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Desalting of tails and loins of dried salt-cured saith by cooking

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Report

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Summary/recommendation:

Before preparation of a meal from the dried salt-cured fish, reducing the salt content by soaking the fish into water is commonly applied. In Jamaica and in the Dominican Republic, however, the salt content is reduced by cooking before further preparation and consumption. Despite long traditions for such a pre-treatment, descriptions on how cooking influences the salt content has to our knowledge, not been published. Thus, the aim of this work was to obtain knowledge on issues influencing the salt content in pieces of dried salt-cured saith when applying cooking as a method of desalting.
Loins and tails of dried salt-cured saith were either rinsed in two minutes or rehydrated in cold water for two hours before cooking. After reaching 100 °C of the cooking water, the water was drained away, i.e., the cooking time was 0 min. In this experiment, the salt content in the tails were lower compared to the loins after each cooking session. Furthermore, the effect of rehydration in 2 hours was more distinct for the loins than for the tails, i.e., a lower salt content was obtained in loins being rehydrated for 2 hours than for those being rinsed for 2 min. The effect of prolonging the cooking time from 0 to 2 and 3 minutes was also studied. Pieces of tails were rinsed in 2 min prior to cooking. When compared to a cooking time of 0 min, the rate of salt loss did not increase with a cooking time of 2 or 3 min. Irrespective of tails or loins or pre-treatment before cooking, the final salt content of 5 to 6% was obtained. It is emphasized that smaller pieces or a rehydration in water over night would most probably result in a lower salt content of the cooked fish.

Summary/recommendation in Norwegian:

Det er undersøkt hvordan saltinnholdet i klippfisk av sei reduseres ved koking. Tradisjonell metode er å redusere saltinnholdet i klippfisk ved utvanning, mens i Jamaica og i den Dominikanske Republikk kokes saltet ut i stedet. Spord og loins stykker av klippfisk sei ble kokt i vann, og i forkant ble fisken enten skylt i vann i 2 minutter, eller lagt i vann i 2 timer. Koketider på 0, 2, og 3 minutter ble testet ut, og det ble tatt ut prøver for salt og vann analyse etter hver koking. I forsøk med en koketid på 0 minutter, var saltinnholdet i spord stykkene lavere sammenlignet med loins stykkene. Forbehandlingen, 2 minutter eller 2 timer utvanning, hadde størst betydning for loins, dvs 2 timer utvanning før koking, resulterte i det laveset saltinnholdet. Koketider på 2 og 3 minutter resultert ikke i et lavere saltinnhold i spord stykkene som ble testet ut. Uavhengig av om det var spord eller loins stykker, eller forbehandling før koking, var saltinnholdet i fra 5 til 6%. Det antas at dersom bitene hadde vært mindre, eller om bitene hadde vært vannet ut over natt før koking, hadde saltinnholdet vært lavere.

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1 Introduction

Dried salt-cured whitefish (also known as "clip fish" due to the outdoor locations where the fish was dried in earlier days) is a highly appreciated raw material for various dishes due to its delicate taste and storage stability. The product is primarily produced in Norway and Portugal, and is exported and consumed in Southern Europe, Angola, Congo, Brazil, and the Caribbean. A variety of cold-water species like Atlantic cod (*Gadus morhua* L.), Pacific cod (*Gadus macrocephalus*), ling (*Molva molva*), tusk (*Brosme brosme*), saithe (*Pollachius virens*), and haddock (*Melanogrammus aeglefinus*) are mostly used. These species are caught in the North Atlantic, North Pacific, North Sea, and the Barents Sea. This product's export volume was 91 587 and 91 795 tons in 2018 and 2019, respectively. The corresponding export value amounted to NOK (Norwegian Kroner) 4.2 and 4.7 billion in 2018 and 2019, respectively (Norwegian Seafood Council, 2020).

Before further preparation and consumption, the level of salt has to be reduced from approximately 15-21% to about 2-3%. Traditionally this is performed by soaking of the fish in chilled water for 24-48 h. The rehydration has usually been carried out in private households, but for convenience reasons, industrial rehydration has become common in some countries, for instance, in Portugal.

An alternative to rehydration in chilled water is cooking. Cooking is commonly applied in Jamaica and in the Dominican Republic. In 2018 and 2019, the export volume of dried salt-cured products to Jamaica were 5 169 and 5 850 tons, while corresponding export volume to the Dominican Republic were 13 353 and 13 282 tons (Norwegian Seafood Council, 2020). The final cooked product is crumbled into mince, and this mince is typically mixed with vegetables, oil, and herbs, as shown below (Figure 1).

Figure 1 Jamaican style saltfish (Photo: G. Lorentzen, Nofima) (Receipe available at https://www.youtube.com/watch?v=Rr2rg3QWb5o)

Today, there is limited information on how cooking influences the rate of salt decrease. Thus, on behalf of the Norwegian Seafood Council - Brasil, Nofima has carried out a small-scale experiment to obtain basic knowledge on issues related to loss of salt in a cooking process. Although the salt content has been focused, analyses of volume applying 3D-imaging and water content, have also been included. In traditional desalting by rehydration in water, the fish's volume influences the rate of salt decrease, and it is hypothesized that volume is also relevant when applying cooking as a desalting method. During desalting, the salt content decreases, and the water content in the fish increases. Thus, analyses of water content were also included in this study.

The experiments were performed at Nofima, Tromsø, in September 2020.

2 Material and methods

2.1 Raw material and drying process

Split salted saithe from Torsvågbruket AS, Vannøya, northern Norway, was purchased on the 21st of August 2020. Upon arrival at Nofima, Tromsø, excessive salt was removed by tossing two and two fishes against each other. Afterward, the fish were labeled individually, weighted, and put into a drying cabinet to produce dried salt-cured saith. The weight of the fish ranged from 814 to 1210 g.

To obtain a dried salt-cured product, a weight reduction of approximately 19% was aimed. This was obtained by drying the fish up to 212 hours at ambient temperature. The final water content was measured applying a cross-section method of two selected fish (Codex, 2005).

The temperature and humidity in the drying cabinet were logged during the drying process by using K-type thermocouples connected to data loggers (model 175H1, Testo Ltd., Hampshire, UK). Also, the temperature in the product's muscle was logged during the drying and in selected cooking sessions.

2.2 Preparation before cooking

Applying a band saw, the split dried and salt-cured saith was cut. In the front, the thicker pieces (i.e., the loins) were separated from the thinner tail parts in the rear. The pattern for cutting is illustrated in Figure 2.

Figure 2 Pattern for cutting the split dried salt-cured saith into loins and tails (Photo: G. Lorentzen, Nofima).

The pieces used in the experiment were loins and tails as shown in Figure 3.

Figure 3 After the final cutting, the four loins pieces located to the left and four tail pieces located to the right (Photo: G. Lorentzen, Nofima).

Average width, length, and height of the loins were 6,01 (± 0,42), 6,43 (± 0,58), and 2,00 (± 0,23) cm, while the corresponding values for the tails were 6,27 (± 0,52), 6,22 (± 0,65), and 1,55 (± 0,14) cm, respectively.

Afterward, the pieces were labeled using T-bar tags (Floy tag, Inc., Seattle, WA, USA), enabling us to keep track of the samples through the subsequent experiments. Finally, the weight of each piece was recorded.

2.3 Measurement of volume applying 3D imaging

In addition to the weight, we estimated the volume of each sample applying 3D (Lorentzen, Ageeva, & Heia, 2021). In traditional rehydration with soaking the dried salt-cured fish into the water, the rate of transport of salt out of the fish depends on the distance from the core to the surface. Thus, information about the volume is essential. In case of cooking, it is hypotheseized that the rate of salt out of the fish also depends on the distance from the core to the surface. Hence, the volume was measured before the cooking.

To measure the fish samples' volume, 3D imaging was performed using a Gocator 2370 camera (LMI Technologies BV, Kerkrade, The Netherlands). The camera was mounted 53 cm above a flat conveyor belt, with the laser line pointing downwards perpendicular to the conveyor belt, and the camera looking down at an angle relative to the laser line (Figure 4). The image resolution was 0.3, 0.5, and 0.0022 mm across the belt (x), along the belt (y), and in the vertical (z) directions, respectively.

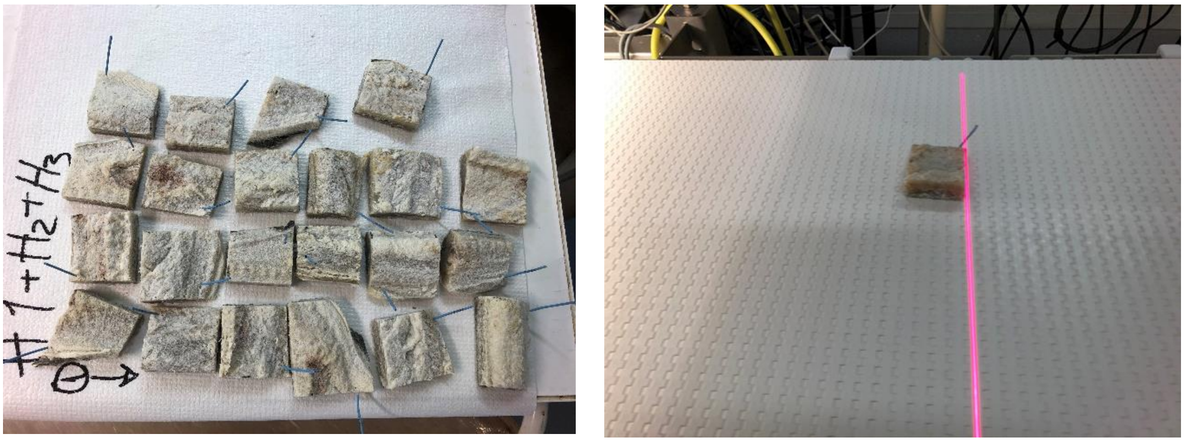

Figure 4 *Labelled samples prepared for 3D imaging (left) and 3D imaging on a conveyor belt (right) (Photos: G. Lorentzen, Nofima).*

2.4 Rinsing and rehydration

Before cooking, the tails and loins were either rinsed in two minutes in cold tap water or rehydrated for two hours in cold tap water with a water and product weight ratio of 9:1 (Figure 5). A strainer basket was used for the rinsing. During the rehydration, the water temperature was kept at a maximum of 4 °C. The tails and loins were distributed on a grate, placed 2 cm above the bottom of a box, that allowed the salt to drain below the fish.

Figure 5 *Rinsing in tap water in 2 minutes (left), and rehydration by soaking the fish into fresh cold water (right) (Photo: G. Lorentzen, Nofima).*

2.5 Experimental setup

In total, six cooking experiments were performed. During the first four experiments, three cooking sessions were performed. After each cooking session, the water was drained away, and two to four pieces were withdrawn for analyses. Afterward, fresh cold water was added to the remaining pieces for the next cooking session at a 1:9 product weight and water ratio. This procedure was repeated in all cooking sessions.

The cooking was terminated as soon the water temperature reached 100 °C. In the next two cooking experiments (experiment no. 5 and 6), the effect of a water temperature of 100 °C for 2 and 3 min was explored, i.e., a cooking time of 2 and 3 minutes. In these experiments, four cooking sessions were performed. An overview of the experiments performed is presented in Table 1.

Table 1 Experimental setup for experiments with cooking of dried salt-cured tails and loins of saith.

Exp. no	Piece of the fish	Desalting before cooking	Cooking sessions/minutes in boiling water
1	Tails	2 min rinsing	3/0
2	Tails	2 hours rehydration	3/0
3	Loins	2 min rinsing	3/0
4	Loins	2 hours rehydration	3/0
5	Tails	2 min rinsing	4/2
6	Tails	2 min rinsing	4/3

After each cooking session, the withdrawn fish pieces were analyzed for salt and water content.

2.6 Salt- and water content of the products

The salt content was determined after homogenization of the sample, and the analyses were performed according to Volhard method (AOAC, 1995). The water content was measured by oven drying of a homogenate sample after 105 °C for 16 h (Cohen, 1971). After the oven drying, the samples were put in an oven at 570 °C overnight to obtain ash (AOAC, 2005). The ash weight relative to the initial weight was calculated and used as an approximate for the salt content.

All analytical determinations were performed in two to four samples.

2.7 Statistical analysis

Experiments 1 to 4 were performed in duplicate, i.e., two casseroles, and the results presented are the average with a standard deviation. In experiments 5 and 6, only one casserole was used.

The data generated in the experiments 1 to 4 were analyzed using Unscrambler (Version 10.3, CAMO Process AS, Oslo, Norway). Principal Component Analysis (PCA) was used to identify any differentiations in the data due to the use of various desalting regimens of different fish pieces (loins and tails). Prior to the analyses, the variables were weighted by 1/STDEV to standardize the data.

3 Results and discussion

3.1 Drying of salted saith

Upon arrival, the fish was dried in a cabinet at Nofima. The profile for relative humidity (%RH), and the temperature in the cabinet is presented in Figure 6A.The temperature profile of two selected fish for the same period is presented in Figure 6B.

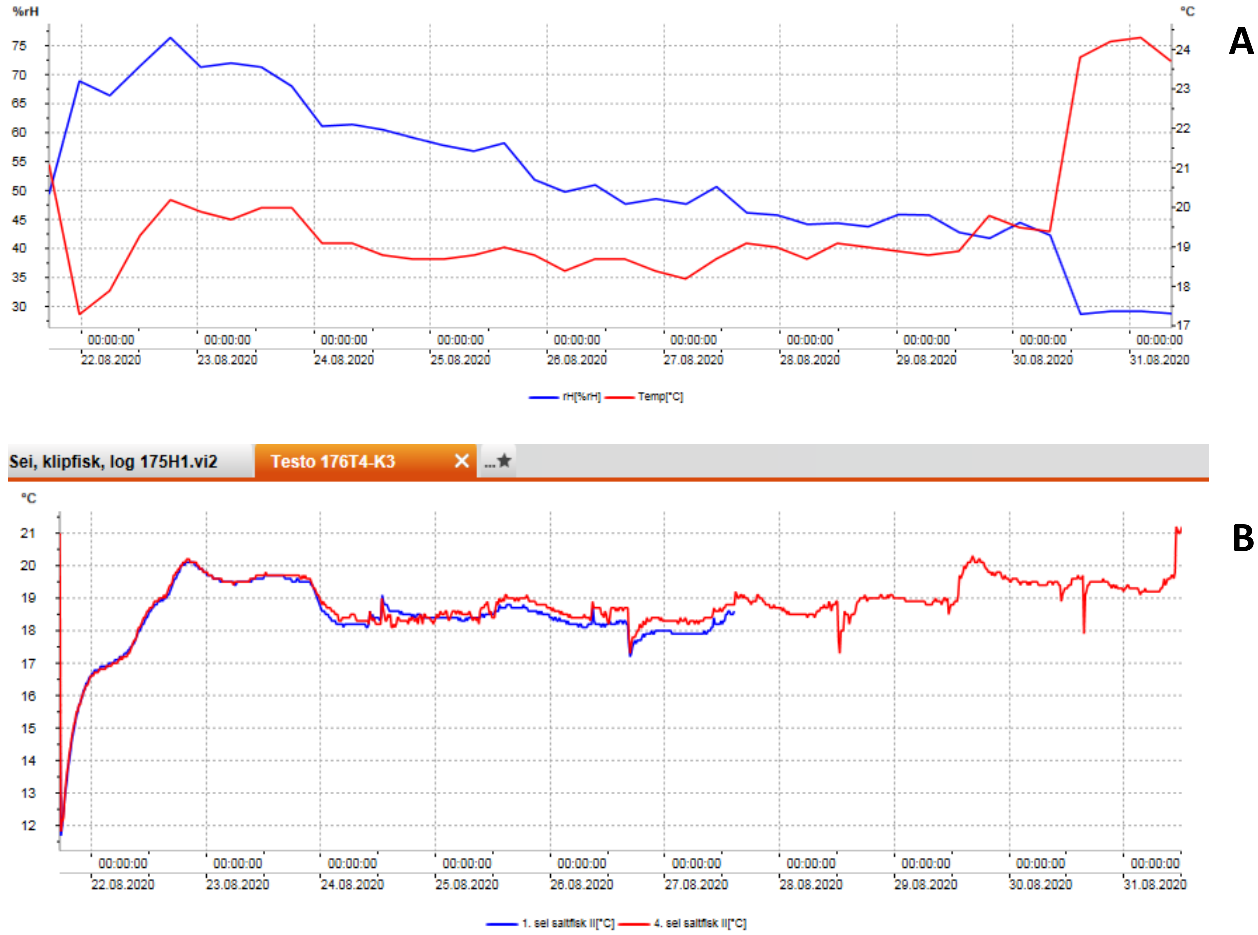

Figure 6 Profile of relative humidity (%RH) and temperature (°C) in the cabinet during the drying process (A), and temperature (°C) in two selected fish during the same period (B).

3.2 Salt and water content of dried salt-cured saith

After applying the cross-section method, the average salt and water content of the fish used in the experiments were 18,44 (± 2,16)% and 48,25 (± 2,15)%, respectively.

3.3 Weight, volume, and temperature profiles

Before the cooking started, the average weight, including the standard deviation of the tails and loins used in the experiments (exp. no. 1–6), were 59,59 (± 11,57) and 70,03 (± 11,31) g, respectively. The tails’ and loins' average volume were 62,25 (± 11,91) and 73,66 (± 15,30) cm^3, respectively.

After rinsing in 2 minutes, the weight changes for the tails and loins were 0,88 (± 1,18) and 0,59 (± 1,06)%, respectively. After 2 hours of rehydration by soaking the fish into the water, the corresponding weight changes were 4,59 (± 1,83) and 4,41 (± 1,23)%. This shows that despite the initial weight and volume differences between the tails and loins, the following weight changes were not coherent with the products' origin, but rather the pre-treatment, i.e., whether the fish was rinsed in two minutes or rehydrated in 2 hours.

In the initial experiments (Table 1, exp. no. 1–4), the temperature profile in the cooking water, and the core in one selected loin was recorded during the first and second cooking session (Figure 7).

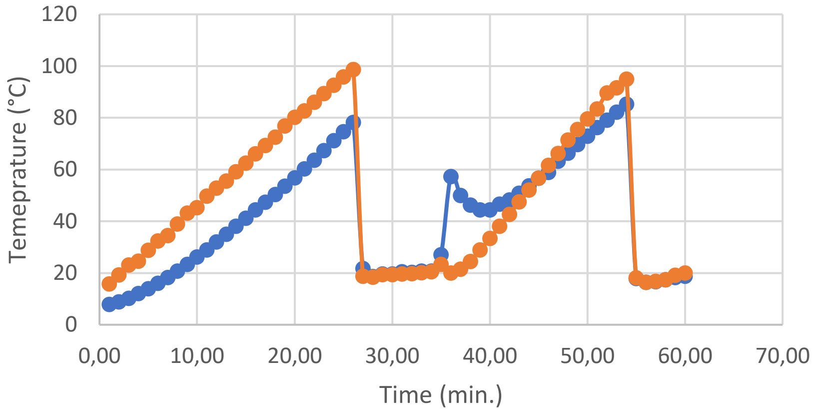

Figure 7 *Temperature profile in cooking water (orange) and inside a loin (blue) during the first and second cooking session.*

In the first cooking session, the temperature difference between the water and core of the loins was about 20 °C, while in the second cooking session, the corresponding difference was less, only about 10 °C. The logging of temperature was repeated in the subsequent cooking sessions with tails as well, and the temperature pattern in these cooking sessions was comparable to those presented in Figure 7.

In experiments 5 and 6, the core temperature of the tails reached about 96–99 °C. After reaching a water temperature of 100 °C, a stopwatch was used to control a cooking time of 2 and 3 min.

Before each cooking session, the remaining pieces' weight was recorded, and fresh cold water was added at a product and water weight ratio of 1:9 (Figure 8). Due to fewer products in the consecutive cooking sessions, the amount of added water became less and less. Because of this, the time reaching a water temperature of 100 °C became shorter and shorter in the subsequent cooking sessions.

Figure 8 Cooking of dried salt-cured saith in a product to water ratio of 1:9 (Photo: G. Lorentzen, Nofima).

After cooking, the pieces of fish were cooled down on a plate before further analyses (Figure 9). Although being exposed to cooking up to four times, the pieces of the fish did not fall apart.

Figure 9 Cooked tails and loins of dried salt-cured saith (Photo: G. Lorentzen, Nofima).

3.4 Salt content, experiments 1 to 4

The average salt content in tails and loins from the experiments 1 to 4 is presented in Figure 10.

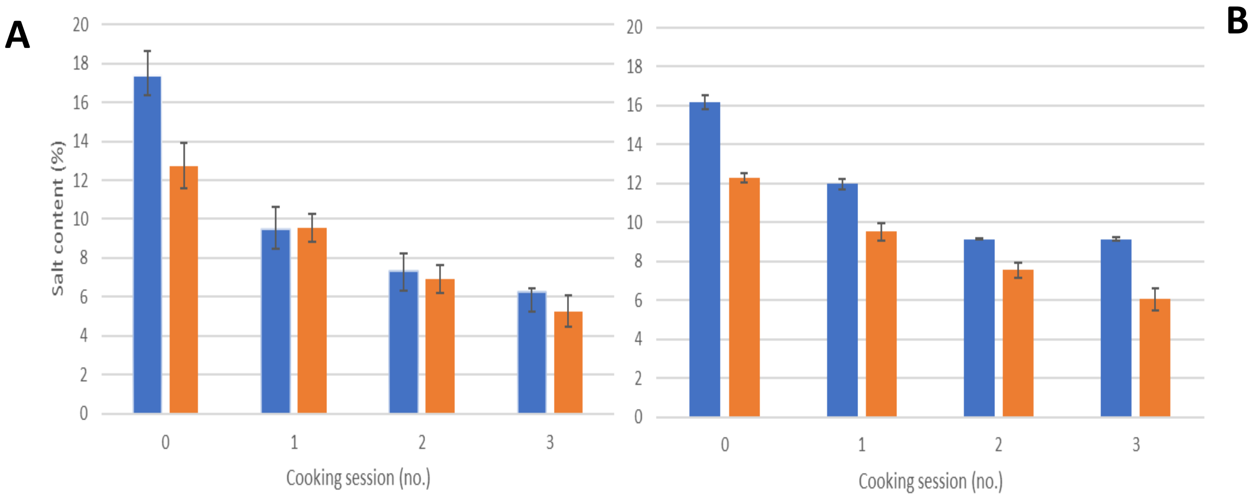

Figure 10 Salt content (%) in tails (A) and in loins (B). Pieces rinsed in 2 minutes (blue columns) and rehydrated for 2 hours (orange columns) before cooking, in total, three cooking sessions. The standard deviation is illustrated with vertical bars.

For both tails and loins, the rehydration for 2 hours resulted in about 4% lower salt content when compared to the pieces being rinsed in fresh tap water for two minutes (cooking session 0). After cooking session no. 1 for the tails, the effect of rehydration for two hours became less distinct when comparing with the 2 min rinsing in the following cooking sessions (Figure 10, A). On the contrary, the 2 hour rehydrated loins obtained a lower salt content as compared to those being rinsed for 2 min, and this pattern repeated after each cooking session (Figure 10, B). This shows that the ability to lose salt during the cooking varies whether it is a tail or a loin, and this is assumed to be coherent with the differences in the weight and volume of the tails and loins (Figure 3). Thus, these factors play a role in the ability in losing salt during cooking.

Salt content in the range of 5 to 6% after the third cooking session is assumed to be a bit high when compared to traditional rehydration of such products. For instance, after traditional rehydration in water in 48 h at 4 °C, the salt content is in the range from 2 to 3% (Lorentzen, Olsen, Bjørkevoll, Mikkelsen, & Skjerdal, 2010). These fish products are, however, intact after the following heat treatment, and it is served as a whole piece. This product is often used as the main ingredient in bacalao dishes served in Brazil, in southern Europe, and Norway. In Jamaica and in the Dominican Republic, however, the cooked fish is usually disintegrated into a mince and mixed with other ingredients, as illustrated in Figure 1. Other areas of application of the cooked disintegrated fish are in stews, salads, and pies. The differences in the type of product and application are assumed to allow a higher salt content of the cooked disintegrated fish and still not being perceived as too salt.

In case the salt content still is perceived to be too high, prolonged rehydration (i.e., overnight) would most probably ensure a lower salt content after the cooking. As an alternative to prolonged rehydration, cutting the split fish into smaller pieces in advance would most probably ensure a lower salt content of the final cooked fish product as the loss of salt is coherent with the volume.

The standard deviation expresses the variance of the salt content among the samples analyzed after each cooking session. The standard deviation among the tails were higher when compared to the corresponding loins. This can be explained by a more significant variation in the shape of the tails than of the loins (Figure 3).

As a control, tails and loins were rehydrated, applying the traditional method of soaking the fish in freshwater in 48 h. The salt and water content of the tails and loins on average were 3,52 (± 0,37) and 73,63 (± 1,41)%, respectively. All data generated in experiments no.1 to 4 are included in Appendix 1.

3.5 Salt content, experiments 5 and 6

As the salt content was relatively high after three cooking sessions when compared to the salt content obtained after traditional desalting (Figure 10), we studied if a prolonged time of cooking could influence the salt content. Thus, in the following cooking study, a cooking time of 2 and 3 minutes was applied. Also, we explored if one additional cooking session, i.e., in total, 4 cooking sessions, would influence the final salt content. The results are presented in Figure 11.

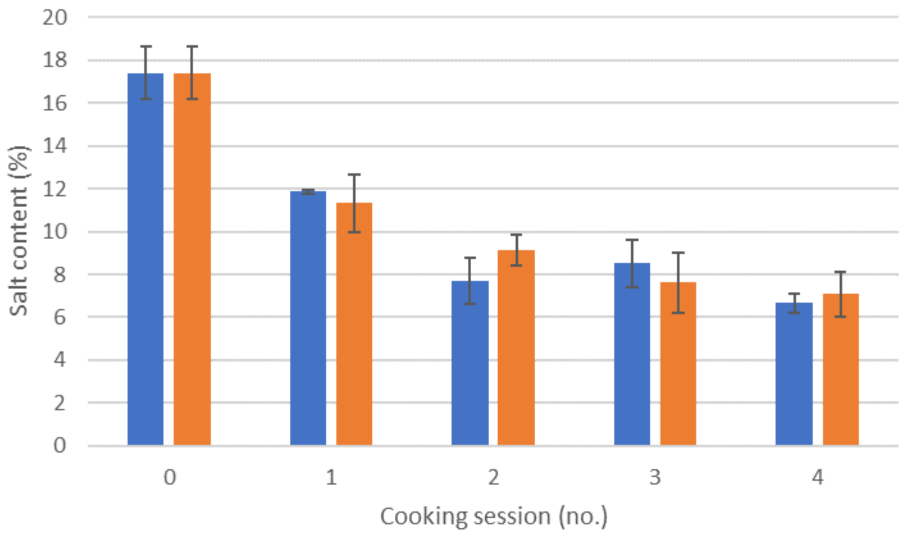

Figure 11 Salt content in tails cooked for two (blue columns) and three (orange columns) minutes in each cooking session. In advance, the fish were rinsed for two minutes in fresh tap water (cooking session no. 0). The standard deviation is illustrated with vertical bars.

Figure 11 shows a limited benefit in terms of reduced salt content by cooking the products after reaching the boiling point. The benefit of prolonging the cooking time from two to three minutes is also limited. When comparing the salt content in tails being rinsed 2 min before cooking (Figure 10, A), the average salt content is slightly higher after a cooking time of both 2 and 3 min (Figure 11). The rationale for this is not known. The best effect of cooking appears to be already after the second cooking session, making the subsequent cooking sessions minor effective in terms of obtaining a lower salt content.

In this study, the weight change was measured after each cooking session relative to the weight before the cooking. Irrespective of cooking time and number of cooking sessions, the average weight loss was in the range of 13 to 17%. Parallel to this, the water content of the fish increased after each cooking session, starting with 48% and ending with 56% (Appendix 2).

All data generated in experiments 5 and 6 are included in Appendix 2.

3.6 Considerations of the primary effects

To obtain an overview of the results generated from the experiments 1 to 4, the data were subjected to a principal component analysis (PCA) (Figure 12). The variables used in the PCA included weight, weight change, volume, salt-, and water content.

The correlation loading plot (Figure 12 A) and score plots (Figure 12 B-D) illustrate that the first and the second principal components (PC-1 and PC-2) cumulatively accounted for 81% of the data variance. Along PC-1, 55% of the data variance was explained, while along PC-2, 26% of the data variance was explained.

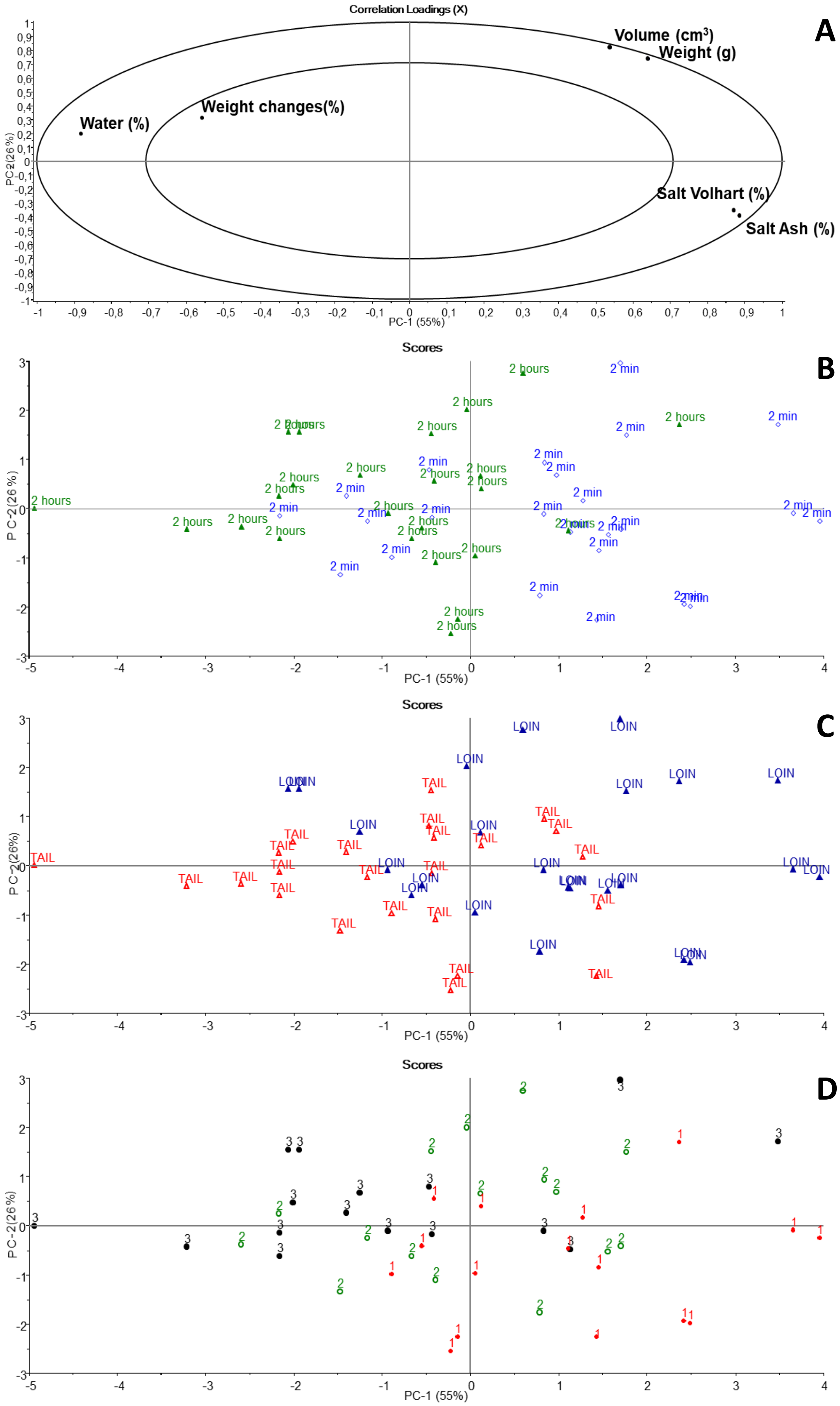

Figure 12 Loading plot (A) and score plot with observations grouped by the preparation of the samples before the cooking, 2 hours rehydration and 2 min rinsing (B), tails and loins (C), and cooking session (D). The outer and inner ellipse indicate 100 and 50% explained variance, respectively (A).

The salt content correlated negatively with the water content of the fish product. This implies that a higher salt content was coherent with lower water content, and *vice versa*. The methods used in determining the salt content, Volhard's and the oven method resulting in ash, correlated positively. This shows that these two methods can be replaced by each other. However, removal of skin and bone from the muscle before the ash analysis is required.

There was a positive correlation between volume and weight of the samples, which was expected as the heavier sample the higher volume. The weight change did not contain enough structured variation to be included in the result evaluation. In other words, the effect of the weight change on the outcome was less than 50% (i.e., located inside the inner 50% ellipse).

In the score plots (Figure 12 B – D), the different groupings of the observations are illustrated. There is a tendency of a grouping between the products dependent on being rinsed for 2 min or being rehydrated for 2 hours before cooking (Figure 12 B). When analyzing the Correlation Loadings - and Scores plots together (Figure 12 A and B), one can see that the variables Salt Volhart (%) and Salt Ash (%), and most of the 2 min rinsed samples were to the right in both plots. At the same time, the variables Salt Volhart (%) and Salt Ash (%) correlated negatively to the Water (%) by being located to the right and left, respectively. It means that the samples rinsed for 2 min obtained higher salt concentration and lower water content compared to the samples being rehydrated in 2 hours. In other words, 2 hours of rehydration resulted in a higher water- and lower salt content when compared to the fish being rinsed for 2 min.

According to Figure 12 C, there is a slight grouping differing the loins and tails. The loins are grouped to the right, while the tails are grouped to the left in the plot. This coincides with the location of the variables Weight (g), Volume (cm^3), Salt Volharts (%), and Salt Ash (%) in the Correlation Loading plot (Figure 12 A). This reflects the differences in the products size and salt content, as the loins were heavier with a higher volume, and also had higher salt content than the tails. In contrast, the tails located to the left in the score plot obtained a higher water content than loins.

In the third score plot, the distribution in samples in relation to the cooking sessions (from 1 to 3) is illustrated (Figure 12 D). Most observations for cooking session 1 are located to the lower right in the Score plot, while cooking sessions 2 and 3 distributed successively in diagonal to the left in the plot. The distribution of cooking session 1 coincides with the location of the variables Salt Volharts (%) and Salt Ash (%) in the Correlation Loading plot (Figure 12A). This implies that those samples had highest salt content as they were cooked only once. Subsequently, the water content and salt content increased and decreased, respectively in the subsequent cooking sessions 2 and 3.

4 Conclusion

Dried salt-cured saith was cooked as an alternative to the traditional rehydration in cold water. The split fish was cut in loins and tails, and the weight and volume of each piece were recorded.

Before the cooking, the pieces were either rinsed for 2 min in cold tap water or rehydrated in water for 2 hours. The difference and effect of these two methods were observed immediately, i.e., before the cooking started. After each cooking session, the differences between these two methods were minor for the tails, while a more distinct effect of the methods was observed for the loins. After each cooking session of the loins, rehydration for 2 hours implied a lower salt content compared to the corresponding 2 min rinsing. After three cooking sessions, the salt content was on average app. 6 and 5% for tails being rinsed in 2 minutes and rehydrated for 2 hours respectively. Corresponding average salt content for the loins were 9 and 6%.

After each cooking session, the salt content was lower for the tails than for the loins, showing that the volume and weight influenced the rate of salt loss during the cooking. Thus, there is a coherence between the decrease in salt content and the volume of the fish product. This is comparable to what is observed during the traditional method for desalting when applying soaking in water for 36 to 48 hours.

The benefit of cooking the fish after reaching the boiling point was limited in terms of reducing the salt content. Prolonged cooking time from two to three minutes did not influence the decrease in salt content either. After the fourth cooking session, the average salt content in tails after cooking in 2 and 3 minutes were 6,4 and 7%, respectively.

In this study, several parameters such as drying of the salt-cured fish (water content), size of the products, pre-treatment before cooking, water and product weight ratio during cooking, number of cooking sessions, and cooking time had to be selected and defined before the experiments started. The rationale for the definition of the parameters and corresponding intervals (i.e., min. and max. weight, min. and max. volume, min. and max. cooking time, etc.) was uncertain. When interpreting the results presented in this report, the parameters and corresponding intervals applied should, therefore, be taken into consideration. For instance, prolonged time for rehydration in water or cutting the fish into smaller pieces would most probably result in lower salt content of the cooked fish.

Acknowledgment

We want to thank Tonny Enoksen, Nofima for valuable help in performing the experiments.

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Appendix

Appendix 1 - Raw data obtained in experiments no. 1 to 4.

ID	BIT	VEKT	UTVANNI	Oppkokin	VEKT END	Volume [	SALT VOLH	SALT ASKE	VANN (%)
62995	HALE	59,76	48 tm	0	24,43		3,09	3,45	73,36
60623	HALE	58,33	48 tm	0	18,74		3,67	4,09	71,83
2167	HALE	59,6	48 tm	0	20,91		3,39	3,74	75,19
1356	HALE	48	2 min	0	3,58	49,13	16,13	16,59	50,95
1354	HALE	51,2	2 min	0	-0,12	54,14	17,45	17,54	51,76
2158	HALE	72,1	2 min	0	0,76	70,42	18,58	18,69	54,49
2170	HALE	48,88	2 min	1	0,96	54,72	10,24	11,48	51,64
1360	HALE	67,09	2 min	1	1,42	65,42	10,35	11,5	55,5
2172	HALE	45,69	2 min	1	3,20	62,52	8,14	9,05	57,97
1358	HALE	74,32	2 min	1	1,04	74,25	9,17	9,89	54,95
2156	HALE	73,46	2 min	2	2,08	80,34	8,26	9,23	54,19
2175	HALE	75,95	2 min	2	0,51	82,88	7,71	8,4	54,96
2161	HALE	57,8	2 min	2	1,30	60,97	6,62	7,15	57,91
1352	HALE	50,15	2 min	2	-1,48	49,72	6,80	7,62	60,51
2160	HALE	62,11	2 min	3	1,01	62,12	6,20	7,56	54,37
2173	HALE	63,14	2 min	3	0,40	64,93	5,95	6,86	60,05
1353	HALE	54,12	2 min	3	1,42	59,99	5,84	6,61	61,34
1361	HALE	73,72	2 min	3	0,15	73,11	6,96	7,46	59,42
1369	HALE	62,23	2 tm	0	7,68	67,6	12,68	13,25	63,14
1368	HALE	74,25	2 tm	0	5,68	75,79	11,61	13,02	57,55
2163	HALE	69,35	2 tm	0	2,60	67,28	13,94	14,63	59,35
2017	HALE	70,81	2 tm	1	5,58	70,39	9,27	10,1	57,94
2018	HALE	69,68	2 tm	1	5,22	71,03	8,77	9,42	59,69
1362	HALE	43,35	2 tm	1	2,19	43,13	10,15	10,91	57,72
1372	HALE	45,12	2 tm	1	3,46	44,94	9,99	10,71	56,18
1363	HALE	75,72	2 tm	2	3,23	79,11	6,07	6,96	55,71
1375	HALE	61,19	2 tm	2	5,37	56,47	6,73	7,09	60,99
1367	HALE	52,34	2 tm	2	1,24	56,97	7,94	8,47	55,72
1366	HALE	50,98	2 tm	2	6,94	50,61	6,92	7,53	60,99
2154	HALE	61,19	2 tm	3	3,28	61,77	5,33	6,28	58,98
1373	HALE	49,73	2 tm	3	3,38	52,53	6,31	6,95	59,41
2019	HALE	38,93	2 tm	3	7,89	48,13	4,01	4,64	63,97
1370	HALE	45,51	2 tm	3	6,17	48,26	5,37	6,07	59,82
60621	LOINS	80,4	48 tm	0	18,50	83,36	3,94	4,28	74,13
2169	LOINS	61,26	48 tm	0	19,03	62,31	3,45	3,75	76,24
2168	LOINS	61,79	48 tm	0	25,89	59,68	2,9	3,01	77,3
2081	LOINS	67,69	2 min	0	-0,13		16,42	17,41	57,32
2082	LOINS	58,56	2 min	0	-3,42		15,77	16,32	52,06
2083	LOINS	59,87	2 min	0	-2,36		16,33	16,63	49,62
2573	LOINS	59,94	2 min	1	-0,35	59,75	11,73	12,09	51,59
2575	LOINS	79,1	2 min	1	0,20	86,21	11,83	12,48	50,75
2152	LOINS	61,47	2 min	1	-0,08	58,49	11,35	12,5	51,94
2566	LOINS	82,6	2 min	1	0,34	84,33	12,97	13,76	52,69
2574	LOINS	55,22	2 min	2	-0,85	53,83	9,39	9,72	54,16
2563	LOINS	86,81	2 min	2	0,50	91,69	8,84	9,45	55,25
4703	LOINS	69,81	2 min	2	-0,23	69,95	9,07	9,61	51,47
2570	LOINS	68,73	2 min	2	-0,33	69,48	9,26	10,11	53,27
2564	LOINS	63,91	2 min	3	3,29	71,14	10,16	11,19	55,44
2565	LOINS	96,58	2 min	3	0,39	110	7,98	8,70	57,06
4701	LOINS	98,68	2 min	3	1,80	92,95	9,78		
2568	LOINS	67,05	2 min	3	0,39	73,02	8,65	9,23	55,22
2076	LOINS	62,4	2 tm	0	7,05		12,59	13,21	61,65
2077	LOINS	49,18	2 tm	0	6,65		12,14	12,74	62,75
2078	LOINS	55,8	2 tm	0	7,03		12,16	13,26	56,73
60617	LOINS	82,06	2 tm	1	4,14	104,19	10,52	11,03	54,05
60620	LOINS	58,59	2 tm	1	2,47	57,2	9,13	9,47	56,22
2151	LOINS	61,22	2 tm	1	4,64	58,33	8,72	8,79	57,19
313	LOINS	64,29	2 tm	1	4,81	66,92	9,68	10,62	52,33
309	LOINS	61,34	2 tm	2	2,22	54,95	8,00	8,38	57,82
60615	LOINS	77,47	2 tm	2	5,31	87,02	6,55	0	56,25
60609	LOINS	84,51	2 tm	2	6,02	103	7,99	8,42	56,21
60610	LOINS	68,03	2 tm	2	4,17	75,1	7,65	8,17	53,92
310	LOINS	65,01	2 tm	3	5,29	66,26	6,62	7,24	57,12
60607	LOINS	60,79	2 tm	3	1,92	60,08	6,30	6,98	55,59
60618	LOINS	69,37	2 tm	3	4,71	72,57	5,27	5,68	59,77
60611	LOINS	60,03	2 tm	3	5,73	84,25	6,02	6,28	60,02

Appendix 2 - Raw data obtained in experiments no. 5 and 6.

Cooking time 2 min							
ID	WEIGHT	WEIGHT Af	Weigt after cookin	Weight loss (	Cooking sess	Water conte	Salt (%)
2099	92,38	91,15	80,73	12,6109548	1	48,05	11,93
2085	69,97	69,35	59,32	15,2208089	1	51,5	11,79
2095	70,35	70,18	57,24	18,6353945	2	53,73	8,46
2088	56,92	56,91	48,08	15,5305692	2	56,3	6,95
2098	110,12	110,28	90,38	17,925899	3	54,72	9,31
2276	78,18	77,38	63,15	19,2248657	3	55,72	7,75
1624	78,67	76,35	68,82	12,5206559	4	56,48	6,95
2097	70,29	70,61	64,6	8,09503486	4	56,39	6,12
2090	64,93	63,08	52,63	18,9434776	4	56,45	6,91
Cooking time 3 min							
2096	64,5	64,13	65,67	-1,81395349	1	48,67	10,39
2093	100,21	99,68	83,55	16,6250873	1	51,65	12,27
1622	84,42	83,29	73,58	12,8405591	2	53,53	9,67
1620	88,32	86,62	69,71	21,0711051	2	52,94	8,64
2089	64,52	62,92	53,58	16,9559826	3	57	6,64
2092	92,33	92,18	77,52	16,0402903	3	54,62	8,63
1625	104,75	104,05	85,4	18,4725537	4	55,24	8,16
2091	64,53	63,27	55,1	14,6133581	4	56,67	6,09
2084	112,6	111,29	94,65	15,9413854	4	54,56	7,03

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