Titill / Title	Effect of salt content on ripening of herring		
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Styrktaraðilar	RANNÍS		
Ágrip á íslensku	Síld veidd í nóvember 1993 var söltuð samkvæmt léttsaltaðri, millisaltaðri, kryddsaltaðri og harðsaltaðri uppskrift og geymd við 5±1°C í 32 vikur. Síldin var skynmetin reglubundið yfir tímabilið með myndrænni greiningu þar sem notaðir voru 8 matsþættir til að lýsa bragði og 3 til að lýsa áferð. Jafnframt var efnasamsetning sýna ákvörðuð og magn leysanlegra köfnunarefnissambanda ákvarðað í vöðva og mat lagt á virkni próteinsundrandi ensíma í vöðva og pækli. Allir síldarhóparnir fengu einkenni verkunar þegar leið á geymsluna en einkennin réðust af saltmagni (eða uppskrift). Verkunarbragði harðsaltaðrar síldar var lýst sem harðfiskbragði en bragði kryddsíldar sem rjómakaramellubragði með maltkeimi. Léttsaltaða og millisaltaða síldin fengu bæði harðfisks- og rjómakaramellubragðseinkenni. Saltið hafði mikil áhrif á áferð; því meira salt því stinnari, seigari og minna vatnskennd varð síldin. Niðurstöðurnar sýndu nánast enga myndun leysanlegra köfnunarefnissambanda í harðsaltaðri síld meðan þessi sambönd mynduðust hratt í léttsöltuðu síldinni. Á sama hátt reyndist nánast engin próteinsundrandi ensímvirkni vera til staðar í harðsaltaðri síld hvorki í vöðva né í pækli meðan umtalsverð virkni fannst í léttsaltaðri síld. Niðurstöðurnar sýna því ekki gott samband efnafræðilegu mæliaðferðanna og skynmats.		
Lykilorð á íslensku	Síld, verkun, salt, skynmat, bragð, áferð		
Summary in English	In this study herring (*Clupea harengus*) caught in November 1993 was beheaded and salted in barrels using different industrial recipes as lightly, medium, spice and heavily salted. After salting the herring was kept at 5±1°C for 32 weeks. The herring was sampled regularly during the storage period. Ripening was evaluated by sensory analysis using quantitative descriptive analysis with 8 taste attributes and 3 texture attributes. The chemical composition of samples was determined, the amount of soluble nitrogenous compounds in muscle measured and the general proteolytic activity in muscle and brine estimated. All the herring groups obtained during the storage period a ripened taste but the taste characteristic differed depending on the salt content (recipe). The ripened taste of heavily salted herring was described as stockfish taste whereas the ripened taste of spice salted herring was described as sweet, creamy taste with a malty note. The lightly and medium salted herring obtained a ripened taste with both malty/creamy and stockfish taste characteristics. The salt content affected the texture of the herring severly; increased salt caused a firmer, tougher and less watery texture. The results showed virtually no formation of soluble nitrogenous compounds in the heavily salted herring during the storage period whereas these compounds increased considerably in the lightly salted herring. Similarly virtually no general proteolytic activity was observed in the heavily salted herring in muscle or brine whereas considerable activity was found in the lightly salted herring. The results therefore did not show a good correlation between the (bio)chemical methods and sensory analysis.		
English keywords	Herring, ripening, salt, sensory evaluation, taste, texture		

1. INTRODUCTION

In Iceland various recipes are used for the production of salted herring (Stefánsson, 1992). It is common to use as low as 1 part salt to 10 parts herring (lightly salted herring) and up to 1 part salt to 4,5 part herring (heavily salted herring). Spice-salted herring is a popular product for the Scandinavian market and is usually produced using 1 part salt to 7 parts herring (medium salted). Salt content is known to influence the ripening of herring e.g. by affecting the stability and activities of enzymes (Luijpen, 1959; Kiesvaara, 1975; Nielsen, 1995). The question then arises does herring ripen when salted with different amounts of salt and do the products have the same sensory characteristics?

The objective of this trial was to follow the sensory and (bio)chemical changes that take place in herring (*Clupea harengus*) during cold storage when salted with different content of salt. The trial was part of the AIR project 1141 “Enzymatic ripening of pelagic fish species”.

2. MATERIALS AND METHODS

2.1. Salting

The herring *(Clupea harengus)* used in this experiment was caught to the south east of Iceland in November 1993. The herring was from the Icelandic summer spawning stock. The herring was landed and processed at Borgey fish processing plant in south east Iceland. The herring had been kept on ice for approximately 2 days before salting and been size graded. The size 3/500 was used (300 to 500 herring in each 100 kg portion). The herring was beheaded in machines leaving all the intestines in the fish and salted in a standard industrial manner.

Lightly salted herring. Prepared using the following recipe: Salt (5.2 kg) and herring (53 kg). Seven (60 litre) barrels were prepared. The herring was mixed with the salt and put into the barrels. The herring was allowed to settle overnight in the barrels before filling up with 20° brine.

Medium salted herring. Prepared using the following recipe: Salt (7.9 kg) and herring (54,5 kg). Seven (60 l) barrels were salted. The herring was mixed with the salt and put into the barrels. The herring was allowed to settle overnight in the barrels before filling up with 20° brine.

Spice-salted herring. Prepared using the following recipe: Salt (7.9 kg), herring (54,5 kg) sugar (3,7 kg) and spices (390 g; containing $NaNO_3$). Seven (60 l) barrels were salted. The herring was mixed with the dry materials and put into the barrels. The herring was allowed to settle overnight in the barrels before filling up with 20° brine.

Heavily salted herring. Prepared using the following recipe: Salt (13,1 kg) and herring (58,2 kg). Seven (60 litre) barrels were prepared. The herring was mixed with the salt and placed into the barrels. The herring was allowed to settle overnight in the barrels before filling up with 25° brine.

After salting the herring barrels were transported to the Icelandic Fisheries Laboratories and kept at 5±1°C. To ensure an even salt uptake and good ripening the barrels were rolled once every week during the first 8 weeks of salting.

2.2. Sampling and preparation of samples

Sampling was carried out in week 2, 4, 8, 13, 16, 20, 25 and 32 from salting. A new barrel was used at each sampling, except at week 2 and 4 where the same barrel was used. Before sampling the barrel was turned over 3 to 4 times before being opened. After opening, the temperature of brine was determined using a thermometer and the brine strength using a densitometer. Samples were taken in triplicate from brine (3 x 250 ml) and herring (3 x 5 herring for sensory analysis and 3 x 5 herring for other determinations). The herring was always taken from within the depth of the barrel. The brine was filtrated before carrying out measurements. The herring was washed, filleted and skinned by hand. Fillets or fillet pieces were used for sensory evaluation, but for chemical and biochemical analysis a mince prepared from the fillets was used. Most analyses (e.g. sensory analysis) were carried out within the sampling week; in the cases where this was not possible the samples (mince or brine) were frozen and kept at -24°C until the measurements could be carried out. Samples for biochemical determination (muscle extract and brine for enzyme activity analysis) were stored at -85°C until the measurements could be carried out. Extracts stored at -85 °C were thawed as fast as possible under hot water and put on ice immediately after thawing. Frozen mince was taken out of the freezer and kept at room temperature until it started to thaw; then a sample was taken for measurements.

2.3. Measurements

2.3.1 Sensory analysis

Sensory analysis was carried out using a trained in house panel. The panel consisted of ten people who had previously been selected by a procedure similar to the one described by Meilgaard *et al.* (1991) and trained in the evaluation of fish freshness using the Torry scale (Shewan *et al.*, 1953). The panellists were then specifically trained in descriptive analysis of salted herring and had received at least 80 hours of training.

Eight attributes for taste were used: ripened, raw, malty/creamy, stockfish, salty, sweet, spicy and aftertaste. The taste attributes malty/creamy and stockfish taste were used to characterise the ripened taste further. Raw taste in salted herring can be described as the taste of fresh herring commonly associated with the taste of raw (fatty) fish and blood. Each taste attribute was evaluated on an intensity scale anchored at both ends (0 - none to 100 - strong). Three attributes for texture were used: softness, watery and toughness. Softness was defined as the initial force required to compress the sample between the molars. Softness was evaluated on a 100 point scale anchored by the opposites very firm to very soft. Watery was defined as the amount of moisture released on the initial bite of the sample. Watery was evaluated on a 100 point scale anchored by the opposites not watery to very watery. Toughness was defined as the resistance of the sample to breakdown on chewing to a state suitable for swallowing. Toughness was evaluated on a 100 point scale anchored by the opposites very tough to very tender. The panellists were trained in the use of the profile scheme by evaluating salted herring at varying stages of ripening, including extreme samples (no ripening and fully ripened). Training was considered adequate when panellists came to a consensus on the intensity of each attribute. For the purpose of this work a consensus was considered the mean value ±10 points (on a 100 point scale). Retraining was carried out every four weeks.

Panellists evaluated each sample, in triplicate, in separate booths under normal light in IFL´s sensory evaluation laboratory using a computerised system (Hypersense, IFL, Iceland) for direct recording of data. Only two samples were evaluated in each session and only two sessions were carried out each day. The panellists used water and unsalted crackers for palate cleaning between samples.

2.3.2 TCA soluble nitrogen

Protein in muscle and brine was precipitated by adding 10% TCA (trichloroacetic acid). After filtration the amount of low-weight nitrogen compounds soluble in TCA were measured by the semi-macro Kjeltec method (See 2.3.3). Both total nitrogen and TCA-soluble nitrogen compounds were calculated as protein content by multiplying the measured nitrogen with the factor 6.25. TCA index was calculated as the amount of TCA soluble protein in percentages of the total protein content (Stefánsson *et al*, 1995).

2.3.3 Proximate analysis

The salt content of muscle was determined by the method of Volhard (AOAC 937.09.,1990).The moisture content was determined by mixing samples with sand and drying at 105°C for 4 hours (AOCS, Ba 2a-38, 1989). Weight loss was taken as water content. Fat content was determined by the method of Soxhlet (AOAC 960.39., 1990). The nitrogen content was measured with a semi-macro Kjeltec method, ISO 5983-1979 (Digestion System 40, 1016 digester, Tecator, England).

2.3.4 pH, brine strength and temperature

The temperature in barrels on opening was measured directly in the brine using a thermometre. The pH of muscle and brine was determined by the use of a combination electrode at room temperature. Measurements were carried out directly on brine and on a suspension of minced muscle and distilled water (20:80 w:w). A Baume density meter was used to determine the density of brine.

2.3.5 Proteolytic activity in muscle and brine

The general proteolytic activity (GPA) of muscle and brine was determined at pH 8,0 and 25°C using azocasein as substrate. The incubation time was 24 hours for both muscle and brine. This method is a modified method to that of Sareth *et al.* (19892).

2.3.6 Statistical analysis

Statistical treatment of the data was carried out by using Systat for Windows, version 5 (Wilkinson, 1990). Pairwise comparisons (Bonferroni test) was used when determining significant differences with 95% confidence interval ($p<0,05$).

3. RESULTS AND DISCUSSION

3.1. Chemical composition and pH

The whole herring used for the trial contained 16,9% protein, 62% water, 18,4% fat and 0,1% salt which is a typical composition of herring caught during the season (Einarsson, 1987). Table 1 shows pH values in salted herring during the storage period.

Table 1. Muscle pH

Week	LS	MS	KS	HS
4	6,55	6,40	6,42	6,35
8	6,24	6,38	6,37	6,40
13	6,39	6,31	6,39	6,18
16	6,36	6,32	6,40	6,19
20	6,42	6,33	6,42	6,25
25	6,40	6,26	6,30	6,17
32	6,35	6,37	6,38	6,04

LS, lightly salted; MS, medium salted; KS, spice-salted; HS, heavily salted

Similar pH values were observed in the muscle of lightly and medium salted herring. The pH values in heavily salted herring were however consistently lower than pH values in the other groups.

3.2. Breakdown products

Figure 1. shows the changes in TCA index (TCA soluble nitrogen as a percentage of the total nitrogen) in herring muscle during the storage period. It is well known that the amount of low weight nitrogen containing compounds increases during the ripening of herring (Voskresensky, 1965; Kiesvaara, 1975; Marvik, 1979). TCA index is a useful indicator of the formation of low weight nitrogen containing compounds and thus the proteolytic breakdown taking place in herring muscle during salt-ripening (Nielsen, 1995; Stefánsson *et al.*, 1995). The results show a slow increase in TCA index in lightly and medium salted herring during the salting period. The highest values are found for the lightly salted herring. Almost no increase in TCA index was observed for the heavily salted herring. The results suggest a fairly fast proteolytic breakdown in the lightly salted herring but a slow breakdown in the heavily salted herring.

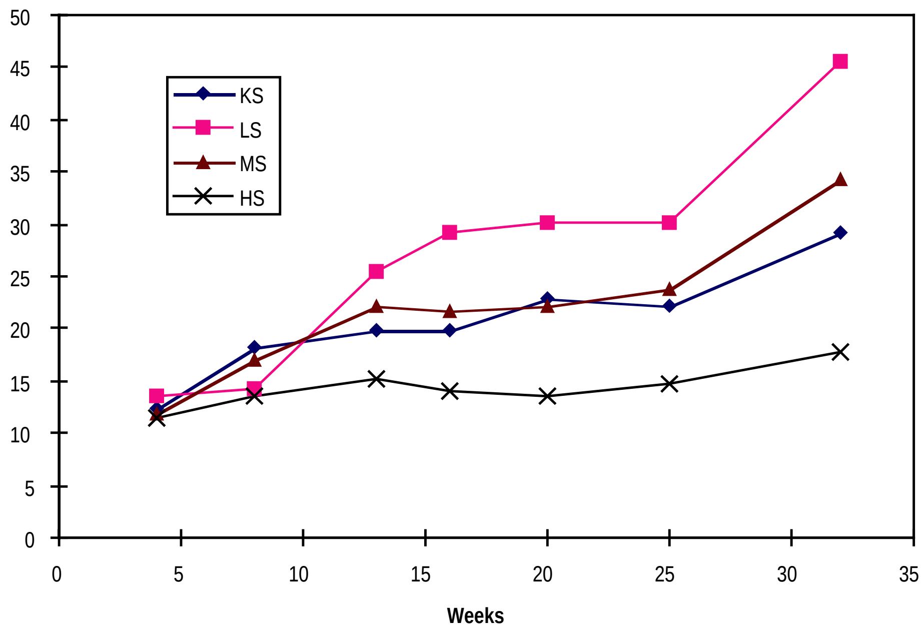

Figure 1. Changes in TCA index in salted herring during storage at 5°C
LS, lightly salted; MS, medium salted; KS, spice-salted; HS, heavily salted

3.3. Sensory evaluation

Figures 2-5 show the results of taste attributes changes in herring muscle during the storage period. A ripened taste was found to form in all herring groups during the trial (Figure 2). The highest intensity was found at all sampling points for the spice-salted herring (medium salted) and this difference was found to be statistically significant at weeks 8, 13, 16 and 20 between spice-salted herring and the other groups. The low salted herring was not evaluated in week 32 as it had spoiled by that time. It is interesting to note that a ripened taste was found to form in the highly salted herring during the trial although the proteolytic breakdown in this group was considerably slower than in the lightly and medium salted herring groups (Figure 1).

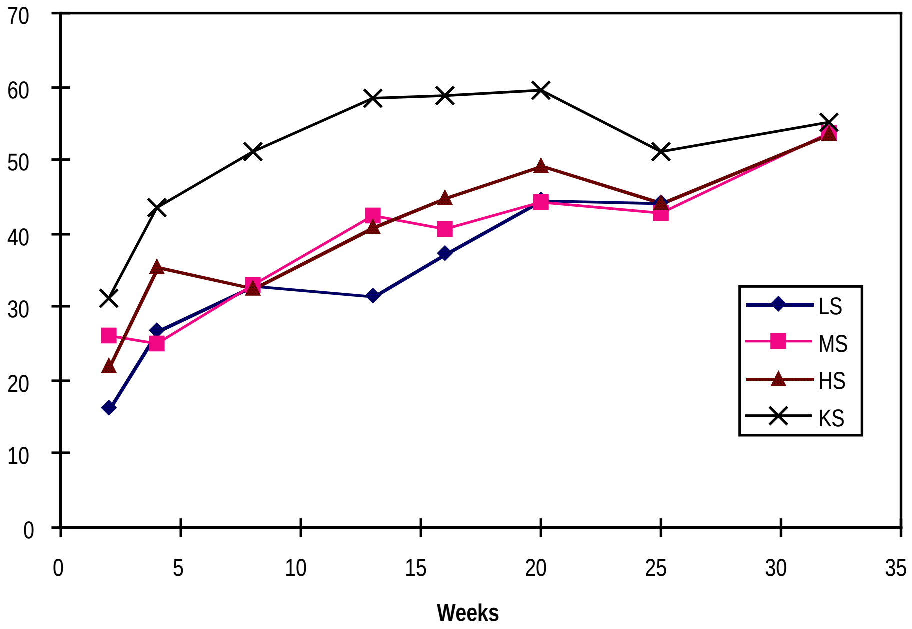

Figure 2. Ripened taste formation in salted herring during storage at 5°C
LS, lightly salted; MS, medium salted; KS, spice-salted; HS, heavily salted

A high intensity of a malty/creamy taste was found to form in the spice-salted herring during the salt storage whereas this taste characteristic was low in the lightly and medium salted herring and almost absent in the heavily salted herring (Figure 3). The panellists described the taste as a creamy sweet taste with a malty note. It is likely that the spices and sugar in combination with some breakdown products form this taste characteristic; in fact this taste attribute can be said to be the characteristic ripened taste in spice-salted herring.

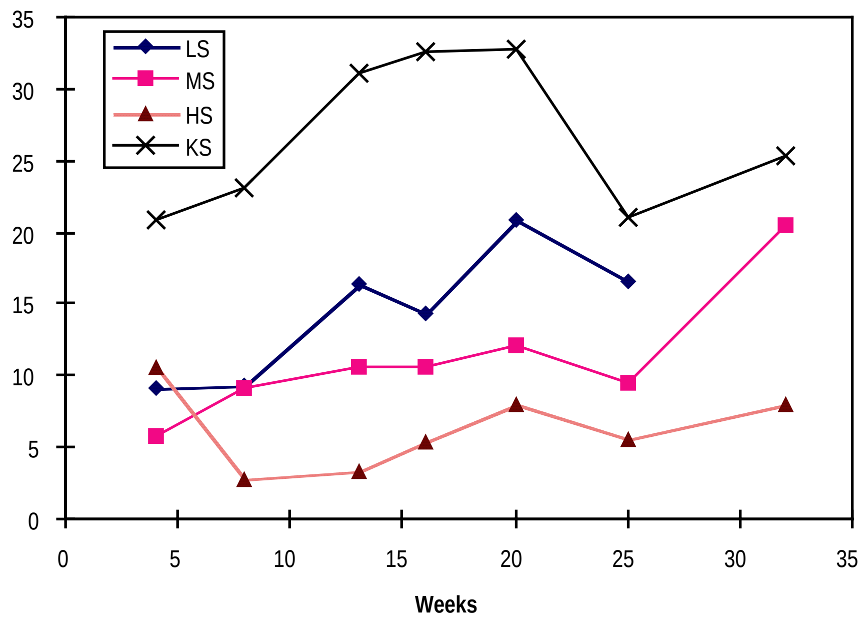

Figure 3. Malty/creamy taste in salted herring stored at 5°C
LS, lightly salted; MS, medium salted; KS, spice-salted; HS, heavily salted

A stockfish taste was found shortly after salting in all the herring groups, but it's intensity appeared to diminish somewhat in the lightly and medium salted herring during the storage period (Figure 4). The heavily salted herring was found to have throughout the storage period a very noticeable stockfish taste. The panellists described the stockfish taste as the taste of dried, salted fatty fish such as the taste of dried ocean catfish. It is likely that this taste characteristic is fairly noticeable in salted herring during the first part of the salting stage, but possibly as more breakdown products are formed and ripening develops the intensity of this taste diminishes and other taste characteristic become more apparent e.g. the malty taste in spice-salted herring. Very little proteolytic breakdown was observed in the heavily salted herring (Figure 1) and possibly that may have caused no decline in the stockfish taste characteristic for this group as observed for lightly and medium salted herring. The results confirm observations made in industry of a typical dryfish taste for "cut" or heavily salted herring (Stefánsson, 1992). It would be interesting in future work to monitor the taste characteristics of highly salted herring for a longer period than 32 weeks.

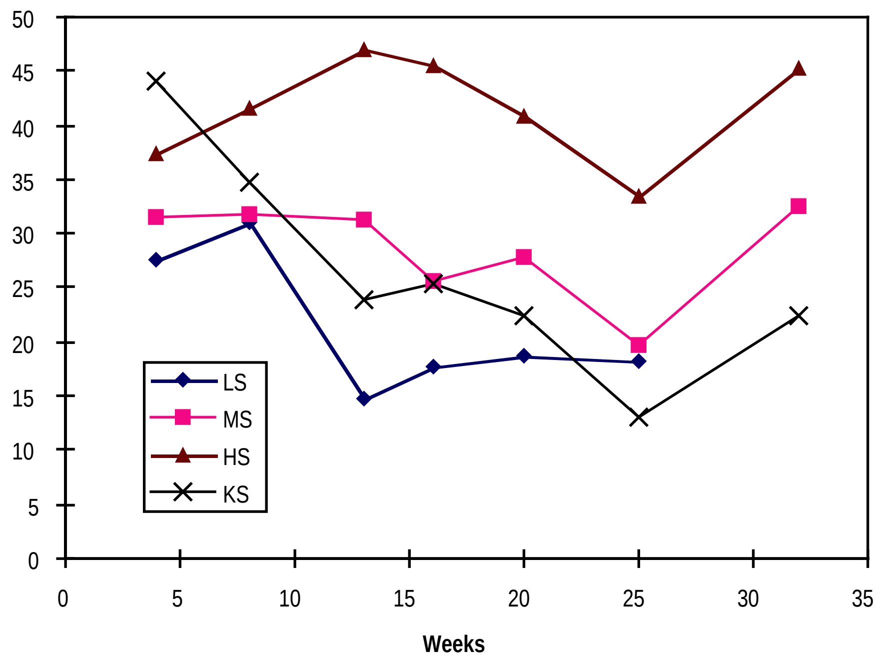

Figure 4. Stockfish taste in salted herring stored at 5°C.
LS, lightly salted; MS, medium salted; KS, spice-salted; HS, heavily salted

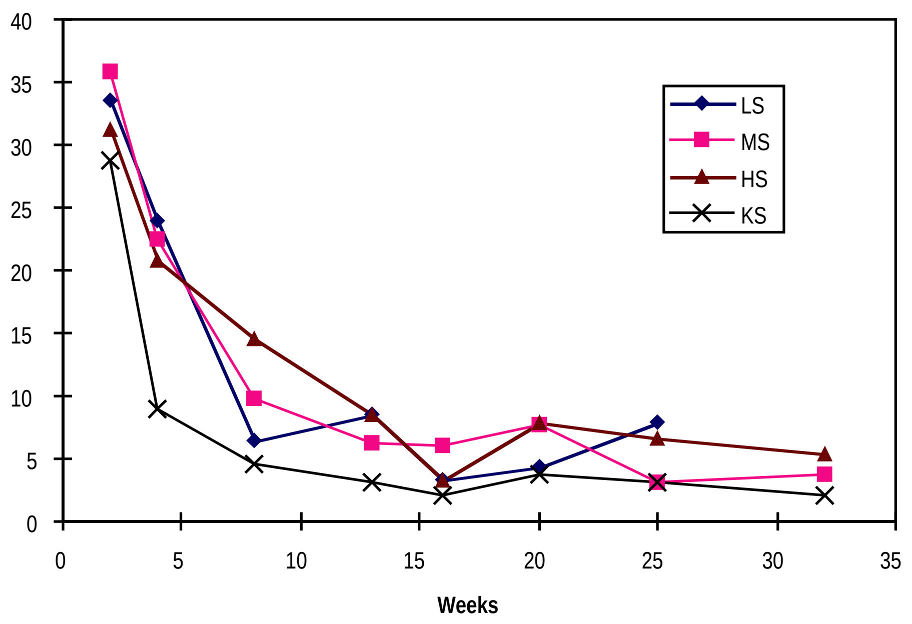

Figure 5. Raw taste in salted herring during storage at 5°C
LS, lightly salted; MS, medium salted; KS, spice-salted; HS, heavily salted

Figure 5 shows that raw taste diminished in all groups during the storage period. It is interesting to note that the raw taste decreased rapidly as well in the highly salted herring; this is in accordance with a fairly fast formation a ripened taste in this group (Figure 2). The raw taste can be considered to be the opposite of the ripened taste

Figures 6 to 8 show changes in the texture attributes softness, tenderness and watery in salted herring during storage at 5°C as determined by sensory evaluation. The softness, tenderness and watery were found to increase rapidly in the lightly and medium salted herring during the storage period whereas the highly salted herring was found to be firm, tough and not watery throughout the storage period (Figures 6,7 and 8). The values for the highly salted herring were found to be statistically significantly different to the values for lightly and medium salted herring at all sampling points except in weeks 2 and 4. The lightly salted herring was found to be softer, tender and more watery than the medium salted herring after about 13 weeks salt storage but the difference was not always statistically significant. The medium salted herring groups were found to obtain very similar texture characteristics throughout the storage period (Figures 6, 7 and 8). It has been suggested by the salt herring industry that sugar may affect the texture of salted herring but this study does not confirm that (Agústsson, 1992).

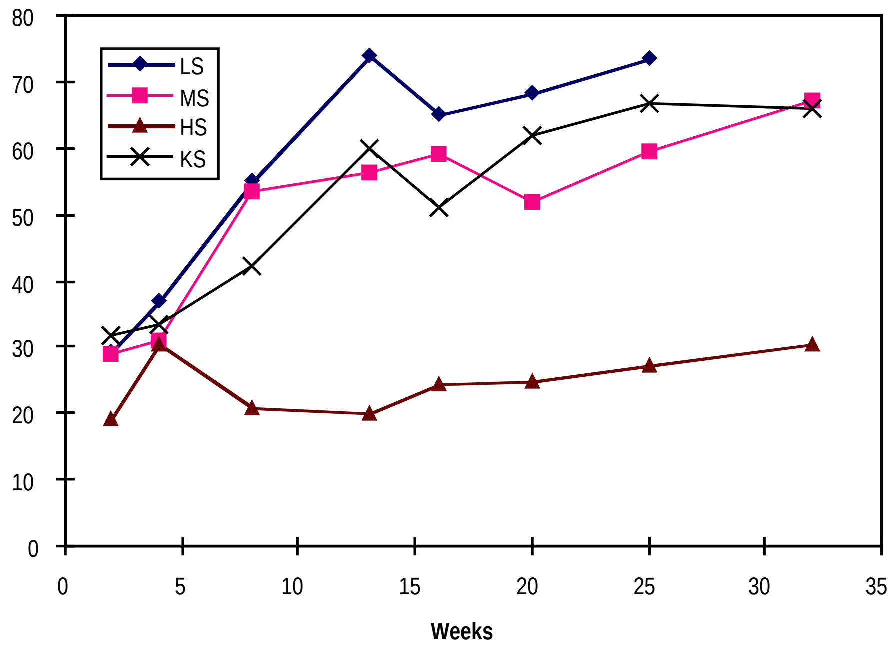

Figure 6. Softness in salted herring during storage at 5°C

LS, lightly salted; MS, medium salted; KS, spice-salted; HS, heavily salted

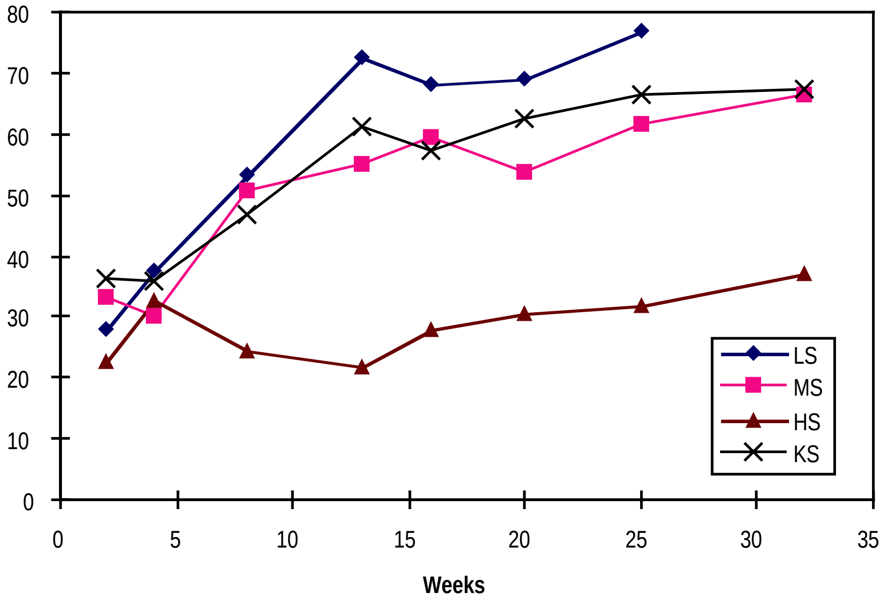

Figure 7. Toughness in salted herring during storage at 5°C

LS, lightly salted; MS, medium salted; KS, spice-salted; HS, heavily salted

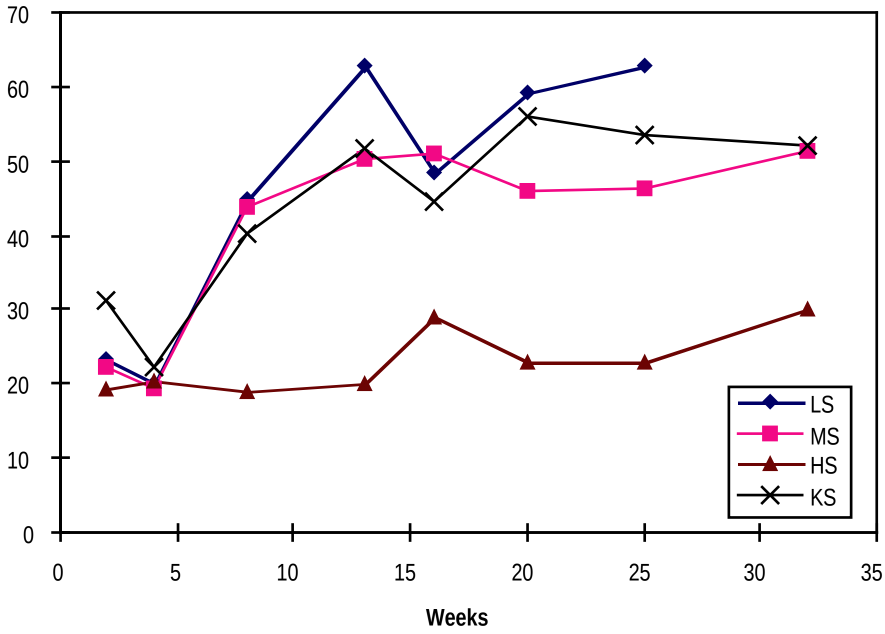

Figure 8. Watery in salted herring during storage at 5°C

LS, lightly salted; MS, medium salted; KS, spice-salted; HS, heavily salted

3.4. Proteolytic enzyme activity

The general proteolytic activity (GPA) in herring muscle and brine can be found in Figures 9 and 10. The highest GPA was found in the muscle of lightly salted herring throughout the storage period whereas virtually no activity was found in the heavily salted herring. The activity of medium salted herring group was fairly low throughout the storage period but appeared to increase somewhat during the latter part of the trial. The spice-salted herring obtained lower GPA values than the medium salted herring. Possibly this may be explained on the basis of higher concentration of soluble substances in spice-salted herring (Na^+, Cl^- ions and sucrose) in comparison with the medium salted herring.

Similarly Figure 10 shows that the brine from lightly salted herring had the highest activity throughout the storage period whereas the brine from the heavily salted herring contained little or no GPA. A similar increase of GPA was found for the medium salted herring groups during the storage period.

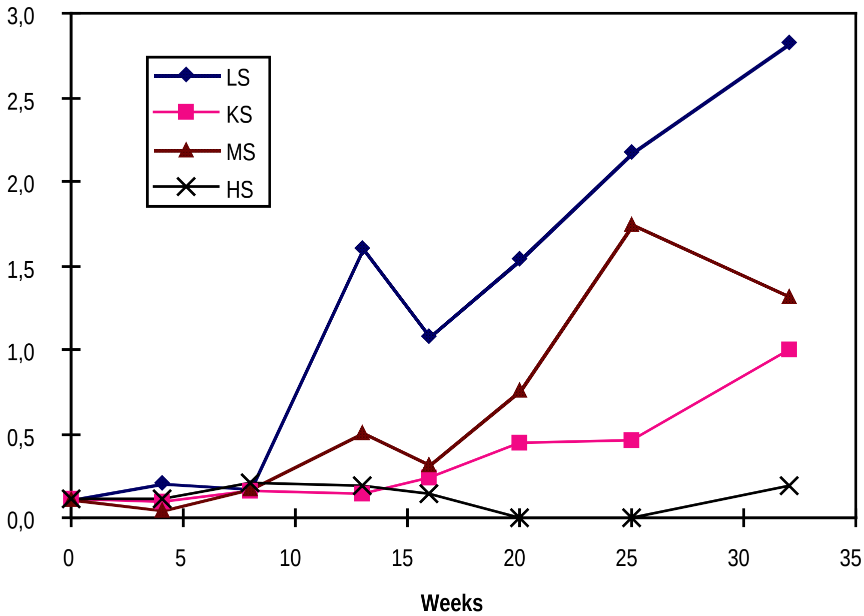

Figure 9. General proteolytic activity at pH 8 in salted herring muscle during storage at 5°C. LS, lightly salted; MS, medium salted; KS, spice-salted; HS, heavily salted

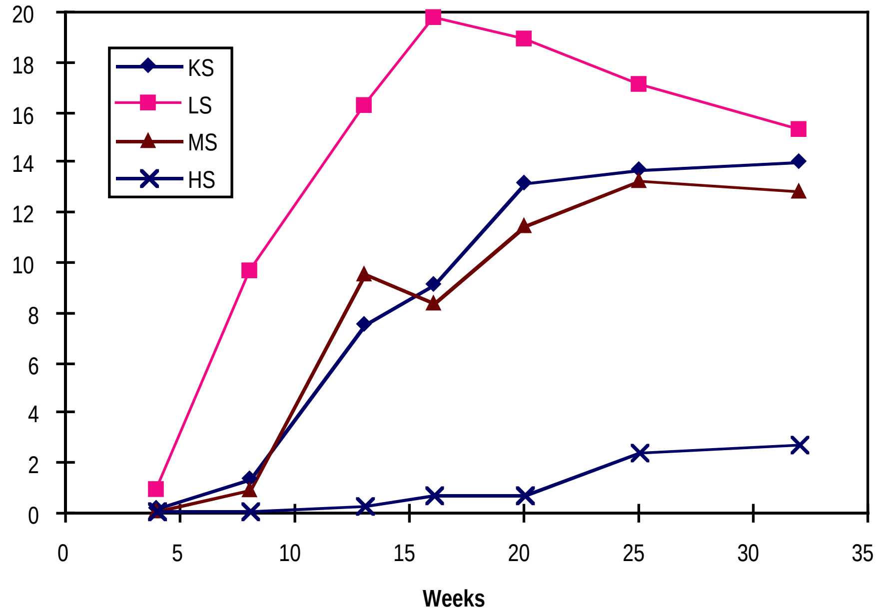

Figure 10. General proteolytic activity at pH 8 in brine from salted herring during storage at 5°C. LS, lightly salted; MS, medium salted; KS, spice-salted; HS, heavily salted

4. CONCLUSION

It can be concluded from this trial that headless ungutted fatty herring which is salted in the ratio of 1-2.25 kg salt to 10 kg of herring ripens. Lightly, medium, spice-salted (medium salt with spices and sugar) and heavily salted herring all obtained a ripened taste but the taste characteristics differed. The ripened taste of heavily salted herring was described as stockfish taste whereas the ripened taste of spice-salted herring was described as a creamy, sweet taste with a malty note. The ripened taste of lightly and medium salted herring appeared to have both malty/creamy and stockfish taste characteristics. The salt content affected the texture of the herring severly. The lightly, medium and spice-salted herring became, after about 13 weeks storage, soft, tender and watery whereas the heavily salted herring was still very firm, tough and not watery after 32 weeks storage. The lightly salted herring appeared to be somewhat softer, more tender and watery than the medium salted herrings. It can therefore be concluded that an increased salt content (in the region 1-2.25 kg to 10 kgs herring) caused a firmer, tougher and less watery texture in salted herring.

This trial poses some questions on the chemical nature of the ripened taste. The heavily salted herring obtained fairly rapidly a ripened taste and it's raw taste disappeared quickly. However this group had very little general proteolytic activity and a slow formation of soluble nitrogenous compounds. For this salting group TCA index and GPA measurements were not useful indications of ripening.

5. ACKNOWLEDGEMENT

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7. APPENDICES

Table 2. Composition of whole headless herring before salting

Sample: Size 3-500

	Value 1	Value 2	Value 3	Value 4	Mean	Stdev.
% Protein	17,20	17,20	16,60	16,60	16,90	0,35
% Water	59,85	60,5	63,82	63,75	61,98	2,10
% Salt	0,24	0	0,12	0,12	0,12	0,10
% Fat	18,4				18,4	

Table 3. Protein, water and salt content in herring muscle

% Protein in spice-salted herring fillets (KS)

Week	Value 1	Value 2	Value 3	Mean	Stdev.
4	18,35	18,33	18,35	18,34	0,01
8	18,4	18,4	18,35	18,38	0,03
13	17,55	17,63	17,6	17,59	0,04
16	17,8	17,89	17,85	17,85	0,05
20	18,07	18,1	18,14	18,10	0,04
25	17,12	17,22	17,2	17,18	0,05
32	17,02	16,99	17	17,00	0,02

% Protein in lightly-salted herring fillets (LS)

Week	Value 1	Value 2	Value 3	Mean	Stdev.
4	17,85	17,85	17,85	17,85	0,00
8	17,72	17,87	17,8	17,80	0,08
13	16,93	16,84	16,88	16,88	0,05
16	16,38	16,41	16,4	16,40	0,02
20	17,1	17,85	17,85	17,60	0,43
25	16,24	16,34	16,36	16,31	0,06
32	16,12	16,06	16,1	16,09	0,03

% Protein in medium-salted herring fillets (MS)

Week	Value 1	Value 2	Value 3	Mean	Stdev.
4	18,7	18,75	18,77	18,74	0,04
8	17,72	17,73	17,65	17,70	0,04
13	17,68	17,59	17,58	17,62	0,06
16	17,72	17,6	17,6	17,64	0,07
20	17,9	17,85	17,85	17,87	0,03
25	17,21	17,24	17,2	17,22	0,02
32	17,27	17,34	17,2	17,27	0,07

Table 3. Protein, water and salt content in herring muscle - cont'd

% Protein in heavily-salted herring fillets (HS)

Week	Value 1	Value 2	Value 3	Mean	Stdev.
4	20,6	20,65	20,55	20,60	0,05
8	20,07	20,08	20,1	20,08	0,02
13	19,7	19,88	19,81	19,80	0,09
16	19,88	19,85	19,86	19,86	0,02
20	19,83	19,89	19,83	19,85	0,03
25	19,33	19,36	19,3	19,33	0,03
32	19,72	19,56	19,65	19,64	0,08

% Water in spice-salted herring fillets (KS)

Week	Value 1	Value 2	Value 3	KS	Stdev.
4	50,74	50,8	50,75	50,76	0,03
8	52,29	52,28	52,34	52,30	0,03
13	52,97	53,29	53,14	53,13	0,16
16	52,83	52,8	52,75	52,79	0,04
20	54,19	54,12	54,34	54,22	0,11
25	53,81	53,93	53,89	53,88	0,06
32	53,56	53,26	53,38	53,40	0,15

% Water in light-salted herring fillets (LS)

Week	Value 1	Value 2	Value 3	LS	Stdev.
4	57,21	57,24	57,24	57,23	0,02
8	58,08	58,02	58	58,03	0,04
13	59,49	59,56	59,49	59,51	0,04
16	59,05	59,01	59,07	59,04	0,03
20	57,94	58,06	57,94	57,98	0,07
25	58,04	58,29	58,06	58,13	0,14
32	60,58	60,41	60,33	60,44	0,13

% Water in medium-salted herring fillets (MS)

Week	Value 1	Value 2	Value 3	MS	Stdev.
4	52,44	52,4	52,82	52,55	0,23
8	56,64	56,69	56,53	56,62	0,08
13	56,24	56,29	56,31	56,28	0,04
16	56,81	56,7	56,63	56,71	0,09
20	56	56,12	55,9	56,01	0,11
25	55,15	55,04	55,18	55,12	0,07
32	57,09	57,13	56,75	56,99	0,21

Table 3. Protein, water and salt content in herring muscle - cont'd

% Water in heavily-salted herring fillets (HS)

Week	Value 1	Value 2	Value 3	HS	Stdev.
4	48,44	48,32	48,5	48,42	0,09
8	48,87	48,85	48,84	48,85	0,02
13	48,31	48,28	48,32	48,30	0,02
16	49,06	49,15	49,07	49,09	0,05
20	47,34	47,34	47,27	47,32	0,04
25	48,16	48,1	48,33	48,20	0,12
32	49,17	49,05	48,88	49,03	0,15

% Salt in spice-salted herring fillets (KS)

Week	Value 1	Value 2	Value 3	KS	Stdev.
4	11,66	11,65	11,62	11,64	0,02
8	11,54	11,29	11,35	11,39	0,13
13	11,75	11,66	11,63	11,68	0,06
16	11,89	11,89	11,88	11,89	0,01
20	12,33	12,33	12,19	12,28	0,08
25	12,16	12	12,18	12,11	0,10
32	11,9	11,89	11,88	11,89	0,01

% Salt in lightly-salted herring fillets (LS)

Week	Value 1	Value 2	Value 3	LS	Stdev.
4	11,98	11,92	11,98	11,96	0,03
8	11,77	11,66	11,89	11,77	0,12
13	11	10,99	10,99	10,99	0,01
16	11,39	11,39	11,39	11,39	0,00
20	11,72	11,72	11,68	11,71	0,02
25	11,36	11,34	11,34	11,35	0,01
32	11,49	11,47	11,48	11,48	0,01

% Salt in medium-salted herring fillets (MS)

Week	Value 1	Value 2	Value 3	MS	Stdev.
4	13,4	13,43	13,47	13,43	0,04
8	12,68	12,6	12,61	12,63	0,04
13	13,23	13,35	13,24	13,27	0,07
16	13,27	13,29	13,28	13,28	0,01
20	13,69	13,72	13,69	13,70	0,02
25	13,1	13,12	13,1	13,11	0,01
32	13,41	13,4	13,41	13,41	0,01

Table 3. Protein, water and salt content in herring muscle - cont'd

% Salt content in heavily-salted herring fillets (HS)

Week	Value 1	Value 2	Value 3	HS	Stdev.
4	14,94	15,12	15,33	15,13	0,20
8	16,41	16,15	16,23	16,26	0,13
13	16,25	16,23	16,33	16,27	0,05
16	15,99	16,03	16,03	16,02	0,02
20	16,22	16,23	16,24	16,23	0,01
25	15,54	15,57	15,61	15,57	0,04
32	15,7	15,72	15,7	15,71	0,01

Table 4. TCA soluble protein content (%) in herring muscle

% TCA protein content in spice-salted herring (KS)

Week	Value 1	Value 2	Value 3	KS	Stdev.
4	0,61	0,63	0,62	0,62	0,01
8	0,92	0,92	0,92	0,92	0,00
13	0,96	0,96	0,96	0,96	0,00
16	0,96	0,99	0,96	0,97	0,02
20	1,14	1,14	1,14	1,14	0,00
25	1,05	1,05	1,05	1,05	0,00
32	1,36	1,36	1,36	1,36	0,00

% TCA protein content in lightly-salted herring fillets (LS)

Week	Value 1	Value 2	Value 3	LS	Stdev.
4	0,68	0,66	0,66	0,67	0,01
8	0,7	0,7	0,7	0,70	0,00
13	1,18	1,18	1,18	1,18	0,00
16	1,31	1,31	1,31	1,31	0,00
20	1,45	1,45	1,45	1,45	0,00
25	1,35	1,35	1,35	1,35	0,00
32	2,01	2,01	2,01	2,01	0,00

% TCA protein content in medium-salted herring fillets (MS)

Week	Value 1	Value 2	Value 3	MS	Stdev.
4	0,61	0,61	0,62	0,61	0,01
8	0,83	0,83	0,83	0,83	0,00
13	1,09	1,07	1,07	1,08	0,01
16	1,05	1,05	1,05	1,05	0,00
20	1,09	1,09	1,09	1,09	0,00
25	1,14	1,12	1,12	1,13	0,01
32	1,62	1,62	1,62	1,62	0,00

Table 4. TCA soluble protein content (%) in herring muscle - cont'd

% TCA protein content in heavily-salted herring fillets (HS)

Week	Value 1	Value 2	Value 3	HS	Stdev.
4	0,65	0,65	0,65	0,65	0,00
8	0,74	0,74	0,74	0,74	0,00
13	0,83	0,83	0,81	0,82	0,01
16	0,75	0,78	0,75	0,76	0,02
20	0,74	0,74	0,74	0,74	0,00
25	0,78	0,77	0,78	0,78	0,01
32	0,96	0,96	0,96	0,96	0,00