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ORIGINAL ARTICLE

Effect of Salt Treatment in Washing on the Functional Properties of Fish Meat

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ABSTRACT
To know the effect of salt treatment in water washing on functional properties of meat two different species like sardine and croaker were used. Meat to water ratio used for washing was 1:3 for oil sardine; but for croaker, meat to water ratio was 1:2. Again the washing process was repeated three times for oil sardine; but two times for croaker. Different types of salt with different concentrations as CaCl2, MgCl2 and CH3COONa with 5mM, 10mM, 15mM, 20mM, 25mM, 30Mm were used in washing. The studied functional properties were solubility, gel strength, expressible water, emulsion capacity, reduced viscosity, water and fat absorption capacity. The concentration of salt was standardized by observing the optimum value of functionality of protein as 15mM for CaCl2, 20mM for CH3COONa and 30mM for MgCl2. The studied functional properties were varied for each salt. Among the salt for gel strength, MgCl2 represented more than CH3COONa followed by CaCl2 and control. The functionality of protein of washed meat with salt treatment was increased than the control.
Keywords: washing, fish meat, salt treatment, functional property

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INTRODUCTION

In order to enhance the desired functional properties from protein foods many attempts have been made to use salts, enzymes and modification. Concentrated salt solutions have large effects on the structure and properties of proteins including their solubility, denaturation, dissociation into subunits and the activity of enzymes [1]. Some of the salts mentioned in the Hofmeister series used commercially in surimi industry. The process surimi production involves repeated washing the fish mince to remove sarcoplasmic proteins and to concentrate the myofibrillar proteins.

The role of monovalent and divalent salt ions in the stabilization of different fractions of myofibrillar proteins have been documented [2-4] in preparation of gelled products. Khuntia [5] studied the functional properties by using six different salts as CH3COONa, Na2SO4, Na2HPO4, NaF, CaCl2 and MgCl2 in different concentrations in washing of Indian mackerel. These salts have special role to play in enhancing the overall product stability and organoleptic qualities. Joseph and Perigreen [6]; Mandal [7] and Nayak et al. [8] studied effect of salt on washing of fish meat. Considering this in the present study calcium chloride, magnesium chloride and sodium acetate salts were used at different concentrations like 5mM to 30mM were used in washing of fish meat with water. The concentration of salt was standardized by studying the functional properties of salt treated washed meat.

Materials and methods

Indian oil sardine (Sardinella longiceps) and Croaker (Johinus dussumieri) were used in the present study. In laboratory the fishes were washed and dressed by removing the 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. Some portion of 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; but for lean fish like croaker, meat to water ratio was 1:2. Again the washing process was repeated three times for oil sardine; but two times for croaker. Each washing was done for 2 min only. The pH of used water for water washing was 7. After each wash the meat was gently squeezed in a cotton cloth to remove excess water. Another portion of meat was used in washing with different salt with different concentrations as CaCl2, MgCl2 and CH3COONa with 5mM, 10mM, 15mM, 20mM, 25mM, 30Mm. The functional properties of meat was measured after last wash.

Extractability of protein, from meat was determined using EB by Kjeldahl method [9]. The relative viscosity of total protein samples were measured, using an Ostwald Viscometer. The relative viscosity and reduced viscosity of the samples were calculated by the formula given by Yang [10]. Emulsion Capacity was determined according to the method of Swift et al. [11]. Gel strength was measured by using Rheotex (Sunshine) instrument by mixing the washed meat with 2.5% NaCl. 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. Expressible water was determined by the method of Okada [12]. Water absorption capacity of freeze dried material was determined by the method of Sosulki [13]. The fat absorption capacity of freeze dried was estimated according to the method of Lin et al. [14].

Results and discussion

The changes in the functional properties of meat after washing with water without salt treatment are presented in Table 1. This Table represents that the functional properties of protein were increased after washing than unwashed meat. After washing the solubility as % of total protein was decreased but gel strength was increased. The marginal increase of 17% on an average in the gel strength of washed meat of fishes may be due to loss of sarcoplasmic proteins and modori inducing proteases (MIP) during washing, which are known to inhibit the gel formation [15].

Table 1. Proximate composition and properties of washed fish meat as control

Characteristics	Values			
	Sardine	Mackerel	Pink perch	Croaker
Solubility(% of total protein)	72.14(±0.02)	74.45(±0.04)	77.57(±0.02)	78.87(±0.04)
Gel Strength (g-cm)	304.47(±5.39)	332.25(±7.13)	468.38 (±5.0)	481.42(±3.18)
Expressible water (%)	26.36(±0.18)	26.02(±0.18)	24.72(±0.13)	24.59(±0.23)
Emulsion capacity (ml of oil /mg protein)	0.49(±0.001)	0.57 (±0.015)	0.76(±0.014)	0.85(±0.017)
Reduced viscosity at zero protein conc. (dl/g)	0.65	0.63	0.60	0.57
Water absorption capacity (g of water/g of dried material)	2.46(±0.35)	2.84(±0.25)	4.07(±0.10)	4.26(±0.43)
Fat absorption capacity(g of oil/g of dried material)	2.89(±0.13)	3.02(±0.28)	4.35(±0. 09)	4.64(±0.08)

*Values in parenthesis indicate standard deviation, n=3

Emulsion capacity and reduced viscosity was increased after washing. But after washing water and fat absorption capacity was decreased. The decrease in values of water absorption capacity of washed meat would be due to structural rearrangement of major protein components as affected by washing. Again the decrease in values of fat absorption capacity of washed meat would be due to structural rearrangement of major protein components as affected by washing.

Effect of different concentrations of salt in washing is represented in the Tables 2 and 3. The solubility of total proteins from the fishes in the present study at different concentrations of salt solutions was carried out using phosphate buffer (0.05 M, pH 7.5) as the solvent. The increase in solubility due to washing in salt may be attributed to the interaction of salt ions with oppositely charged groups on the proteins to form a double layer of ionic group, which decreases electrostatic interaction between protein molecules, causes more protein solvation and thereby increases protein solubility. The uptake percentage of these salt MgCl2, CaCl2 and CH3COONa are to an extent about 30mM, 15mM and 20mM respectively.

Table 2. Effect of different concentration of salt in washing on the functional property of sardine meat

Property& treatment	Concentration of salt					
	5mM	10mM	15mM	20mM	25mM	30mM
Solubility	74.17 (±0.02)	74.43 (±0.04)	74.87 (±0.02)	74.41 (±0.03)	74.12 (±0.05)	74.09 (±0.03)
CaCl2						
MgCl2	75.21 (±0.03)	75.37 (±0.05)	75.54 (±0.02)	75.63 (±0.03)	75.85 (±0.05)	75.96 (±0.04)

CH3COONa	73.97 (±0.02)	74.17(±0.04)	74.43(±0.03)	74.61 (±0.05)	74.39(±0.02)	74.03 (±0.04)
Gel strength	375.62 (±9.17)	466.37 (±10.18)	487.24 (±9.79)	462.8 (±10.04)	369.57(±9.52)	362.48 (±11.04)
CaCl2						
MgCl2	398.25 (±10.13)	473.17 (±10.16)	498.23(±10.15)	527.36 (±9.95)	562.54(±10.04)	604.19 (±11.03)
CH3COONa	381.24 (±10.06)	417.16 (±10.08)	463.25(±11.01)	516.32 (±9.87)	459.43(±9.92)	412.18 (±10.04)
Expressible water	25.65 (±0.21)	24.74(±0.17)	24.53 (±0.19)	24.78 (±0.23)	25.71 (±0.22)	25.78 (±0.24)
CaCl2						
MgCl2	25.42 (±0.17)	24.67 (±0.20)	24.42 (±0.19)	24.13 (±0.21)	23.78 (±0.22)	23.36 (±0.19)
CH3COONa	25.59 (±0.19)	25.23 (±0.20)	24.77 (±0.21)	24.24 (±0.19)	24.81 (±0.20)	25.18 (±0.22)
Emulsion capacity	0.47 (±0.017)	0.50 (±0.012)	0.55 (±0.014)	0.49 (±0.015)	0.46 (±0.017)	0.45 (±0.018)
CaCl2						
MgCl2	0.54 (±0.013)	0.58(±0.012)	0.64 (±0.014)	0.71 (±0.015)	0.75 (±0.014)	0.54 (±0.013)
CH3COONa	0.50 (±0.014)	0.56 (±0.015)	0.62 (±0.013)	0.69 (±0.016)	0.61 (±0.013)	0.55 (±0.014)
Reduced viscosity	0.76	0.78	0.82	0.77	0.75	0.73
CaCl2						
MgCl2	0.72	0.74	0.76	0.79	0.81	0.72
CH3COONa	0.69	0.70	0.72	0.74	0.71	0.69
Water absorption capacity	2.64 (±0.18)	2.66 (±0.17)	2.69 (±0.15)	2.65 (±0.16)	2.63 (±0.16)	2.62 (±0.15)
CaCl2						
MgCl2	2.68 (±0.14)	2.72 (±0.13)	2.77 (±0.15)	2.84 (±0.14)	2.89 (±0.12)	2.68 (±0.14)
CH3COONa	2.67 (±0.15)	2.70 (±0.14)	2.75 (±0.16)	2.80 (±0.15)	2.73 (±0.14)	2.68 (±0.13)
Fat absorption capacity	3.11(±0.35)	3.14(±0.31)	3.20(±0.25)	3.13(±0.19)	3.10(±0.21)	3.09(±0.22)
CaCl2						
MgCl2	3.16(±0.30)	3.23(±0.26)	3.31(±0.29)	3.42(±0.31)	3.49(±0.27)	3.16(±0.30)
CH3COONa	3.14(±0.30)	3.19(±0.29)	3.25(±0.28)	3.33(±0.31)	3.23(±0.32)	3.18(±0.29)

*Values in parenthesis indicate standard deviation, n=3

Table 3. Effect of different concentration of salt in washing on the functional property of croaker meat

Property and treatment	Concentration of salt 5mM	10mM	15mM	20mM	25mM	30mM
Solubility	79.13 (±0.02)	79.52(±0.04)	79.92(±0.05)	79.35(±0.03)	79.07(±0.04)	78.99(±0.02)
CaCl2						
MgCl2	80.14(±0.03)	80.28(±0.04)	80.47(±0.02)	80.64(±0.05)	80.75(±0.03)	80.87(±0.04)
CH3COONa	79.19(±0.04)	79.33(±0.01)	79.57(±0.04)	79.87(±0.02)	79.48(±0.05)	79.07(±0.02)
Gel strength	565.39(±10.06)	672.28(±10.04)	708.41(±9.74)	667.15(±11.20)	554.24(±9.87)	549.23(±10.16)
CaCl2						
MgCl2	672.24(±10.05)	797.15(±9.85)	835.18(±9.79)	887.27(±10.05)	952.53(±10.17)	1024.48(±10.12)
CH3COONa	579.17(±9.65)	618.24(±9.57)	667.32(±10.02)	724.12(±9.87)	662.16(±10.04)	611.36(±10.12)
Expressible water	23.75(±0.18)	22.68(±0.21)	22.32(±0.25)	22.73(±0.19)	23.86(±0.18)	23.91(±0.24)
CaCl2						

MgCl2	22.68(±0.18)	21.43(±0.19)	21.05(±0.17)	20.53(±0.20)	19.88(±0.21)	19.16(±0.19)
CH3COONa	23.61(±0.14)	23.18(±0.15)	22.63(±0.13)	22.16(±0.16)	22.78(±0.14)	23.29(±0.13)
Emulsion capacity	0.81(±0.012)	0. 86(±0.011)	0. 92(±0.01)	0. 84(±0.009)	0. 80(±0.011)	0. 79(±0.013)
CaCl2						
MgCl2	0.82(±0.013)	0.88(±0.015)	0.95(±0.014)	1.02(±0.012)	1.10(±0.015)	1.16(±0.014)
CH3COONa	0.86(±0.012)	0.91(±0.013)	0.97(±0.014)	1.04(±0.015)	0.94(±0.013)	0.89(±0.010)
Reduced viscosity	0.70	0.72	0.74	0.71	0.68	0.66
CaCl2						
MgCl2	0.62	0.64	0.66	0.69	0.71	0.73
CH3COONa	0.62	0.64	0.66	0.69	0.65	0.62
Water absorption capacity	4.84(±0.14)	4.89(±0.16)	4.95(±0.12)	4.87(±0.17)	4.81(±0.18)	4.80(±0.17)
CaCl2						
MgCl2	4.87(±0.16)	4.93 (±0.15)	4.99 (±0.14)	5.06 (±0.17)	5.14 (±0.16)	5.21 (±0.14)
CH3COONa	4.90±0.12)	4.95(±0.11)	5.01(±0.13)	5.08(±0.14)	4.99(±0.12)	4.93(±0.13)
Fat absorption capacity	4.99(±0.29)	5.04(±0.30)	5.11(±0.27)	5.02(±0.26)	4.97(±0.28)	4.96(±0.31)
CaCl2	5.02(±0.27)	5.08(±0.31)	5.15(±0.29)	5.22(±0.30)	5.31(±0.28)	5.38(±0.27)
MgCl2	5.06(±0.22)	5.12(±0.21)	5.20(±0.23)	5.29(±0.24)	5.18(±0.23)	5.09(±0.22)

*Values in parenthesis indicate standard deviation , n=3

The initial increase in solubility may be attributed to the salting “in” of proteins while the subsequent decrease in solubility may be due to the salting “out” of proteins [16]. The salting out behavior for CaCl2 was 15mM and for CH3COONa it was 20mM. But as all the salts were treated up to 30mM the salting out behavior for MgCl2 was not studied.

In the present study the concentration of test salt which affected on solubility of fish meat as MgCl2 (30mM) > CaCl2 (15mM) > CH3COONa (20mM) > Control. Among the studied fish species the solubility (% of total protein) was as croaker>sardine.

The gel strength of the prepared gels was measured by using Rheotex. The table represents that among the different test salts MgCl2 had a large influence in enhancing the gel strength. On the other hand, salts such as CaCl2 and CH3COONa reduced the gel strength after the concentration of 15mM and 20mM. But the gel strength increased up to 30mM in case of MgCl2. Again among all species croaker meat provided more gel strength than sardine.

One of the factors contributing to the poor gel forming ability of dark fleshed fish muscle is higher content of sarcoplasmic proteins. The sardine and Indian mackerel being a dark-fished fish, which may contain high sarcoplasmic proteins, may produce gels of poor gel strength. The effect of divalent metal ions like Ca++ and Mg++ on the strength of the gels indicated that MgCl2 had better effect in the enhancement of gel strength. So, the gel strength of MgCl2 > CH3COONa > CaCl2 > Control. The lower gel strength values of CaCl2 and NaCl treated gels are mainly due to the precipitation of high molecular weight myofibrillar proteins.

The expressible water content of the prepared gels using different salts was found to have an inverse relation with the gel strength. The water inside the gel in free form can be expelled out by application of pressure. The retention of water inside gel is related to the type of network formed and the other ingredients used. The control had an highest expressible water content.

The emulsion capacity (EC) value for CH3COONa > MgCl2 > CaCl2> Control. The EC of any protein system is mainly dependent on the solubility of proteins in the given solvent, pH and temperature [17]. In the present investigation, the EC was more in croaker followed by sardine. Similar observation was obtained by Mandal [7].

The extrapolation of apparent reduced viscosity to zero protein concentration yielded a value from 0.57 to 0.82 dl/g in different sample [18]. Similar result was observed in the present investigation. From the study, it was observed that reduced viscosity was maximum for CaCl2 and followed by MgCl2, CH3COONa and Control. The higher reduced viscosity in CaCl2 treated samples is due to extensive hydration. In the present investigation, the reduced viscosity was more in croaker followed by sardine.

The water absorption capacity (WAC) of fish meat is a function of the treatment in washing with different test salt solutions. Water binding by proteins is influenced by several factors such as amino acid composition, protein conformation, surface topology, surface hydrophobicity, ionic concentration, ionic species, pH and temperature. WAC for CH3COONa > MgCl2 > CaCl2 > Control. The WAC of proteins from prawns decreased with increase in concentration of sodium acetate used for dip treatment [19].

The mechanism of fat absorption by proteins is attributable mostly to physical entrapment of oil by the proteins. The FAC for CH3COONa > MgCl2 > CaCl2 > Control. The ability of proteins to bind fat is important in such applications as meat replacers and extenders, principally because it enhances flavour retention and mouth feels. The enhancement of fat binding capacity will be advantageous in structured seafoods. The reason for increase in FAC as affected by test salts may be due to exposure of hydrophobic groups in major protein fractions, which may favor interaction with non-polar solvent like fats and oils.

Conclusion

In the present investigation, the effect of different test salts on the functional properties of proteins from fish meat has been assessed. NaCl, CaCl2, MgCl2 and CH3COONa could enhance solubility and lead to better other functionality of protein. The poor gel forming ability of sardine meat was due to high MIPase activity which was further enhanced in presence of CH3COONa. The concentration of salt selected for washing are15mM CaCl2, 20mM CH3COONa and 30mM MgCl2. From the above study it was observed that the functionality of protein of the fish meat was increased in salt treated washing than only water washing for the preparation of surimi. Again among the studied species croaker meat represented the best functionality of protein of its meat.

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