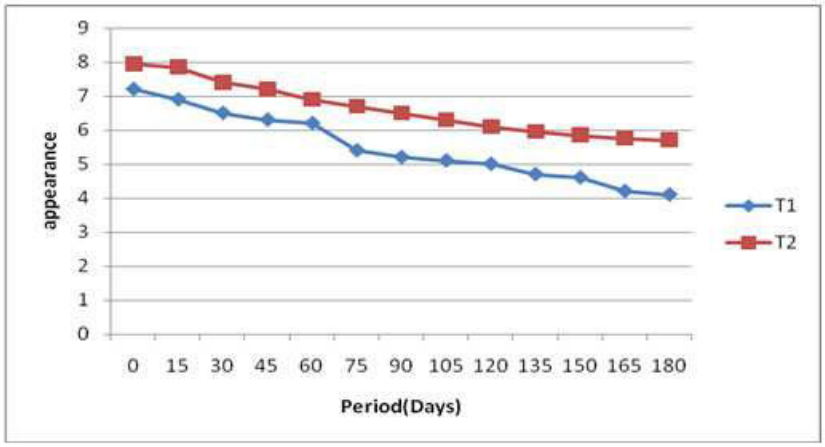
Sensory evaluation is the most reliable test for raw materials and processed fishery

products[39]. Being a subjective method, sensory evaluation in coupled with other methods, form an important quality index[40,41]. Sensory changes involved in fish are the results of the values of microbial and chemical changes taking place during storage period. Changes noted by the panellist compiles with the change recorded in microbiological and biochemical quality parameters with storage period. A decreasing sensory attributes, color, appearance odour and texture, and increase in chemical quality parameters are in close agreement to each other. The mean panel scores of sensory attributes such as appearance, color, odour and texture decreased as the storage time increased in all treatments. Highest score was attained by T2 sample, where mechanical drier was used for drying. This clearly proves the superiority of mechanical drier over the Sun drying method as far as sensory characteristics are concerned. Although no much difference in biochemical parameters was noted between sundried and mechanically dried samples, there was significant difference in sensory attributes, a parameter commonly used by consumer for acceptance or rejection of product. (Table No1) Superiority of mechanically dried fish over Sun dried fish may be attributed to controlled environment, temperature and short period of drying. The treatments T1 was favorable till the end of the 5th month and it was disliked by the panelists afterward. On the other hand, treatment T2 was favoured till the end of the experiments. This shows the mechanically dried product has an edge over the sun dried product in term of shelf life. A significant difference due to interaction between storage month and products treatment was also observed. Thus, it is clear from this experiment that use of mechanical drier of salt cured fish gives better result in terms of appearance, color, odour and texture without significant variation in composition and other quality parameters.

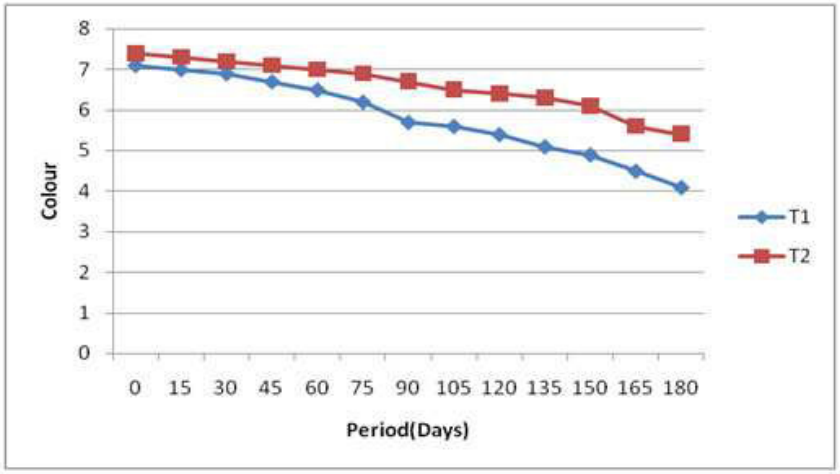
Table 1
Sensory characteristics of Sun dried (T1) and mechanical dried (T2) horse mackerel during storage period.

Storage period (days)	Appearance		Colour		Odour		Texture	
	(T1)	(T2)	(T1)	(T2)	(T1)	(T2)	(T1)	(T2)
0	7.2 ± 0. 01	7.95 ± 0.11	7.1 ± 0.11	7.4 ± 0.12	7.0 ± 0.10	7.5 ± 0.01	7.1 ± 0.10	7.5 ± 0.11
15	6.9 ± 0. 01	7.85 ± 0.13	7.0 ± 0.03	7.3 ± 0.11	6.9 ± 0.10	7.3 ± 0.10	7.0 ± 0.01	7.4 ± 0.01
30	6.5 ± 0.05	7.40 ± 0.05	6.9 ± 0.05	7.2 ± 0.02	6.8 ± 0.10	7.2 ± 0.20	6.9 ± 0.05	7.3 ± 0.05
45	6.3 ± 0.06	7.20 ± 0.14	6.7 ± 0.06	7.1 ± 0.14	6.7 ± 0.01	7.1 ± 0.01	6.8 ± 0.03	7.2 ± 0.02
60	6.2 ± 0. 01	6.90 ± 0.01	6.5 ± 0.02	7.0 ± 0.04	6.6 ± 0.11	7.0 ± 0.01	6.6 ± 0.02	7.0 ± 0.05
75	5.4 ± 0.01	6.70 ± 0.06	6.2 ± 0.01	6.9 ± 0.03	5.9 ± 0.03	6.9 ± 0.01	6.5 ± 0.01	6.9 ± 0.06
90	5.2 ± 0.11	6.50 ± 0.01	5.7 ± 0.12	6.7 ± 0.07	5.7 ± 0.22	6.8 ± 0.01	5.8 ± 0.11	6.8 ± 0.07
105	5.1 ± 0.03	6.30 ± 0.44	5.6 ± 0.03	6.5 ± 0.12	5.5 ± 0.01	6.7 ± 0.20	5.6 ± 0.03	6.6 ± 0.44
120	5.0 ± 0.01	6.10 ± 0.04	5.4 ± 0.01	6.4 ± 0.04	5.3 ± 0.01	6.6 ± 0.11	5.4 ±0.04	6.5 ± 0.11
135	4.7 ± 0.05	5.95 ± 0.08	5.1 ± 0.05	6.3 ± 0.02	4.8 ± 0.10	6.5 ± 0.30	5.3 ± 0.03	6.4 ± 0.06
150	4.6 ± 0.10	5.85 ± 0.02	4.9 ± 0.10	6.1 ± 0.02	4.7 ± 0.20	6.3 ± 0.10	4.8 ± 0.10	6.3 ± 0.02
165	4.2 ± 0.15	5.75 ± 0.04	4.5 ± 0.15	5.6 ± 0.04	4.5 ± 0.04	6.2 ± 0.10	4.6 ± 0.14	6.2 ± 0.01
180	4.1 ± 0.07	5.70 ± 0.01	4.1 ± 0.07	5.4 ± 0.35	4.1 ± 0.10	6.0 ± 0.02	4.1 ± 0.06	6.0± 0.10
Tx	**5.91**	**6.20**	**6.17**	**6.84**	**6.12**	**6.98**	**6.13**	**6.43**

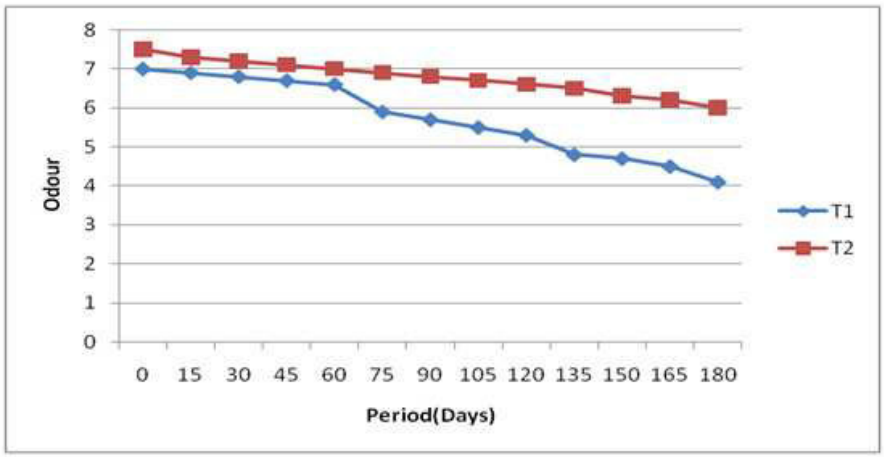
Graph 1
Changes in appearance during storage period.



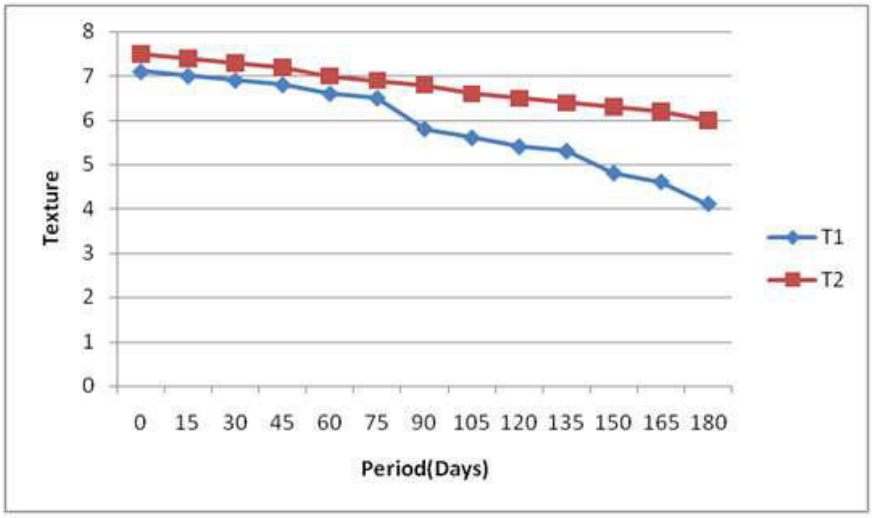
Graph 2
Changes in colour during storage period



Graph 3
Changes in odour during storage period



Graph 4
Changes in texture during storage period.



CONCLUSION

Based on the result obtained from the study of 180 days, it seems quite clear that both methods, Sun drying and mechanical drying were equally effective in salt cured fish with almost proximate composition and quality parameters. But mechanically dried horse mackerel had an edge over Sun dried fish in terms of appearance, colour, odour, texture as well as longer shelf life. Good organoleptic characteristics, coupled with longer shelf life, therefore, shall fetch high market price. This may compensate the high cost of the production for mechanically dried product fish. for clinical and preclinical studies.

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