Chemical and Physical Characteristics of Lightly Salted Minced Cod (*Gadus morhua*) 45b

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ABSTRACT

The production of a lightly salted product from minced cod was investigated. The addition of 13% salt to cod mince showed several advantages over the previously employed 25% salt treatment. The lightly salted product had a gelatinous-fibrous texture which had shape stability after drying and cooking. When dried to 30% moisture, better water binding capacity was seen during rehydration and after cooking, with improved texture as measured on the Instron instrument.

INTRODUCTION

RECENT MEDIA ATTENTION on world hunger, particularly on the African continent, has demonstrated rather dramatically the ongoing need for new and perhaps unconventional food sources. Protein from marine products is nutritionally complete and, in light of increasing economic and environmental pressures to utilize fishery by-catch materials and underutilized species, fish may represent a potential solution for the malnourished populations of the world. One product which may be particularly promising is minced fish flesh. Its production offers several advantages over the more conventional means of using seafoods: (1) provides a higher yield; (2) permits use of filleting waste, shrimp by-catch and nontraditional species; (3) easy incorporation with other foodstuffs to increase nutritional aspects and palatability; (4) cost is fairly minimal; and (5) it is a simple process requiring no special skills and a very short processing time.

An effective method of using minced fish flesh may be salting, since this ensures preservation and actually requires little further processing. Additionally, a salted mince product may substitute for more traditional salt fish, of which production has declined dramatically over the past few decades, in spite of a fairly healthy demand from tropical countries (Bligh and Regier, 1976).

Salting of minced fish was first introduced by Del Valle and Nickerson (1968). Their process involved grinding of shark flesh with salt, followed by further mixing, pressing of the salt minced flesh at 13,790 kN/m^2 (2000 lb/in^2) to remove water and form cakes, and drying the cake, either artificially or naturally. The product was called "quick salted", due to the rapid rate of salt penetration into exposed muscle. Low moisture content and sufficient salt eliminated bacterial action and insured good storage stability at ambient temperatures.

Del Valle and Gonzalez-Inigo (1968) used this process with other species of fish and noted that insufficient salt content resulted in a gelatinous mass which could not be pressed. Excessive salting produced a very brittle cake after pressing. A correlation was made between the minimal amount of salt necessary and the water holding capacity of the fresh fish. Finally, they showed that only negligible amounts of protein were lost in press juice and leaching water.

Wojtowicz et al. (1977) studied several undefined parameters of the earlier salted mince methods and determined that one part salt with three parts minced flesh was most desirable for saturation and maximum dehydration. Salt concentrations in excess of 25% resulted in an excessively salty product. Also, the addition of salt must be rapid to by-pass the intermediate gel stage with its resultant irreversible rubber-like texture. Temperature during mixing was found to influence rate of salting; a temperature of 35°C, accompanied by efficient stirring, was recommended. Removal of brine from the salt minced flesh involved loss of nutritional components such as water soluble proteins, vitamins, and minerals. However, it also eliminated some highly reactive and undesirable components such as pigments, amino acids, peptides, amines, carbohydrates and carbonyls.

Wojtowicz et al. (1977) also noted that salt minced fish could be stored without further drying when: (1) moisture was not higher than 40–45%; (2) storage temperature was 2–8°C; (3) protection against oxygen and light was provided. Further drying was necessary, however, since the product would be stored normally without refrigeration or even at tropical temperatures. A moisture content of 18–22% (water activity 0.68 and 0.72) reduced chances of halophilic bacterial growth at ambient temperatures.

The main disadvantages of the Wojtowicz product were its lack of protein functionality and its unattractive fibrous texture (Bligh and Duclos 1981). The purpose of the present study

Table 1—Composition of dried (30% moisture) salt minced cod following various salt treatments and its characteristics before drying

Salt Treatment %	Composition Protein%	Salt%	Characteristics (before drying)
5	55	15	Firm protein gel, sticky, translucent, yellowish color.
9	50	20	Gelatinous, sticky, translucent.
13	48	22	Semi-gelatinous, semifibrous, cohesive, slightly white.
17	44	26	Noncohesive, semi-fibrous, white.
20	44	26	Semi-dry fibrous protein, opaque white, friable
25[a]	40	30	Semi-dry fibrous protein opaque white, friable

[a] Wojtowicz et al. (1977)

Table 2—Water uptake during rehydration of dried salt minced cod

	Salt Treatment (%)				
Weight (g)	5	9	13	17	20
Wt before soaking	28.55	32.53	29.83	28.59	29.14
Wt after soaking[a]	46.99	45.22	54.16	43.94	42.76
% water uptake	39.2	28.1	44.9	34.9	31.9

[a] Soaked 4 hr at approx. 21°C in 10 volumes of water.

Table 3—Composition of salt minced cod after rehydration and cooking

	Salt treatment (%)				
Composition	5	9	13	17	20
Moisture	66	68	72	67	68
Protein	31	30	26	30	31
Salt	3	2	2	3	1
Total	100	100	100	100	100

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was to investigate production of a lighter salted minced cod product that would eliminate these undesirable characteristics of the earlier product. Duerr and Dyer (1952) reported denaturation of cod muscle protein at salt concentration of 8–10% in the muscle. Minced cod with a salt concentration in this range, rather than 25% previously used, should yield a product with greater protein functionality and more desirable physical characteristics.

MATERIALS & METHODS

Raw material

Strictly fresh whole and gutted cod (*Gadus morhua*) were purchased from local suppliers. The fish were split manually, the backbone and kidney were removed, and they were rinsed in clean tap water before being minced. Fine grade fishery salt was used for salting.

Pilot plant production

Split cod were mechanically deboned using a Bibun SDX 16 meat-bone separator (Ryan Engineering Inc., Seattle, WA) fitted with a 5 mm hole drum. The mince was held at 5°C until salting later the same day. Batches of minced cod, weighing approximately 2.1 kg each, were mixed for 5 min in a Hobart mixer with 9,13,17,20, or 25% salt (w/w). The mixture was held at 35°C for 30 min with frequent stirring. Released brine was removed using a vacuum filter press (Passey and Hotton, 1978). The pressed slabs (approximately 61 × 22 × 1 cm) were dried to 30–35% moisture in a mechanical drier with an inlet temperature of 29°C and relative humidity of 60%. Drying time ranged from 28–54 hr, depending upon the salt treatment. The dried product was held for 24 hr at 5°C to permit moisture equilibration within the slab. Finally, the dried salt minced cod was cut into cakes approximately 8 cm^2 and sealed (without vacuum) in laminated polyethylene-aluminum foil pouches.

Laboratory analyses

Composition of the various salted minced products was determined in triplicate. Protein was analyzed by the micro-Kjeldahl method for nitrogen (Concon and Soltess, 1973). Sodium chloride levels were determined by conductivity (Duclos-Rendell, 1983). Moisture was determined by measuring weight loss of a 10-g sample dried for 24 hr at 105°C.

Texture analysis was performed on mince which was desalted and rehydrated by soaking a 30-g sample in 10 volumes of water for 4 hr. Excess water was then drained in a Buchner funnel and percentage water uptake calculated from weight difference before and after rehydration. Samples were cooked in 75 mL boiling water for 4 min, and texture analyzed using the Instron Universal Testing Instrument (Gill et al., 1979).

A Gardner Automatic Color Difference meter (Model AC-3, Gardner Laboratory, Bethesda, MD) was employed to analyze color in cooked and cooled mince samples which were pressed to the bottom of a glass petri dish in order to be as flat as possible. These were rotated and measured three times. Average lightness (L) values (where 0 is black and 100 is white) and standard deviations were calculated.

RESULTS & DISCUSSION

THE WATER HOLDING CAPACITY of the minced cod following the various salt treatments is presented in Fig. 1. These results confirmed that the water holding capacity of cod flesh decreased with an increase in salt concentration. A rapid increase in water loss was observed when more than 9% salt was reached in the muscle, demonstrating that salt treatments of less than 25% can be used to denature the protein and to release appreciable quantities of water from the flesh. The 13% salt treatment was very effective, removing about one-half of the water that was released by the 25% salt treatment, while retaining some functional properties of the protein.

Composition of the salted minced products is reported in Table 1. At a common moisture level of 30%, protein values decreased inversely with increased additions of salt as expected. Compared to the product of Wojtowicz et al. (1977), 13% salt treatment yielded an end product with appreciably more protein and less salt. Furthermore, it retained a formed shape (i.e., a cake) and had an acceptable semi-fibrous texture which could withstand handling after drying. Conversely, Wojtowicz's product was described as friable and somewhat mealy.

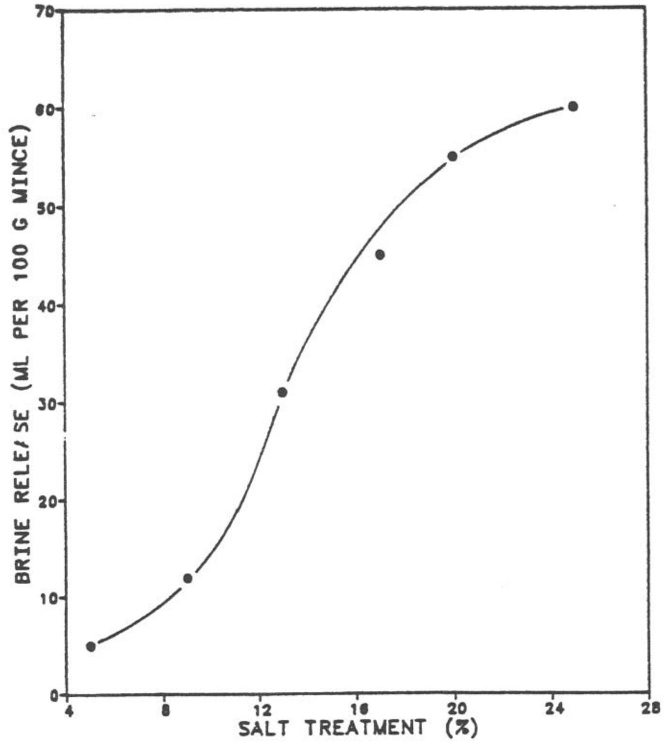

Fig. 1—Brine released (by filter press) versus salt treatment of the minced cod muscle.

Table 4—Textural characteristics of the cooked salt minced cod as measured on the Instron instrument

Salt Treatment	Peak height Force (kg)[a]	Peak slope (kg/cm)	No. of samples
25	350.3 ± 8.4 (S.D.)	28.74 ± 2.00	6
20	282.7 ± 4.5	17.62 ± 6.00	3
17	205.3 ± 18.1	16.34 ± 1.94	10
13	147.3 ± 17.7	8.26 ± 1.02	10
9	137.2 ± 8.0	7.63 ± 1.25	10

[a] The average peak height for fresh cod samples after cooking was 66.2, where the average peak slope was 19.8.

Protein functionality of the salt treated products was studied in relation to their water uptake during rehydration and cooking (Table 2). Water uptake was not proportional to the amount of salt added. The results indicated that the 13% salt product absorbed more water (by weight) than the others, showing an improvement in water binding capacity.

Composition of the various products was re-examined after cooking (Table 3). Rehydration and cooking removed most of the salt, making the product acceptable for consumption. Of more significance, however, was the fact that the 13% salt product retained its water holding capacity and shape stability through cooking.

Results for Instron texture measurement are shown in Table 4. Textural deterioration is characterized by higher peak heights and steeper peak slopes. The texture values showed that increasing amounts of salt contributed to toughening. Although the 9% salt product was the most tender, its gelatinous characteristics were undesirable in that they inhibited moisture removal and produced a rubbery product. This appeared to be overcome by the addition of about 13% salt which still yielded a product with better texture than higher salt treatments.

The appearance of the cooked products was also noted. The 9% salt treatment was rubbery and wet; the 20 and 25% salt treatments were fibrous (mealy) and dry; the 13 and 17% salt

Table 5—Mean color values (L)[e] for cooked salt minced cod products[f]

	Salt treatment (%)				
	5	9	13	17	20
Initial Product	58.95 ± 0.10[d]	60.82 ± 0.87[bcd]	65.57 ± 0.8[a]	62.45 ± 0.91[b]	61.88 ± 1.11[bc]
Stored Product[f]	62.95 ± 1.19[c]	65.29 ± 1.84[b]	68.55 ± 1.28[a]	64.09 ± 0.66[bc]	67.97 ± 075[a]

[a-d] Values are means of three determinations, plus or minus standard deviation. In each row, values with the same superscript are not significantly different (P = 0.05).
[e] L = lightness, where 0 is black and 100 is white.
[f] Product stored 2 months approx. 21°C.

treatments had more textured structures resembling traditional salt cod.

The color of the products was measured in relation to salt content and storage for 2 months at approx. 21°C (Table 5). The results indicated that the lighter salt treatment at 13% produced a product as white as the higher salt treatments and that this characteristic was maintained during limited storage at ambient temperature.

It was found that the typical odor and taste of salted cod developed more rapidly when the mince was dried immediately after salting and was subsequently stored at about 21°C for at least 9 days. Prolonged storage prior to drying did not induce flavor and odor development which appeared to be promoted by the drying process.

This study on light salting of minced cod revealed that improvements can be made on the previous heavy salted products. The water binding properties of minced cod tissue were significantly altered by the addition of 13% salt to enable the production of a product with improved protein functionality. Although 25% salting normally released twice as much tissue-bound water as 13% salt treatment, the latter product had better rehydration capacity and shape retention even after cooking. Moreover, the texture of the light salted material was more like that of traditional salt cod.

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