

Effect of different salting methods on the nutritional and sensory characteristics of hilsa (*Hilsa ilisha*)

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A study was conducted to evaluate the overall quality in terms of proximate composition, rancidity, NPN (non protein nitrogen) content, protein digestibility, and sensory characteristics of hilsa (*Hilsa ilisha*) salted by different methods at ambient temperature (26-30°C). The salting methods included, salting of hilsa with dry crystalline salt, salting with previously prepared unsaturated brine (25g salt in 100ml water w/v) and salting with previously prepared saturated brine (dissolving salt in water until saturation). The hilsa salted with saturated brine showed longest shelf life (12 weeks) while the products by other two methods had shelf lives of 8 weeks only. Rancidity was maximum in the dry salted hilsa. The non-protein nitrogen content was also highest in the dry salted fish. However, the sensory characteristics of the dry salted hilsa was the best among the three different types, although the sensory characteristics were altered after 8 weeks. Hilsa salted with saturated brine retained its sensory characteristics up to 12 weeks. Despite some biochemical changes and sensory characteristics, hilsa salted with saturated brine is good and ensures a longer shelf life.

Fish is the cheapest and most abundant source of animal protein in Bangladesh. Of all the fishes consumed in Bangladesh, hilsa (*Hilsa ilisha*) has a universal appeal to the consumer because of its excellent flavour and delicate meat. Salting is a method of preservation of fatty fish traditionally practiced in Bangladesh. The traditional method of hilsa salting is that the fish is cut transversely in such a way that the fish is separated into small chunks on the dorsal side but remain joined in the belly side of the body. Dry crystalline salt is rubbed on the fish body and stacked together until ripening. Atmospheric oxygen is free to attack the unsaturated fatty acids of the fat of hilsa which possess high content of fat. The product becomes slimy and unattractive. Therefore, appropriate method of salting is needed to obtain a better quality product with long shelf life for preservation of large amount of surplus hilsa fish. The main feature of salting is the removal of a portion of water from the fish meat and its partial replacement with salt. The present study was undertaken to find out the effect of different types of salting on the storage life and quality changes in *Hilsa ilisha*.

Materials and Methods

Preparation of dry salted fish: Iced, fresh, uniform size hilsa and crystalline salt were collected from the

local market. The fish were washed with potable water. After removing scales, fins, gills and viscera the fish were cut transversely by a sharp knife in such a way that the chunks remain attached at the belly side. Dry salt (about 25% of the weight of fish) was then rubbed well on the cut surface, inside as well as outside and kept in a bamboo basket allowing for the self brine to drain out.

Preparation of brine (salt solution): Unsaturated salt solution was prepared by dissolving dry salt in water at the ratio of 25 g salt/100 ml water. Saturated salt solution was prepared by dissolving dry salt in water until no more salt dissolved in water. It required 28 g of salt in 100 ml of water.

Wet salting (saturated and unsaturated): The fish were nobbed, washed and uniformly sliced. The slices were then transferred into previously prepared saturated and unsaturated brine in two separate plastic tubs and kept immersed in the solution at room temperature (26-30°C) for the experimental period. The concentration of the saturated salt solution was maintained during storage by adding excess crystalline salt after 3rd and 5th day and whole solution was changed after the 1st week. All the products were kept at room temperature for further studies.

Sampling procedure: Salt crystals were removed from the surface of chunks of dry salted fish using tissue paper. In the case of wet salted fish water on

the surface of meat was removed with tissue paper employing a mild pressure on the slices from both sides by hand. Then the slices were chopped with skin and bone.

Biochemical analyses: Protein, lipid, ash, moisture, pepsin digestibility, free fatty acid and salt content of the salted hilsa were determined according to the methods of AOAC¹. Non protein nitrogen (NPN) was estimated by the standard micro-kjeldahl technique. Peroxide value was determined according to Egan *et al.*². Free alpha amino nitrogen was determined according to the method described by Lie³. Six different samples (chunks) were taken and homogenised properly for biochemical analyses and other parameters. The mean value of three individual observations were reported.

Sensory evaluation: Changes in the sensory characteristics like colour, texture, flavour of both dry salted and wet salted fish were determined organoleptically by a panel according to the method described by Howgate *et al.*⁴ for EC (European Commission) freshness grade for fishery product, and acceptability was calculated.

Results and Discussion

The changes in moisture and salt content in fish tissues in three different types of salted products during salting are presented in Table 1. During salting process, moisture content decreased and salt content increased considerably in the first week of storage. The moisture content in dry salted product decreased considerably from 52.98% (in fresh beheaded whole fish) to 33% during 8 weeks whereas, incase of wet salted (saturated and unsaturated) products, it came down to 46.08 and 47.25% respectively on 8th week. This indicates that more water was retained in the wet

salted product than in dry salted fish. Rapid penetration in the initial stage of salting and slow penetration at the latter stages indicated that exchange of water is largely responsible for the movement of salt in addition to osmosis. In dry salting, though the fish were covered by salt they could not take more salt because water exchange was practically absent⁵.

Changes in proximate composition of salted hilsa during storage are shown in Table 2. Moisture loss was highest in the dry salted hilsa. Leaching out of fat was observed and fat retention was maximum, as expected, in dry salted hilsa. During osmosis an amount of fat/lipid was leached out from fish to surrounding brine. At the end of the study less amount of fat was retained in the wet salted fishes. It is generally known that the salt soluble protein is leached out from fish body during osmosis. It was reported that higher percentage of protein leached out into the brine in salted fish compared to the raw hilsa fish⁶⁻⁸. Leaching out of lipid has also been reported⁸. Marked increase in the ash content of the three types of salted hilsa was found. Results (Table 2) show that the nutritional composition of three types of salted hilsa are comparable. The shelf life is also important factor when comparison is made. However, spoilage of fish, if any, due to salt preservation should be evaluated. For evaluating the quality of preserved fish, changes in protein, non protein nitrogen, pepsin digestibility, fat and organoleptic properties were considered.

The organoleptic quality of the products have been shown in Table 3. The dry salted hilsa fish and unsaturated wet salted fish were found acceptable up to 8 weeks of storage whereas the fish salted with saturated salt solution remained in acceptable condition for 12 weeks of storage despite the too salty

Table 1—Changes in moisture content and salt penetration in different types of salted hilsa

Period (weeks)	Salting in dry crystalline salt		Salting in saturated brine		Salting in unsat brine	
	Moisture (%)	Salt w.w	Moisture (%)	Salt w.w.	Moisture (%)	Salt w.w
0	52.98	1.38	52.98	1.38	52.98	1.38
1	45.07	12.98	46.02	12.57	48.73	10.87
2	44.00	14.57	45.53	14.52	45.77	12.61
3	43.40	16.41	45.37	15.97	46.61	13.47
4	45.38	17.07	45.92	17.02	47.09	14.11
5	42.49	18.15	47.66	17.87	48.95	15.66
6	32.63	19.88	46.00	18.14	47.21	15.78
7	35.08	19.27	45.00	19.02	49.36	16.10
8	33.06	18.94	46.08	18.41	47.25	15.47

Table 2—Changes in proximate composition of dry salted and wet salted (saturated and unsaturated) hilsa observed during 12 weeks of storage.

Period (weeks)	Moisture (%)			Protein (%)			Lipid (%)			Ash (%)		
	Dry	Sat.	Unsat.	Dry	Sat.	Unsat.	Dry	Sat.	Unsat.	Dry	Sat.	Unsat.
0	52.98	52.98	52.98	17.37	17.37	17.37	26.93	26.93	26.93	1.68	1.68	1.68
1	45.07	46.02	48.73	23.24	15.00	14.94	22.65	18.03	18.63	17.82	17.85	12.93
2	44.00	45.53	45.77	25.60	15.31	14.83	22.00	17.74	19.08	18.92	18.36	14.90
3	43.40	45.37	46.61	24.21	12.55	13.85	23.24	17.20	17.03	18.72	18.64	14.71
4	45.38	45.92	47.09	25.28	14.21	13.95	21.87	15.18	16.17	16.29	18.84	14.80
5	42.49	47.66	48.95	23.87	13.71	14.53	21.06	15.26	15.26	16.25	18.39	15.29
6	32.63	45.99	47.21	24.95	15.21	12.94	15.67	14.07	14.69	17.80	18.63	15.48
7	35.08	44.99	49.36	25.12	15.70	14.28	17.36	12.22	15.07	16.89	18.97	15.37
10	—	49.55	—	—	14.69	—	—	17.47	—	—	18.42	—
12	—	53.84	—	—	14.33	—	—	12.80	—	—	19.03	—

Dry=Hilsa salted with dry crystalline salt

Sat.=Hilsa salted with saturated brine

Unsat.=Hilsa salted with unsaturated brine

Table 3—Changes in physical characteristics of different types of salted hilsa (DS= Dry salted; WSS= Wet salted-saturated; WSU= Wet salted-unsaturated)

Weeks of obs.	Product	Flavour (odour and taste)	Colour	Texture	Remarks
0	DS	Neutral fishy odour	Silvery	Elastic	Acceptable
	WSS	Neutral fishy odour	Silvery	Elastic	Acceptable
	WSU	Neutral fishy odour	Silvery	Elastic	Acceptable
2	DS	Characteristic odour and taste of salted hilsa	Slightly brown	Slightly tough	Acceptable
	WSS	Characteristic odour and taste of salted hilsa	Faded brown	Semi elastic	Acceptable
	WSU	Salty taste and very low stimulating fishy odour	Silvery	Semi elastic	Acceptable
4	DS	Characteristic odour and taste of salted hilsa	Slightly red	Comparably tougher	Acceptable
	WSS	Characteristic odour and taste of salted hilsa	Faded brown	Less firm	Acceptable
	WSU	Semi-decomposed odour	Fade	Not firm	Acceptable
6	DS	Characteristic odour and taste of salted hilsa	Yellowish	Tough	Acceptable
	WSS	Salty taste and slightly fishy odour	Faded	Slightly tough	Acceptable
	WSU	Slightly putrid and decomposed odour	Fade	Soft	Acceptable
8	DS	Characteristic odour and taste of salted hilsa	Yellowish	Tough	Nice and acceptable
	WSS	Salty taste and slightly undesirable odour	Slightly brown	Slightly tough	Acceptable
	WSU	Strong decomposed odour	Fade	Soft	Not acceptable
10	DS	Strong decomposed odour	Yellow	Slightly soft	Not acceptable
	WSS	Salty taste and slightly decomposed odour	Slightly brown	Not so soft	Not so good but still acceptable
12	WSS	Salty taste and slightly decomposed odour	Slightly brown	Not so soft	Not good but acceptable

taste. Some putrid odour was found in unsaturated wet salted hilsa. Among the three types of salted hilsa of the present study the dry salted hilsa was graded as best followed by the hilsa salted with saturated brine for taste but this type (saturated brine) was found to possess longest shelf-life by the consumers taste panel.

Free alpha amino nitrogen (FAN) content of salted hilsa are shown in Table 4A. Only dry salted hilsa show increase in FAN content while the other two products do not show any appreciable change in FAN, at the end of ripening when the results are compared with the FAN of raw hilsa. Such increase in FAN of dry salted hilsa is due to the muscle enzymes. In the present study all of the three different salted products were stored with salt for ripening as chunks after gutting. So it is expected that only the muscle enzymes contributed on the process. Neither the gut enzymes nor the bacteria are important. The phenomenon is also supposed to be influenced by muscle pH of fish since the enzyme activity is governed by substratum pH. Compared with the gut enzymes, the muscle enzymes of fish play a less degree of activity during ripening⁹. This is why proteolysis was slightly less than that of 'patis' fermentation. The FAN content of hilsa stored in salt solutions were found less than that of raw hilsa. This might be because of the fact that a fraction of FAN content was diffused out of the fish tissue to the surrounding salt solution.

The changes in the NPN of dry salted, wet salted fish during storage are reported in the Table 4B. It is seen that the initial NPN contents of dry salted, wet salted products increased from 63.5 mg/100g on '0' day to 211.46 mg/100g, 48.56 mg/100g and 88.02 mg/100g respectively after 7 weeks of observation. In wet salted fish (saturated and unsaturated), the NPN were 48.56 mg/100g and 88.02 mg/100g respectively, which are much less compared to the dry salted fish. From Table 4B it is obvious that the quality of the hilsa fish salted with saturated salt solution was best. However, it should be kept in mind that a fraction of the NPN was diffused out of the fish body to the surrounding salt solution.

Pepsin digestibility of salted fish products are presented in Table 4C. The values indicate no marked difference in the various methods of preservation. The highest value was found on 2nd week and 8th week in dry salted and wet salted products respectively. These digestibility values are similar to

Table 4—Changes in free alpha-amino nitrogen (FAN) content (A), NPN (B), and Pepsin digestibility (C) in dry salted and wet salted (saturated and unsaturated) hilsa during storage.

Period (Weeks)	Dry (mg/100g)	Saturated (mg/100g)	Unsaturated (mg/100g)
A) Free alpha amino nitrogen (FAN) (Values in mg/100 g)			
0	63.30	63.30	63.30
1	61.90	39.05	54.95
2	73.11	16.11	27.69
3	71.56	16.63	36.15
4	72.31	21.32	40.77
5	74.13	21.98	47.69
6	85.42	30.55	52.63
8	94.51	35.82	62.25
10	—	21.98	—
12	—	24.62	—
B) Non-Protein nitrogen (NPN) (Values in mg/100 g)			
0	63.50	63.50	63.50
1	41.70	26.78	40.15
2	49.39	18.53	39.75
3	58.49	32.17	56.57
4	77.35	33.25	61.00
5	89.25	39.75	74.38
6	163.84	42.32	79.57
7	211.46	48.56	88.02
C) Pepsin digestibility values (Values in %)			
0	92.99	92.99	92.99
2	94.85	91.48	91.60
4	93.40	90.88	91.60
6	92.67	91.95	92.12
8	94.08	93.34	92.71

those reported in the previous study¹⁰ (92-98%). Pepsin digestibility test is widely used for assessing the quality of various dried fishery products like fish meal, dried fish, salted dried fish etc. Different types of products can be compared by digestibility test and bearing some limitations, pepsin test is an effective method for detecting the presence of non-digestible proteinous materials. In the present study, where there was no marked difference in the digestibility values, there was little nondigestible proteinous material in the products. It also indicates that the products are comparable when the digestibility values are considered.

Free fatty acid (FFA) value of the various salted products are shown in Table 5. The values increased from 1.16% on the '0' day to 11.7, 7.8 and 8.9%

Table 5—Changes in free fatty acid (FFA) and peroxide (PO) value in drysalted and wet salted (saturated and unsaturated) hilsa during storage

Period (weeks)	Dry salted		Wet salted saturated		Wet salted unsaturated	
	FFA (%)	PO (meq/kg)	FFA (%)	PO (meq/kg)	FFA (%)	PO (meq/kg)
0	1.16	9.2	1.16	9.2	1.16	9.2
1	4.95	48.08	4.6	37.20	4.8	45.15
2	5.1	68.83	4.8	59.76	6.2	67.72
3	6.4	95.67	5.7	78.72	6.7	89.28
4	7.1	113.42	6.2	89.54	7.1	107.67
5	7.6	106.39	6.9	97.57	7.5	102.36
6	8.2	101.71	7.2	103.23	8.2	96.87
7	11.7	93.29	7.8	96.91	8.9	87.17

respectively for dry salted and wet salted products (saturated and unsaturated). The increase in free fatty acid value is directly related to the degree of spoilage. In the present study dry salted fish show a higher FFA which might be due to exposure to air at room temperature (26-30°C). Wet salted products show comparatively lower FFA because the fish chunks were immersed in salt solution. Hence there was less degree of oxidation. The fat quality in terms of FFA was best in the hilsa fish salted with saturated salt solution.

To assess the oxidative rancidity, peroxide value was taken as a parameter in the present study. The peroxide value (PO) of the three different types of salted products increased from 9.2 meq/kg oil on the beginning to 113.42 (4th week), 103.23 (6th week) and 107.67 (4th week) meq/kg in dry salted and wet salted (saturated and unsaturated) products respectively (Table 5). After that period, the PO decreased slowly with time. Peroxide value gradually increased with time typically reaching a peak value midway through the ripening period and then decreased to the end of ripening. Peroxide value decreased after attaining the highest value. This is because during the initial stage of oxidation the rate of peroxide formation is higher than the rate of its degradation. After a certain period of time peroxide formation is less than that of its degradation to other compounds. The highest peroxide value 113.42 meq/kg oil was found in dry salted fish than the other two products because dry salted fish was stored in open air. Comparatively lower peroxide value was obtained in wet salted fish because the products were immersed in salt solution which saved the products from oxidative rancidity.

Results of the present study showed that the nutritional and sensory characteristics of the hilsa fish preserved in saturated salt solution is better. So salting with saturated salt solution is better suited for hilsa although the fish salted with the other two methods are acceptable.

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