High Temperature Processing of Fish Sausage III - Studies on Some of the Storage Characteristics

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The proximate composition of the high temperature processed fish sausage was found to be 14.56% protein, 4.65% fat, 69.14% moisture, 2.12% ash and 8.12% carbohydrate. The quality of the product during storage was assessed on the basis of the changes observed in the physical, chemical and microbiological parameters. The results of the different tests such as pH, volatile base nitrogen (VBN), trimethyl amine nitrogen (TMA–N) and jelly strength are summarised and discussed. The total bacterial load increased gradually during storage but was not proportional to the initial load.

Fish sausage and allied fish paste products are prone to spoilage mostly due to microbial action and other chemical changes that take place within the product. In this investigation an attempt has been made to study the quality changes occurring in the high temperature (115.6°C for 20 min) processed fish sausage during storage.

Materials and Methods

Storage studies were conducted employing physical, chemical and microbiological parameters. To test the quality and shelf life of the product, samples stored at room temperature (28 ± 2°C) were drawn at a frequency of three days and those stored in the cooler storage (2±2°C) and refrigerator (10 ± 2°C) were analysed weekly. The proximate composition of the raw material and final product was estimated as per AOAC methods (1970). The pH of fish sausage was determined by Horiba M–5 meter. Trimethyl amine nitrogen (TMA–N) and volatile base nitrogen (VBN) of the products were estimated by the method of Beatty & Gibbons (1937). Gelly strength was determined using Okada Gelometer (Tanikawa, 1971). Sampling and preparation of the product for microbial analysis were according to the APHA (1958) procedures.

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Results and Discussion

The proximate composition of the raw material and final product are given in Table 1. The fish being a lean variety recorded 0.78% fat and 17.43% protein, whereas the final product had 4.65% fat and 14.56% protein. The relative increase in fat and decrease in protein content in fish sausage might be attributed to the addition of starch (9%), fat (Vanaspathi 4%) and other ingredients in the preparation of the sausage.

Table 1. *Proximate composition of the raw material and final product*

	Raw material	Final product
Protein %	17.43	14.56
Fat %	0.78	4.65
Moisture %	76.81	69.14
Ash %	1.62	2.12
Carbohydrate %	—	8.12

The changes observed in the pH of the different samples of fish sausage are presented in Table 2. The incipient pH of control sample was found to be 6.8 and this remained almost constant during storage. The initial pH of fat coated sorbic acid (FCSA) and glucono-delta-lactone (D-lactone) treated samples were found to be 6.1 and this reduced

Table 2. *pH of various samples of fish sausage stored at different temperatures*

	Room temperature (28 ± 2°C)			
Days	Control	FCSA	D-lactone	FCSA+ D-lactone
0	6.8	6.1	6.1	5.8
3	6.8	6.1	6.1	5.8
6	6.8	6.1	6.1	5.8
9	6.8	6.1	6.1	5.8
11	—	—	6.0	5.7
12	—	—	—	5.7
13	—	—	—	5.7

	Anteroom storage (2±2°C)				Refrigerated temperature (10±2°C)			
Days	Control	FCSA	D-lactone	FCSA+ D-lactone	Control	FCSA	D-lactone	FCSA + D-lactone
0	6.8	6.1	6.1	5.8	6.8	6.1	6. 1	5.8
7	6.8	6.1	6.1	5.8	6.8	6.1	6. 1	5.8
14	6.8	6.1	6.1	5.8	6.8	6.1	6. 1	5.8
21	6.7	6.1	6.1	5.7	6.7	6.1	6.05	5.7
28	6.8	6.1	6.1	5.7	6.7	6.1	6.05	5.7
35	6.7	6.1	6.1	5.7	6.6	6.1	6. 1	5.6
42	6.7	6.1	6.2	5.6	6.7	6.0	6. 0	5.7
49	6.6	6.0	6.1	5.6	6.6	6.0	6. 0	5.6
56	6.6	6.0	6.0	5.6	6.6	6.0	6. 0	5.6
63	6.6	6.1	6.0	5.6	6.6	6.0	6. 0	5.6
70	6.5	6.0	6.1	5.6	6.5	5.9	6. 0	5.6
77	—	—	6.0	5.5	—	—	5. 9	5.5
80	—	—	6.0	5.5	—	—	5. 9	5.5

Table 3. *VBN and TMA content (mg%) of various samples of fish sausage stored at different temperatures*

	Room temperature (28 ± 2°C)									Anteroom storage (2 +2°C)								Refrigerated temperature (10 ± 2°C)							
Days	Control		FCSA		D-Lactone		FCSA+D-lactone		Days	Control		FCSA		D-lactone		FCSA + D-lactone		Control		FCSA		D-lactone		FCSA + D-lactone	
	VBN	TMA	VBN	TMA	VBN	TMA	VBN	TMA		VBN	TMA	VBN	TMA	VBN	TMA	VBN	TMA	VBN	TMA	VBN	TMA	VBN	TMA	VBN	TMA
0	7.5	2.2	7.5	2.2	6.5	2.2	6.5	2.2	0	7.5	2.2	7.5	2.2	6.5	2.2	6.5	2.2	7.5	2.2	7.5	2.2	6.5	2.2	6.5	2.2
3	7.5	3.4	10.3	3.4	7.5	2.8	7.5	2.8	7	7.5	3.4	9.3	3.4	6.5	2.2	7.5	2.2	7.5	2.2	9.3	3.4	7.5	2.2	7.5	2.2
6	9.3	3.4	11.2	3.9	9.3	2.8	7.5	2.8	14	7.5	2.8	11.2	4.5	7.5	2.2	9.3	2 2	9.3	3.4	9.3	3.4	9.3	2.2	11.2	3.4
9	11.2	3.9	11.2	3.9	9.3	3.4	9.3	3.4	21	9.3	2.8	11.2	4.5	9.3	3.4	11.2	3.4	11.2	3.9	11 2	3.4	10.3	3.4	12.1	3.4
11	—	—	—	—	10.3	3.4	11.2	3.9	28	11.2	3.4	14.0	5.0	9.3	3.4	11.2	3.4	9.3	3.9	11.2	3.9	11.2	3.9	13.1	3.4
12	—	—	—	—	—	—	12.1	3.9	35	11.2	3.4	14.9	5.0	10.3	3.9	13.1	4.5	11.2	4.5	13.1	4.5	11.2	3.9	11.2	3.4
13	—	—	—	—	—	—	12.1	4.5	42	12.1	4.5	14.9	4.5	11.2	3.9	13.1	3.4	13.1	4.5	14.0	4.5	11.2	3.4	13.1	3.9
									49	13.1	4.5	15.8	5.6	11.2	3.9	13.1	4.5	13.1	4.5	14.0	4.5	11.1	3.9	13.1	3.9
									56	13.1	5.0	15.8	4.5	11.2	3.4	14.0	5.0	13.1	5.0	14.9	5.0	12.1	4.5	14.0	4.9
									63	14.0	5.0	15.8	5.6	12.1	4.5	14.0	5.0	14.0	5.0	14.9	5.0	13.1	4.5	14.0	4.9
									70	14.0	5.6	14.9	5.6	12.1	4.5	13.1	4.5	14.0	5.0	15.9	5.6	14.0	5.0	13.1	4.9
									77	—	—	—	—	13.1	5.0	14.0	5.6	—	—	—	—	14.0	5.0	14.9	5.0
									80	—	—	—	—	13.1	5.0	14.9	5.6	—	—	—	—	14.9	5.6	14.9	5.0

Table 4. *Jelly strength (g cm) of various samples of fish sausage stored at different temperatures*

Days	Room temperature (28 ± 2°C) Control	FCSA	D-lactone	FCSA + D-lactone	Days	Anteroom storage (2 ± 2°C) Control	FCSA	D-lactone	FCSA+ D-lactone	Refrigerated temperature (10 ± 2°C) Control	FCSA	D-lactone	FCSA+ D-lactone
0	459	370	382	382	0	459	370	382	382	459	370	382	382
3	388	355	328	336	7	447	381	298	304	416	308	318	363
6	320	312	342	301	14	384	306	290	292	340	264	264	348
9	301	284	286	272	21	354	332	249	262	372	294	248	322
11	—	—	254	248	28	326	284	256	251	381	272	240	356
12	—	—	—	288	38	348	272	262	242	362	256	228	284
13	—	—	—	252	42	292	261	248	240	372	248	246	262
					49	312	248	284	221	344	216	232	216
					56	281	254	268	206	319	192	221	198
					63	266	192	246	238	281	228	264	164
					70	248	156	232	184	162	164	208	184
					77	—	—	214	172	—	—	198	156
					80	—	—	186	148	—	—	164	148

Table 5. *Total plate count (per g) of various samples of fish sausage stored at different temperatures*

	Room temperature (28 ± 2°C)					Anteroom storage (2 ± 2°C)				Refrigerated temperature (10 ± 2°C)			
Days	Control	FCSA	D-lactone	FCSA + D-lactone	Days	Control	FCSA	D-lactone	FCSA + D-lactone	Control	FCSA	D-lactone	FCSA + D-lactone
0	1.9×10^3	1.5×10^3	2.0×10^2	1.2×10^2	0	1.9×10^3	1.5×10^3	2.0×10^3	1.2×10^2	1.9×10^3	1.5×10^3	2.0×10^2	1.2×10^2
3	4.5×10^3	3.8×10^3	4.5×10^2	2.3×10^2	7	2.7×10^2	1.6×10^3	4.5×10^2	1.8×10^3	1.4×10^3	1.8×10^3	6.5×10^3	4.1×10^3
6	8.3×10^3	5.1×10^3	3.1×10^2	6.2×10^2	14	3.6×10^3	2.6×10^3	1.4×10^3	2.3×10^3	2.5×10^3	2.3×10^3	1.8×10^3	8.4×10^2
9	2.6×10^4	8.2×10^3	2.8×10^3	2.8×10^3	21	4.3×10^3	3.2×10^3	9.0×10^2	6.2×10^2	5.8×10^3	3.2×10^3	2.4×10^3	1.5×10^3
11	—	—	1.2×10^4	7.2×10^3	28	3.9×10^3	4.8×10^3	4.1×10^3	1.1×10^2	4.2×10^3	4.8×10^3	3.6×10^3	3.2×10^3
12	—	—	—	2.1×10^4	35	6.2×10^3	4.9×10^3	4.6×10^4	2.8×10^3	6.9×10^3	5.1×10^3	5.2×10^3	4.8×10^3
13	—	—	—	8.6×10^3	42	8.2×10^3	5.2×10^3	5.8×10^3	4.2×10^3	5.4×10^3	4.6×10^3	6.8×10^4	7.6×10^3
					49	6.7×10^3	5.1×10^3	6.2×10^3	5.9×10^3	1.8×10^4	5.8×10^3	1.2×10^4	7.2×10^3
					56	7.8×10^3	6.8×10^3	7.2×10^3	7.1×10^3	3.5×10^4	2.1×10^4	7.2×10^5	8.9×10^3
					63	5.2×10^4	2.3×10^4	9.1×10^3	8.3×10^3	7.9×10^6	7.2×10^4	1.8×10^4	1.2×10^4
					70	8.1×10^4	5.1×10^4	1.8×10^4	2.2×10^4	1.2×10^5	2.4×10^5	4.1×10^4	1.8×10^4
					77	—	—	5.3×10^4	4.3×10^4	—	—	6.2×10^4	4.8×10^4
					80	—	—	7.2×10^4	6.8×10^4	—	—	8.1×10^4	5.3×10^4

value may perhaps be due to the acidic nature of FCSA and D-lactone. The FCSA + D-lactone treated sample registered a pH of 5.8 which might be due to the cumulative acidic nature of both FCSA and D-lactone. The pH of all the samples were found to decrease gradually during storage. This might be attributed to the acid formation in fish sausage over a prolonged period of storage (Tanikawa, 1971).

Table 3 shows the changes observed in volatile base nitrogen (VBN) and trimethyl amine nitrogen (TMA–N) contents of fish sausage during the storage period. The VBN and TMA–N contents of the control were found to be 7.5 mg% and 2.2 mg% respectively, which was noticed to increase to 11.2 mg% and 3.9 mg% over a period of 9 days. But the VBN contents of the control stored in the cooler storage and refrigerator rose to 14.0 mg% at the end of 70 days. Similarly, the VBN and TMA–N contents of FCSA, D-lactone and FCSA+D-lactone treated samples increased gradually during storage (Table 3). This increase might be attributed to the activity of certain bacteria which would have survived the heat processing.

The changes observed in the jelly strength during storage are given in Table 4. The initial jelly strengths of the control, FCSA, D-lactone and FCSA+D-lactone treated samples were in the order of 459, 370, 382 and 382 g cm. respectively which are highly desirable for fish sausage and other paste products. However, the decreased jelly strengths noticed in other samples might be due to the effect of the acidic nature of the preservatives on the texture of the products. Moreover, the jelly strength was found to decrease gradually as the storage period advanced. This might be due to the degradation of starch that takes place due to the bacterial activty and bacterial enzymes which in turn reduces the binding quality resulting in softening of the product and subsequent reduction in the jelly strength (Yermal *et al.*, 1972).

The high bacterial count recorded initially might be due to the surviving thermophillic spores that had tolerated a high processing temperature (Uchiyama, 1961). Moreover, during the cooling process a favourable condition might develop facilitating the germination of the bacterial spores giving rise to higher initial counts. However, the addition of preservatives to fish sausage registered a marginal decrease in the total microbial load. This decrease might be due to the combined inhibitory effect (germicidal power) of the preservatives and the pH of the product on the growth and multiplication of micro-organisms (Simidu, 1956; Goda & Iss, 1959). The bacterial count did not increase considerably during storage (Table 5) owing to the unfavourable temperature of storage for the thermophillic vegetative cells to multiply and propagate.

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