Bangladesh J. Fish. Res., 13(1), 2009: 83-88

Standardization of setting temperature and time for fish meat

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Abstract
Meat to water ratio used for washing was 1:3 for oil sardine and mackerel; but for pink perch and croaker, it was 1:2. Again the washing process was repeated three times for oil sardine and mackerel; but two times for pink perch and croaker. The washed meat was mixed with 2.5% NaCl and set at +5^{0}C and +40^{0}C for 1, 2 and 3 hr. The gel strength and expressible water content was measured. Basing on this study, setting temperature at +40^{0}C was selected and with respect to time 1hr for sardine and mackerel and 3 hr for pink perch and croaker was selected.

Key words: Fish meat, Gel strength, Marine fish

Introduction

When salt is added to surimi and ground paste is left for a certain period of time, a slightly translucent gel is formed which is celled a "suwari". This phenomenon is known as setting (Lanier 1986). Setting is a gel-forming phenomena which occurs when salted meat paste is incubated below 40^{0}C (high temperature setting) for 2-4 hr or following an extended period (12-24hr) at lower temperatures of 0-40^{0}C (low temperature setting) reported by Wu *et al.* 1985. Setting enhances surimi gelling properties in a great extent (Kamath *et al.* 1992, Seki *et al.* 1998). Kamath *et al.* (1992) suggested non-disulphide covalent cross-linking of myosin heavy chain in setting of Allaska pollack and Atlantic croaker surimi. They observed Myosin heavy chain (MHC) content of cooked gels of pollack and croaker surimi decreased during preincubation ("setting") at temperatures ranging from 4-50^{0}C. Decreases in MHC content were attributed to either non disulfide covalent cross-linking or proteolysis. Maximum production of cross-linked polymers occurred at the optimum setting temperature, i.e., at 25^{0}C for pollack surimi and 40^{0}C for croaker surimi In the present study standardization of setting temperature and time was done by setting the fish meat at +5^{0}C and +40^{0}C for 1, 2 and 3 hr. The fishes used for this purpose are Indian oil sardine (*Sardinella longiceps*), Indian Mackerel (*Rastrelliger kanagurta*), Pink perch (*Nemipterus japonicus*) and Croaker (*Johinus dussumieri*).

Materials and methods

In the laboratory fishes were washed and dressed by removing scales, skin, viscera and head. After washing and dressing, the meat was picked by meat picking machine and the picked meat was minced by mincer. Minced meat of each species was then washed with chilled potable water. Meat to water ratio used for washing was 1:3 for fatty fish like oil sardine and mackerel; but for lean fish like pink perch and croaker, meat to water ratio was 1:2. Again the washing process was repeated three times for oil sardine and mackerel; but two times for pink perch and croaker. Each washing was done for 2 minutes only. The p^H of used water for water washing was 7. After each wash the meat was gently squeezed in a cotton cloth to remove excess water.

About 100g of the treated/untreated fish mince was taken and macerated in a mortar with pestle for 10 minutes at 5^0C. Then 2.5 g of NaCl was added, grinding was continued for another 10 minutes till a viscous paste was obtained. The viscous paste was immediately stuffed into krehlon casings of size 3.0x15 cm (diameter x length). The stuffed casings were kept for settings at 5^0C and 40^0C for 1, 2 and 3 hrs without disturbance. The set meat was used for preparation of gel. Then the stuffed casings were kept in a temperature controlled water bath for 20 min at 90^0C. The gels were then immediately cooled in iced water and stored at 4^0C for 24 hrs before the measurement of gel strength and expressible water.

Gel strength was measured by using Rheotex (Sunshine) instrument A piece of about 25 mm thickness taken from gel was placed under the plunger of gellometer. The pressure on gel piece was applied by the plunger. The gel strength was calculated by the following formula:

Gel strength(J) = Stress x Strain g-cm

Expressible water was determined by the method of Okada (1963). A known weight of gel piece of 2 mm thickness was placed between two pre weighed filter papers. A pressure of about 10 kg/cm^2 was applied for 20 seconds on the filter paper by putting an iron weight of 10 kg. After scrapping all the meat from the filter paper, the weight of filter paper was recorded. The expressible water was expressed as percent of meat based on the quantity of water absorbed by the filter paper.

Results and discussion

Washed fish meat with salt treatment was mixed with 2.5% NaCl and was set at $+5^0$C and $+40^0$C for 1hr, 2hrs and 3 hrs. The effect of setting in different time on gel strength and expressible water for different fishes are presented in Table 1 for $+5^0$C and in Table 2 for $+40^0$C. Generally, setting can be performed at low (0-$+4^0$C), medium($+25^0$C) and high($+40^0$C) temperature (Lanier 1992). Different species have a different optimum setting temperature undetermined by the heat stability of myosin. Pollack and croaker have optimum setting temperature of 25 and 40^0C respectively

(Kamath *et al.* 1992), where as croaker surimi showed no setting response at +4°C. So in the present study setting was done 1, 2 and 3 hrs for +5°C and +40°C . The positive effect of setting on final quality of gel and gel strength is advocated by a number of workers (Niwa *et al.* 1981, Numakura *et al.* 1985, Roussel and Cheftel 1990). For such a gel strengthening the bonds involved may be hydrogen bonds, hydrophobic interactions, disulphide linkages and various other interactions, which takes place during setting such as cross-linking of myosin heavy chain. However the role of hydrogen bonds in setting with conclusive evidence is not given as in presence of water the mutual interaction between polar residues of protein and water molecules compete with that between residues (Hamaguchgi 1967). The role of hydrophobic interaction in setting is very important (Miyazima 1974, Niwa 1975).

Table 1. Effect of setting temp. at +5°C on gel strength & expressible water content of fish meat

Treatment	Gel strength (g-cm)			Expressible water (%)		
	1hr	2hr	3hr	1hr	2hr	3hr
Sardine	372.25 (±5.45)	428.17 (±5.87)	475.28 (±7.58)	25.68 (±0.12)	25.12 (±0.19)	24.65 (±0.27)
Mackerel	498.56 (±5.71)	563.42 (±6.89)	623.38 (±7.76)	24.42 (±0.10)	23.77 (±0.16)	23.17 (±0.26)
Pink perch	615.86 (±12.52)	703.27 (±10.75)	805.19 (±10.34)	23.25 (±0.35)	22.37 (±0.24)	21.35 (±0.35)
Croaker	633.67 (±11.56)	727.43 (±11.72)	836.24 (±10.89)	23.07 (±0.21)	22.13 (±0.15)	21.04 (±0.15)

*values in parenthesis indicate standard deviation, n=3

Table 2. Effect of setting temp. at +40°C on gel strength & expressible water content of fish meat

Treatment	Gel strength (g-cm)			Expressible water (%)		
	1hr	2hr	3hr	1hr	2hr	3hr
Sardine	506.57 (±14.36)	471.32 (±14.36)	489.26 (±14.3)	24.34 (±0.27)	24.69 (±0.16)	24.51 (±0.24)
Mackerel	676.28 (±8.43)	636.31 (±11.78)	657.21 (±11.78)	22.64 (±0.09)	23.04 (±0.29)	22.83 (±0.25)
Pink perch	623.45 (±10.78)	645.28 (±10.57)	687.45 (±10.69)	23.17 (±0.43)	22.95 (±0.53)	22.53 (±0.26)
Croaker	642.17 (±10.81)	675.43 (±11.35)	724.13 (±10.24)	22.98 (±0.29)	22.75 (±0.19)	22.16 (±0.24)

*values in parenthesis indicate standard deviation , n=3

The gel strength in 1 hr setting was 372.25, 498.56, 615.86 and 633.67 g-cm in sardine, mackerel, pink perch and croaker meat respectively at +5°C. But at +40°C the gel strength in 1 hr setting it was 506.57, 676.28, 623.45 and 642.17 g-cm in sardine, mackerel, pink perch and croaker meat respectively. Again when time was increased to 3 hrs at +40°C the gel strength changed to 489.26, 657.21,687.45 and 724.13 g-cm in

sardine, mackerel, pink perch and croaker meat respectively and the respective expressible water % was 24.51, 22.83, 22.53 and 22.16 %. Figs. 1 and 2 represents that as the setting time increased the gel strength was increased in case of setting temperature $+5^0$C ; where as in case of $+40^0$C setting the gel strength was varied for different hrs in different species. The croaker meat set at $+5^0$C for 3 hrs represented highest gel strength as 836.24 g-cm. But at $+40^0$C the sardine and mackerel meat showed 506.57 and 676.28 g-cm in 1 hr; where as in pink perch and croaker meat in 3 hrs the highest gel strength was 687.45 and 724.13 g-cm respectively.

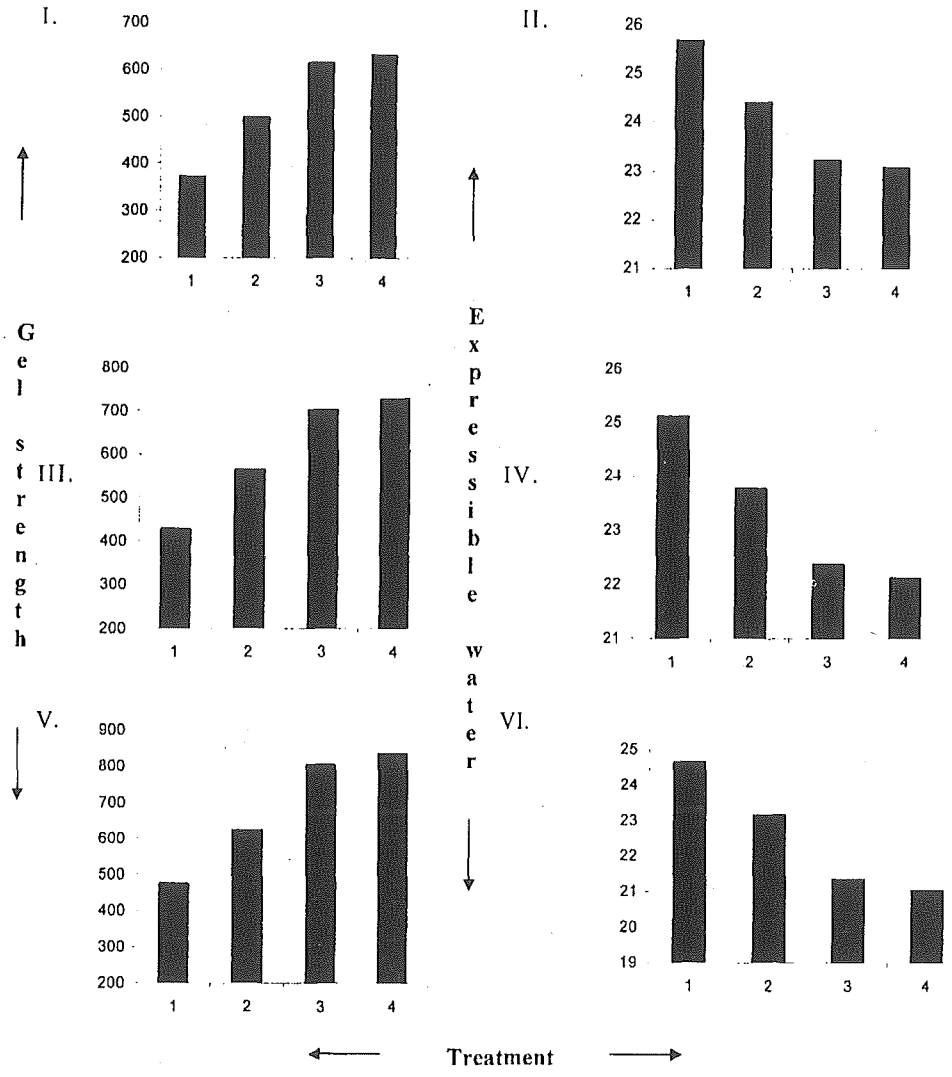

Fig. 1. Effect of setting temperature at on the gel strength and expressible water of mackerel meat set at $+5^0$C.
II & I. for 1 hr.; III & IV. for 2 hr.; V& VI. for 3 hr . 1- control, 2- treatment of $CaCl_2$

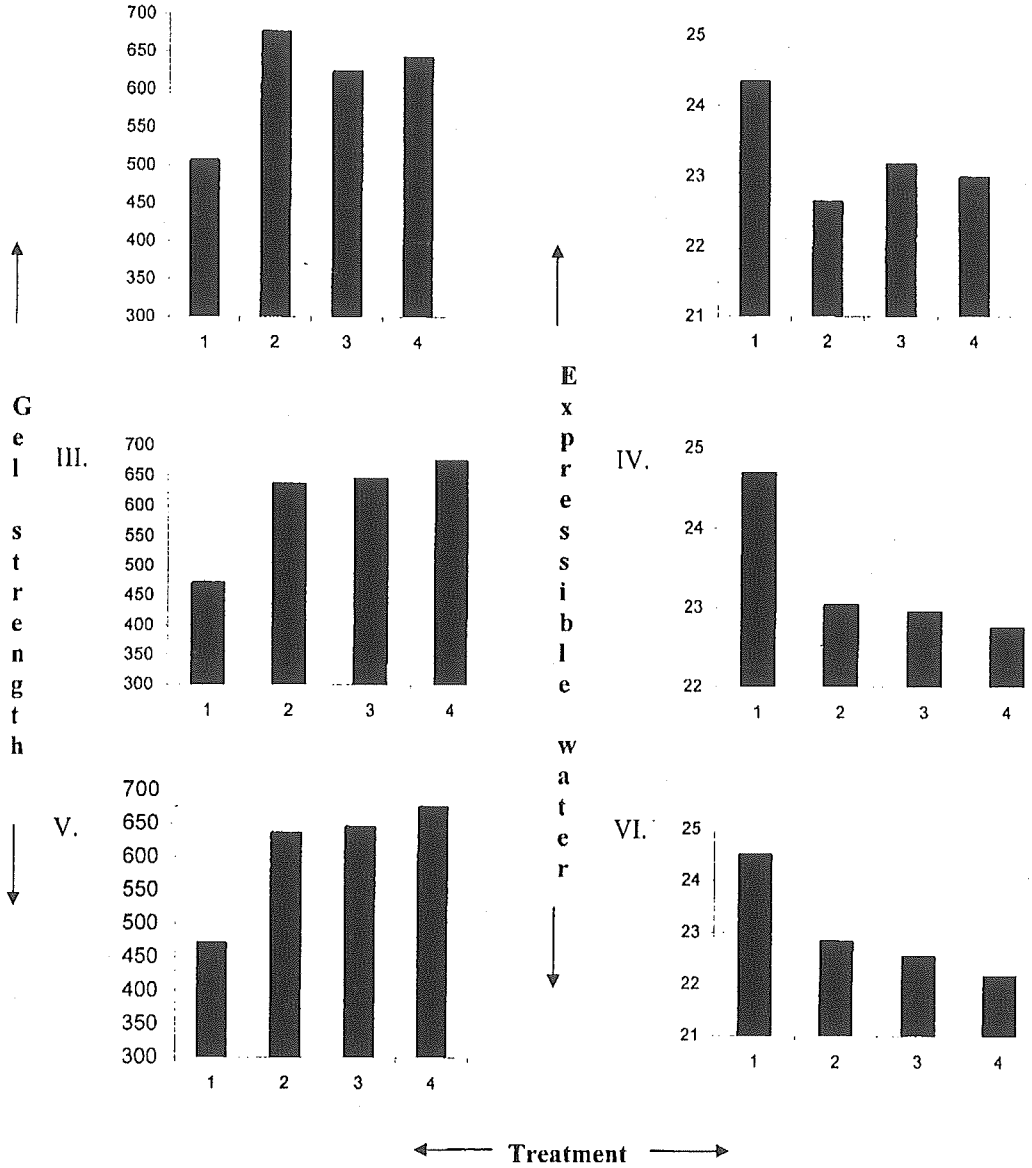

Fig.2. Effect of setting temperature at on the gel strength and expressible water of mackerel meat set at +40^{0}C
II & I. for 1 hr.; III & IV. for 2 hr.; V& VI. for 3 hr
1- control, 2- treatment of $CaCl_2$, 3- treatment of $MgCl_2$, 4- treatment of CH_3COONa

Results of gel strength and expressible water content as effected by setting time for washed meat indicate that setting had a profound effect on gel strength of the heat processed gel. The gel strength was increased as the time increased in case of setting temperature +5^{0}C ; Where as in case of +40^{0}C setting the gel strength was varied for different hrs in different species. Highest gel strength and lowest expressible water

content was observed in 1hr for sardine and mackerel washed salted meat. Like wise for pink perch and croaker washed meat it was 3hr. Similar type of result was observed by Benjakul et al. 2004 in the fish species like threadfin bream, bigeye snapper, barracuda and big eye croaker.

In the preparation of surimi and surimi-based products higher gel strength is necessary as to get the best texture and good acceptability of the product. So among the setting temperature $+40^0$C was selected and with respect to time 1hr for sardine and mackerel and 3 hr for pink perch and croaker was selected.

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(Manuscript received 30 May 2009)